

# SAT<sup>®</sup> 2016

4 **DIFFICULT** MATH TESTS

## ROCK THE SAT MATH TEST

4 REALISTIC SAT MATH TESTS

232 REALISTIC QUESTIONS + FULL SOLUTIONS

COMPLETE SAT MATH TEST BREAKDOWN

METHODS AND STRATEGIES



EXAM MASTERS<sup>TS</sup>

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# Rock The SAT Math Test



## About the Math Test

In this introductory chapter, we break down the whole SAT math test and show you what it's composed of, what it tests, and how to ace it. The first thing to realize is that the SAT math test has changed its focus to mainly test students on algebra and problem-solving using real-world scenarios. The majority of it covers Basic Algebra and Advanced Algebra. Therefore, most of the concepts in these two divisions of math are fair game. And there are a lot of concepts. But, the good news is that you've already learned all or most of these concepts in school. The new SAT has really become aligned to your school curriculum. It basically covers most of Grade 11 Math and a tiny bit of Grade 12 Math. Here are the main sections on the SAT math test:

Math Topic	Main Focus	# of Questions	% of Total
<b>Heart of Algebra</b>	mastery of linear equations and systems	19 Questions	32.76 %
<b>Problem Solving and Data Analysis</b>	being quantitatively literate	17 Questions	29.31 %
<b>Passport to Advanced Math</b>	manipulation of complex equations	16 Questions	27.59 %
<b>Additional Topics</b>	understanding of rarer math concepts	6 Questions	10.34 %

From this table, we can see that the additional topics only make up for 10.34% and the rest of the topics account for 89.66% of the total questions in the math section. This is very key for us to know, as it will guide our strategy for the math section (which we will discuss later).

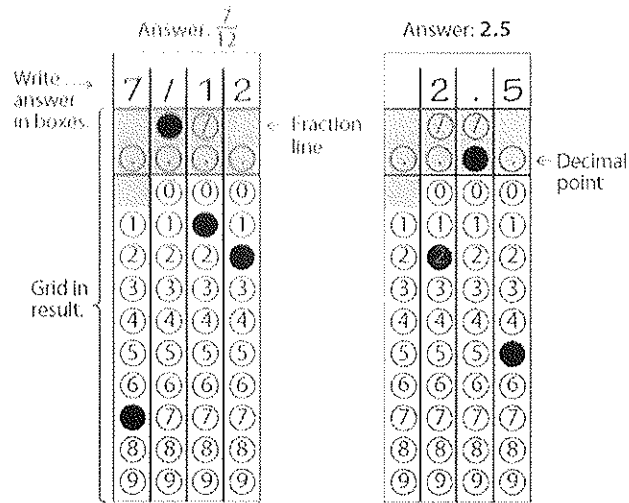
## Calculator and No-Calculator Portions

The math test will be Section 3 and Section 4 of the whole SAT and will consist of portions where you will be allowed to use a calculator and portions where you will NOT be allowed to use a calculator. Don't let this scare you, as most of the questions will be solvable without calculators. The calculator will mainly be for questions which give you ugly numbers with decimal places or things like the quadratic formula. In general though, the questions in the no-calculator portion will be solvable faster than the questions in the calculator portions.

## Types of Questions

The majority of the questions in each section will be multiple-choice, accounting for 80% of all the questions. Each multiple-choice question will have four options to choose from, with only one correct or best answer. Remember, that there will be NO penalty for guessing wrong. So, make sure to answer each and every question.

The other type of question is the grid-in response question (20% of the total questions), which is basically a question without answer choices for you to choose from. For this type of question, you have to come up with the answer and write it in appropriately on the answer sheet. Again, NO penalty for getting wrong answers. **One major thing to note for this is that you must write your answer in the grid-in boxes provided and also fill-in the appropriate bubbles underneath – otherwise, you won't get the credit!!**



Now let's take a further look at what each of the topics actually tests.

### Heart of Algebra

The point of this category is to see if you can demonstrate both procedural skill and a thorough understanding of linear equations, linear functions, and linear equalities. This is accomplished by asking you to solve straightforward questions or challenging questions. Remember that a lot of these concepts can and will be asked in many different ways. So, it's a good idea to practice with as many questions as you can, to get an idea of how to solve the same concepts in different contexts.

Here, we have outlined these concepts:

Topics and Concepts Covered	
<b>Basic Algebra</b>	<ul style="list-style-type: none"> <li>• Substituting and evaluating expressions</li> <li>• Writing algebraic expressions</li> <li>• Dependent &amp; independent variables</li> <li>• Combining like terms</li> <li>• Interpreting linear expressions</li> <li>• Division by zero</li> <li>• One-variable linear equations</li> <li>• One-variable linear inequalities</li> <li>• Dimensional analysis for converting units</li> <li>• Two-variable linear equations</li> <li>• Ordered-pair solutions</li> <li>• X-intercepts and y-intercepts</li> <li>• Slope, Point-slope form, Standard form</li> </ul>

It is important to note that many Heart of Algebra questions will ask to solve for the following:

1. Define one or more variables
2. Determine the algebraic relationship between the variables
3. Solve for the required variable
4. Interpret the results to answer what the question is specifically asking

There will be a total of 19 questions for this category – 11 for the Calculator portion and 8 for the No-Calculator portion.

## Problem Solving and Data Analysis

This section tests your ability to understand and represent data. This means that you have to pay attention to things such as units, measurements, ratios, trends, and principles of statistics. Some questions may be as simple as reading a value off of a graph, whereas, other questions may ask you to calculate something, like the probability of occurrence of a particular event. You will definitely have to know how to read data from line graphs, bar graphs, histograms, box-and-whisker plots, scatterplots, and two-way tables (categorical data). Here is a table of all the concepts covered in this section:

Topics and Concepts Covered
<ul style="list-style-type: none"> <li>• Ratios and proportions</li> <li>• Scatterplots, tables, and graphs               <ul style="list-style-type: none"> <li>- Describing trends</li> <li>- Independent vs Dependent variables</li> <li>- Analyze presented data</li> <li>- Line graphs, Bar graphs, Histograms, Box-and-Whisker Plots</li> <li>- Determine if it's a linear, quadratic, or non-linear function</li> <li>- Draw conclusions</li> </ul> </li> <li>• Categorical data</li> <li>• Probabilities               <ul style="list-style-type: none"> <li>- Independent vs Dependent events</li> <li>- Mutually exclusive events</li> </ul> </li> <li>• Experimental interpretation</li> <li>• Statistics               <ul style="list-style-type: none"> <li>- Mean, median, mode</li> <li>- Standard deviation, outliers</li> <li>- Precision vs accuracy</li> <li>- Margin of error</li> <li>- Confidence interval</li> <li>- Randomization of sample vs non-randomization</li> </ul> </li> </ul>

For some concepts, you simply have to understand them, rather, than calculate them. For example, you will not be expected to calculate standard deviation, but, will be expected to know that a large standard deviation means the data is more spread out from the mean. ***You will NOT be asked to calculate standard deviation, margin of error, or confidence intervals. But, you must understand what these concepts mean.*** Don't worry; we have designed some awesome statistics questions that should prepare you really well for the stats topics.

Another important thing to note here is that in statistics, confidence intervals other than 95% can be used, but the SAT questions will always use 95% confidence levels.)

There will be a total of 17 questions for this category – all for the Calculator portion.

### Passport to Advanced Math

This category is all about understanding the structure of expressions and being able to manipulate them to solve for different variables. This also means that you have to understand what the variables represent. Basically, this section tests concepts that build on the concepts tested in the Heart of Algebra category. You are further expected to know the basics of equations, functions, and polynomial algebra. Yes, this means that all those things you hate – fractions, radicals, and exponents – are all tested!

Topics and Concepts Covered
<p><b>Advanced Algebra</b></p> <ul style="list-style-type: none"> <li>• <b>Functions</b> <ul style="list-style-type: none"> <li>- Parent functions, function notation</li> <li>- Domain, range, max, min, vertex, intercepts</li> <li>- End behavior, asymptotes</li> <li>- Graphing, transformation</li> <li>- Average rate of change</li> <li>- Interval where it's negative or positive</li> </ul> </li> <li>• Linear equations and functions word problems</li> <li>• Systems of linear equations</li> <li>• Two-variable linear inequalities</li> <li>• Absolute value equations, functions, and inequalities</li> <li>• Expressions with rational exponents and radicals</li> <li>• Exponential growth and decay</li> <li>• Polynomials and polynomial factorization</li> <li>• Quadratic equations and functions           <ul style="list-style-type: none"> <li>- Factoring</li> <li>- Completing the square</li> <li>- Quadratic formula</li> </ul> </li> <li>• Rational and irrational numbers</li> <li>• Evaluating expressions with unknown variables</li> <li>• Manipulating expressions with unknown variables</li> <li>• Reasoning about expressions with unknown variables</li> </ul>

The SAT Math test uses the following Cartesian plane assumptions for any graph on the  $xy$ -plane:

- The axes are perpendicular and the scales are linear.
- The values on the horizontal axis increase as you move to the right.
- The values on the vertical axis increase as you move up.

**Note that this means that you CANNOT assume that the size of the units or measurements on the two axes is the same (unless the question specifically states that they are).**



When you begin your prep for the SAT math section, make sure you master Heart of Algebra before moving on to this section.

There will be a total of 16 questions for this category – 7 for the Calculator portion and 9 for the No-Calculator portion.

### Additional Topics

And finally, this section covers topics in geometry and trigonometry. It also covers complex numbers. The good thing here is that a lot of the geometry formulas are provided for you, so, you don't have to memorize a lot.

**Remember, that this section only makes up about 10% of the total Math test (6 questions out of 58).** So, don't go spending more time prepping on this section than the other sections!

Topics and Concepts Covered	
Lines and angles	<ul style="list-style-type: none"> <li>- Coordinate geometry</li> <li>- Length formula, midpoint formula</li> <li>- Vertical, supplementary, and complementary angles</li> <li>- Interior angles, exterior angles</li> <li>- Properties of parallel lines and perpendicular lines</li> </ul>
Triangles	<ul style="list-style-type: none"> <li>- Right triangles, equilateral triangles, isosceles triangles</li> <li>- Pythagorean theorem</li> <li>- Congruency and similarity</li> <li>- Properties of triangles, triangle inequality</li> </ul>
Circles	<ul style="list-style-type: none"> <li>- Equation of a circle</li> <li>- Radius, diameter, circumference, area</li> <li>- Arc length and sector area</li> <li>- Central angle, tangents, chords</li> </ul>
Other shapes	<ul style="list-style-type: none"> <li>- Squares and polygons</li> </ul>
Trigonometry	<ul style="list-style-type: none"> <li>- Sine, Cosine, Tan (SOHCAHTOA)</li> <li>- Convert between angles and radians</li> </ul>
Complex numbers	

***One important thing to note in this section is that figures ARE drawn to scale unless explicitly stated otherwise (which is totally opposite from the Old SAT).***

There will be a total 6 questions for this category – 3 for the Calculator portion and 3 for the No-Calculator portion.

## Most Commonly Tested Topics

In this part, we wanted to delve into what this SAT Math test really focuses on. If we can find which concepts are commonly tested and which aren't, we can make our studying and prep work that much more efficient and productive.

So, let's further breakdown the SAT Math Test to see which concepts are tested most commonly and which ones aren't.

Here's what we did:

1. We went through the Math Sections of all 6 released tests from CollegeBoard and wrote down which concept was being tested for each and every question.
2. We came up with a total of 26 concepts that showed up repeatedly across the 6 tests, which totalled to 348 questions.
3. We tallied up all the questions according to the concept they tested.
4. We calculated the frequency by dividing the number of times a concept showed up across the 6 tests by the total number of questions we looked at (348).

Here are the results:

Concept	# of Questions	% of Total Questions (348)
Ratios and proportions (including direct vs inverse relationships)	32	9%
Quadratic equations and functions (including roots, restrictions, factors, behavior)	27	8%
Describing trends and max/min points on graphs and tables	24	7%
Writing algebraic expressions	23	7%
Substituting and evaluating expressions	23	7%
System of linear equations	21	6%
Weighted averages, average rate of change, percentages	21	6%
One variable or system of linear inequalities	18	5%
Polynomial expressions and factorization	17	5%
Interpreting linear expression (equation or graph form)	15	4%
Slope of a line, point-slope form, standard equation of a line	14	4%
Rational, exponents, and radical expressions	14	4%
Manipulating expressions with unknown variables	13	4%
Statistics	13	4%
Circles (equation of a circle, circumference, area, radians, arcs, sector areas)	12	3%
Evaluating expressions with unknown variables	12	3%
Exponential functions (including growth, decay, and compound interest equations)	8	2%
Probability	6	2%
Triangles and angles	6	2%
Volumes and areas	6	2%
Function notation	5	1%
Trigonometry	5	1%
Interpreting complex expressions	5	1%
Complex numbers	4	1%
Lines and angles	3	1%
Independent vs dependent variable (including labelling axes)	1	0%

This table gives us some interesting stats to think about. But first, I just want to mention that all of this should be taken with a grain of salt for the following reasons:

1. This data is only based off of 6 CollegeBoard tests – so the sample isn't really that large, which makes our results less accurate. Take everything you read here with a grain of salt.
2. Just because I say "68% of the tested concepts will from the first 11 concepts" doesn't mean that that is exactly what you will see on the real thing. It is simply an analysis of what we found to be the case with the 6 released tests from CollegeBoard.
3. All the percentages are from these 6 released CollegeBoard Tests and we are assuming that CollegeBoard will test in a similar manner on the real administered tests. So, we are trying to make predictions based off of these stats – nothing here is a 100% for sure thing.
4. There were a few questions for which it seemed like they were testing a combination of concepts, rather than just one concept explicitly. For this type of question, we used our judgement to decide which concept it was most importantly testing.

Now, here are the results of our analysis:

The first 11 concepts

Concept	# of Questions	% of Total Questions (348)
Ratios and proportions (including direct vs inverse relationships)	32	9%
Quadratic equations and functions (including roots, restrictions, factors, behavior)	27	8%
Describing trends and max/min points on graphs and tables	24	7%
Writing algebraic expressions	23	7%
Substituting and evaluating expressions	23	7%
System of linear equations	21	6%
Weighted averages, average rate of change, percentages	21	6%
One variable or system of linear inequalities	18	5%
Polynomial expressions and factorization	17	5%
Interpreting linear expression (equation or graph form)	15	4%
Slope of a line, point-slope form, standard equation of a line	14	4%

- The first 11 concepts make up 68% of the questions – which means that for any given math test of 58 questions, 40 of those questions would test these concepts.
- The last 15 concepts only make up 31% of the questions – which means that for any given math of 58 questions, 18 of those questions would test these concepts.
- Out of the first 11 concepts, 6 of the concepts are Heart of Algebra concepts, accounting for 33% or about 1/3 of all tested concepts.
- Out of the first 11 concepts, 3 of the concepts are Problem Solving and Data Analysis concepts, accounting for 22% of all tested concepts.
- Out of the first 11 concepts, 2 of the concepts are Passport to Advanced Math concepts, accounting for 13% of all tested concepts.

## Discussion

So, what does all of this mean? How can it help you? Well, it really depends on what your specific situation and goals are. If you are in a time crunch, for example, then it might be wise to study the 11 most commonly tested concepts, so that you can still get a score around 600. And if you have a bit more time, then study the first 18 concepts so that you have a chance at a 700. However, if you do have a lot of time on your hands, then it would be wise to begin with the concepts outlined in this analysis of the 4 released CollegeBoard tests. This would

allow you to start doing really well on your practice tests, early in your prep, giving you a huge confidence and motivation boost. Then, you can focus on the rarer concepts, common mistakes, and harder material to go from 700 to 800.

Another thing to point out is that out of all of the Additional Topics concepts, it seems that concepts related to circles are the most important. So, if you really hate geometry and don't want to bother with triangles and such, at the very least, you should study up circles.

In Heart of Algebra, we were quite surprised to see some topics so heavily tested. For example, systems of linear equations; each of the 4 tests from CollegeBoard had anywhere between 2 to 6 questions on just this concept. Most of the time they gave you both equations, but rarely they asked you to come up with the equations also. Writing linear algebraic equations from word problems is also a big one. The next few heavily tested concepts were ratios & proportions, polynomials, quadratics, and being able to read graphs and tables for things such as trends, max/min points, and specific values. So, without a doubt, do not go into the test without being comfortable with these things.

In terms of difficulty of questions, it seemed that, generally, the difficulty increased as you got further along in the math section. Section 4 (the calculator portion) had more difficult questions than Section 3. However, a lot of the questions in Section 4 could easily be solved without using a calculator. So, depending on how much you rely on your calculator, you may or may not use it much for section 4.

Overall, the SAT Math test is fair and maybe even easier than the old SAT math. There are no tricks and strangely worded questions. You've learned the majority of these concepts in school - mainly Grade 11 Functions. And the questions are exactly as you've seen them in school also. I think this familiarity of these questions will help decrease anxiety for many students. If you have done well in math at school, then you will definitely do well on this SAT Math test. If you haven't, then you'll have to work a little harder to review all the concepts that you're weak in and show colleges that you have improved in math by doing well on the SAT Math test.

I hope that these tables and analysis have given you a little more insight into the SAT Math test, making it a little more predictable and less scary. If you find that you are lacking in certain skills, then there are great resources to help with your review. Our main goal is to use these findings to create the best practice tests we can for students. As CollegeBoard releases more tests and we can glean more information from student experiences, our tests will get better and better going into the future.

## Strategy

### General Strategies on the Test

- 1. Process of Elimination:** This strategy is golden when you're a bit stuck. If you weren't able to solve the question and find the right answer right away, then start by eliminating the most wrong choices right away – and there are usually one or two of them for every question. Since, you only have four choices to begin with; this really helps narrow it down. After eliminating two choices, even if you have to totally guess, you're chances to guess correctly are 50%.
- 2. Plug-in Answer Choices:** This is another thing to try when you're stuck. Pick one of the answer choices (usually the middle one is the best one to go with) and plug it in to the question. You can usually get the answer this way within two guesses, because the first guess will give you a good idea of what answer choice to try next.
- 3. Substitute Numbers for Variables:** Sometimes, when you're given a formula and asked to manipulate it, you substitute easy numbers into it to make sure you did it right.
- 4. Target Easy Questions First:** This strategy works for those that are very nervous and need a confidence boost early on. You can quickly flip through the section and find which questions you think are easy and do them first. What constitutes an easy question? Well, it's whatever topic you think you're most comfortable with and whether you can get the answer under 30 seconds. That seems like a very short amount of time, but it's not. 30 seconds is a long time. Try counting to 30 seconds right now and you'll see. If you can't get the answer in 30 seconds, then it's not an easy question. Try to notice this during your practice and while you are doing the practice tests in this book. You will notice that you get the easy questions almost immediately. After you're certain you've got all the easy questions, move on to the harder ones.
- 5. Save Data Tables For The End:** These questions usually want you to analyze the data and that can take you 30 seconds to a minute at least. Then they want you to do something with that data, which will take you another 30 seconds to a minute at least. So, although not hard, these questions are time consuming. Save them for the end. Time management is key to doing well on this test. Do the same for any complicated graph question. Sometimes, though, the question will be very simple – they may just want you to read a value off the graph, which you can do very quickly.
- 6. Remember that you can mark-up and write all over your test booklet** – so make sure to actually cross things out that you want to eliminate, put a star besides ones that you think are hard, write down things that you've memorized, and whatever else you feel will help you.
- 7. Read each and every question carefully** and try to come up with the answer before looking at the answers. Then look at every answer before picking the right one.
- 8. Memorize common formulas and facts.** This will naturally help you do questions quicker. This includes memorizing all the formulas provided to you on the reference sheet. This prevents wasting time by flipping back and forth between your question and the reference sheet.
- 9. Try not to depend on your calculator too much.** Most questions on the SAT math test can be done without using a calculator. We recommend using the calculator for mainly questions with really ugly numbers that make it hard to do mental math.

## How to Get a 500+ Score

Getting a score of 500 should be very easy on this test. You just have to know all the basic concepts.

**Number of Correct Questions:** 22 - 26

**Percentage:** 38% - 45%

### Study Plan

- 1 hour a day to review concepts for 2 months
- 30 minutes a day to do practice questions
- At least 4 timed math practice tests

### Main focus of studying:

- Heart of Algebra
- Top 11 concepts from our analysis

## How to Get a 600+ Score

Getting a score of 600 will require a little more effort but will also be relatively easy to accomplish.

**Number of Correct Questions:** 32 – 38

**Percentage:** 55% - 66%

### Study Plan

- 1 - 2 hours a day to review concepts for 2 months
- 30 minutes a day to do practice questions
- At least 6 timed math practice tests

### Main focus of studying:

- Heart of Algebra
- Passport to Advanced Math
- Top 18 concepts from our analysis

## How to Get a 700+ Score

Getting a score of 700 will be harder to accomplish and will require a good amount of effort. We really recommend you start prep early and leave about 4 months to get to this score and above (unless you're very good at math already). From our analysis, we recommend that you study and be comfortable with all 26 of the most commonly tested concepts. You should also thoroughly review Basic Algebra and Advanced Algebra, which covers things such as quadratics, polynomials, rational expressions, radicals, exponents, graphs, functions, and more. This will prepare you very well for the math test and you should be able to get almost all the questions. You can get the hardest questions wrong. Even if you miss a handful of questions, you can still end up with a 700+ score.

**Number of Correct Questions:** 43 – 50

**Percentage:** 74% - 86%

### Study Plan

- 2 - 3 hours a day to review concepts for 2 - 4 months
- 30 minutes - 1 hour a day to do practice questions
- At least 8 timed math practice tests

### Main focus of studying:

- Heart of Algebra
- Passport to Advanced Math
- Problem Solving and Data Analysis
- All 26 commonly tested concepts from our analysis

## How to Get a Perfect 800 Score

Getting a perfect 800 score will be a challenge and will require a tremendous effort. BUT, it's totally doable. You don't have to be a genius to get a perfect 800; you just have to be a hard and disciplined worker. We really recommend you start prep early and leave about 4 months to get to this score. From our analysis, we recommend that you study and be comfortable with all 26 of the most commonly tested concepts, everything outlined for the 'How To Get A 700+ Score' section and also all the Additional Topics concepts tested on the SAT. That means that you should definitely be comfortable with trigonometry, geometry, and complex numbers. Three out of four of the practice tests, released by CollegeBoard, show that you need to get all 58 questions correct in order to get 800 – even missing one can drop you down to a 790. The key to this is going to be time management, targeting your weaknesses with practice tests, eliminating careless mistakes, and doing as many timed SAT math practice tests as possible. The practice tests should be difficult level tests.

**Number of Correct Questions:** 57 – 58

**Percentage:** 98% - 100%

### Study Plan

- 2 - 3 hours a day to review concepts for 2 - 4 months
- 30 minutes - 1 hour a day to do practice questions
- At least 10 timed math practice tests (difficult level tests are better than easy tests)

### Main focus of studying:

- Heart of Algebra
- Passport to Advanced Math
- Problem Solving and Data Analysis
- Additional Topics

- All 26 commonly tested concepts from our analysis

### How to Use Practice Tests

- **Real Conditions:** Always do the practice test under real conditions. Go to a quiet room, time yourself, and complete the whole test without any breaks. Also, it's a good idea to do the practice test at the same time as when you will give your SAT – usually that's around 8 am. This will make sure that you get used to having to think this early on in the day.
- **Targeted Practice:** Practice tests (and any practice questions you do) can let you know what your major and minor weaknesses are. Always analyze your results to find the reason why you got any question wrong (this includes questions you had to guess on). Categorize your weaknesses based on concept or question type. Then review those concepts, starting from the ones you get wrong the most and working your way down. And, of course, make sure to go back and re-do the questions you couldn't do to make sure that you can do them.
- **Concept Review vs Time Management:** Practice tests can let you know whether or not your weakness is time management. The way you do this is to start noticing if you are always rushing near the end of a section. If you feel like you're rushing the last 5 or so questions, then you have a time management issue. You can also check this by doing a practice test where you time yourself, but don't stop a section once the time has run out. Keep going and finish the section, but make a note of all the questions that you had to do once the allotted time passed. Then when you score your test, break it up into two scores: one for the questions you finished within the allotted time and one score that includes the questions that you needed extra time for. Then compare the two scores. If you see that there is a difference of 50 or more points, then you definitely have a time management issue. And if there is almost no difference, then your timing is excellent and you should focus more on the concepts.
- **Careless Mistakes:** Everyone makes careless mistakes. Practice tests give us a great glimpse at what these mistakes are. Go through each practice test and find the careless mistakes you made. Then write down on a piece of paper what that careless mistake was and make sure to read that piece of paper every day. The whole premise behind careless mistakes is that you simply don't notice them when you make them. So, being more aware of them should help eliminate them.
- **When to take them:** Take one practice test at the beginning of your prep to see where you stand and what you already know really well. This could tell you where to start your prep. For example, if you got most of the algebra questions right, but a lot of the quadratic questions wrong, then you would start your prep by reviewing quadratics concepts. After this first practice test, you should not take any more practice tests for 2 – 4 weeks, while you are reviewing concepts. Give yourself some time to learn a chunk of concepts and practice them on questions. Then, start doing 1 practice test every weekend. Remember to analyze the results of each practice test you do and target those weaknesses for the following week, before you do the next practice test. That way you will definitely see improvements every week and it will give you a big confidence and motivation boost.



## How To Score The Tests

1. Add up the number of correct answers you got for Section 3 (no calculator) and Section 4 (calculator). Remember, there is no penalty for wrong answers. This is your raw score.
2. Use the raw score conversion table below to convert your raw score into a scaled score from 200 – 800.

### Raw Score Conversion Table:

Raw Score	Scaled Score
0	200
1	200
2	210
3	230
4	250
5	260
6	280
7	290
8	310
9	320
10	330
11	340
12	350
13	360
14	380
15	390
16	400
17	410
18	420
19	430
20	440
21	450
22	460
23	470
24	490
25	500
26	510
27	510
28	520
29	530
30	530

31	540
32	550
33	560
34	570
35	580
36	590
37	590
38	600
39	610
40	620
41	630
42	640
43	650
44	660
45	670
46	670
47	680
48	690
49	700
50	710
51	720
52	730
53	740
54	760
55	770
56	780
57	790
58	800

# 4 Difficult Full Length Math Practice Tests + Answer Keys + Full Solutions

## IMPORTANT

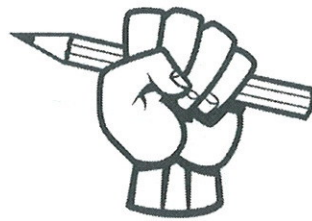
All math tests are in the format of Section 3 and Section 4.

Section 3 does **not** permit a calculator.

Section 4 allows a calculator.

There is a reference sheet at the beginning of each section.

# TEST 1



**ANSWER SHEET**

**Section 3**

- 1  A  B  C  D  
 2  A  B  C  D  
 3  A  B  C  D

- 4  A  B  C  D  
 5  A  B  C  D  
 6  A  B  C  D

- 7  A  B  C  D  
 8  A  B  C  D  
 9  A  B  C  D

- 10  A  B  C  D  
 11  A  B  C  D  
 12  A  B  C  D

- 13  A  B  C  D  
 14  A  B  C  D  
 15  A  B  C  D

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**Section 4**

- 21  A  B  C  D  
 22  A  B  C  D  
 23  A  B  C  D  
 24  A  B  C  D  
 25  A  B  C  D  
 26  A  B  C  D

- 27  A  B  C  D  
 28  A  B  C  D  
 29  A  B  C  D  
 30  A  B  C  D  
 31  A  B  C  D  
 32  A  B  C  D

- 33  A  B  C  D  
 34  A  B  C  D  
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 38  A  B  C  D

- 39  A  B  C  D  
 40  A  B  C  D  
 41  A  B  C  D  
 42  A  B  C  D  
 43  A  B  C  D  
 44  A  B  C  D

- 45  A  B  C  D  
 46  A  B  C  D  
 47  A  B  C  D  
 48  A  B  C  D  
 49  A  B  C  D  
 50  A  B  C  D



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## Section 3

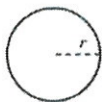
Math Test – No Calculator

Allotted Time: 25 Minutes

Number of Questions: 20

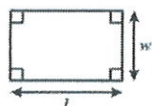
Calculator **NOT** permitted.

## Reference Formulas



$$A = \pi r^2$$

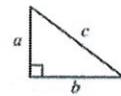
$$C = 2\pi r$$



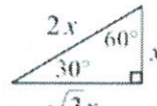
$$A = lw$$



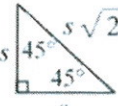
$$A = \frac{1}{2}bh$$



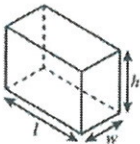
$$c^2 = a^2 + b^2$$



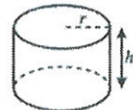
$$\sqrt{3}x$$



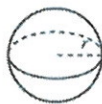
$$s$$



$$V = lwh$$



$$V = \pi r^2 h$$



$$V = \frac{4}{3}\pi r^3$$



$$V = \frac{1}{3}\pi r^2 h$$



$$V = \frac{1}{3}Bh$$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is  $2\pi$ .

The sum of the measures in degrees of the angles of a triangle is 180.



**No Test Material On This Page**

1. If  $\frac{3-x}{2} = 5$ , what is the value of  $\frac{2x-1}{5}$ ?

- A) -3
- B) -1
- C) 1
- D) 3

2.

$$\begin{aligned}x + 2y &= 4 \\4x - 3y &= 5\end{aligned}$$

If ordered pair  $(x, y)$  is a solution of the system of equations above, what is the value of  $xy$ ?

- A) 1
- B) 2
- C) 3
- D) 4

3. George is the owner and the only employee in his café. He estimates the profit of his café using the formula  $4nh - r$ , where  $h$  is the number of working hours,  $n$  is the number of drinks sold per hour and  $r$  is the rent he pays. Which of the following is the best interpretation of the number 4 in the expression?

- A) The number of drinks sold
- B) The price of a drink
- C) The number of guests in the café
- D) The number of working days

4.

$$25x^4 + 10x^2 + 1$$

Which of the following is equivalent to the expression shown above?

- A)  $(5x^2 + 1)^2$
- B)  $(5x^2 - 1)^2$
- C)  $(5x + 1)^4$
- D)  $(5x - 1)^4$

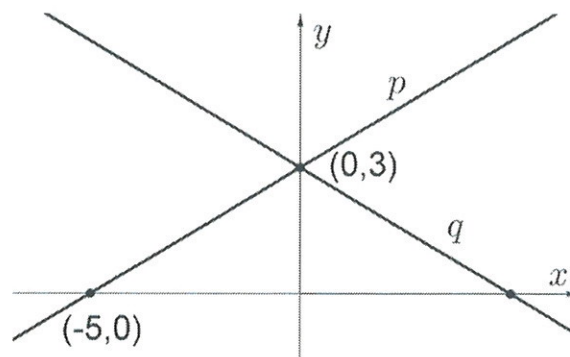
5.

$$\sqrt{6 - 3x^2} - k = 0$$

If  $x < 0$  and  $k = \sqrt{3}$ , what is the value of  $x$ ?

- A) -2
- B) -1
- C) 1
- D) 2

6.



Line  $p$  is reflected over  $y$ -axis into line  $q$ . What is the equation of line  $q$ ?

- A)  $3x + 5y = 15$
  - B)  $3x - 5y = 15$
  - C)  $5x + 3y = 15$
  - D)  $5x - 3y = 15$
7. If  $2x + 3y - 4z = 5$ , what is the value of  $\frac{4^x 8^y}{16^z}$ ?
- A) 30
  - B) 32
  - C) 34
  - D) 36
8. Joshua has 110 bottles. He wants to put them in packs, so that each pack contains an equal number of bottles. What is the maximum number of such packs he can

make, if the number of bottles in a pack is greater than or equal to 6?

- A) 17
- B) 18
- C) 19
- D) 20

9. What is the slope of line which passes through the points  $A(-2,5)$  and  $B(1,-4)$ ?

- A) -3
- B) -1
- C) 1
- D) 3

10. Which of the following lines DO NOT pass through the 1<sup>st</sup> quadrant?

- A)  $-4x + 3y = -7$
- B)  $-4x + 5y = 11$
- C)  $5x + 4y = 17$
- D)  $6x + 5y = -13$

11. Calculate  $i^{25} - i^{22} + i^{14} - i^5$

- A) 0
- B) 1
- C)  $i$
- D)  $-i$

12.

$$P = \frac{W}{W + B}$$

The formula above shows the probability ( $P$ ) of picking a white marble ( $W$ ) from the bag which contains white and black marbles ( $B$ ). Which of the following expresses the number of black marbles in terms of other variables?

A)  $B = \frac{W(P+1)}{P}$

B)  $B = \frac{W(1-P)}{P}$

C)  $B = \frac{P(1-W)}{W}$

D)  $B = \frac{P(W+1)}{W}$

13. What must be the value of  $k$  so that equation  $3x^2 - kx + 4 = 0$ , solved for  $x$ , has 1 solution?

- A)  $\sqrt{2}$
- B)  $\sqrt{3}$
- C)  $2\sqrt{2}$
- D)  $4\sqrt{3}$

14. The population of the city decreases 2% each year. If the initial population is 2,000,000, which of the following functions  $f$  models the population  $t$  years later?

- A)  $f(t) = 2,000,000(0.8)^t$
- B)  $f(t) = 2,000,000(0.98)^t$
- C)  $f(t) = 2,000,000(1.02)^t$
- D)  $f(t) = 2,000,000(1.2)^t$

15.

$$\frac{x^2 - 3x - 10}{x^2 - 7x + 10}$$

Which of the following is equivalent to the expression above?

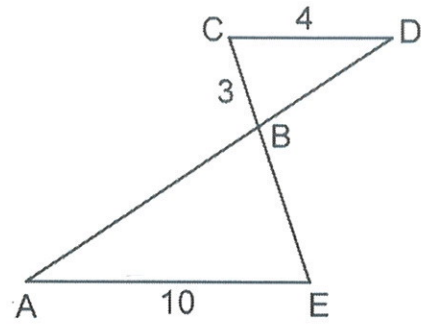
- A)  $x + 2$
- B)  $x - 2$
- C)  $\frac{x+2}{x-2}$
- D)  $\frac{x-2}{x+2}$

Student-Produced Responses

16. Peter bought 24 cans of beer. The cans are sold in packs of 4 and 6 beers. If he bought at least one 4-pack and at least one 6-pack, what is one possible number of 6-packs?

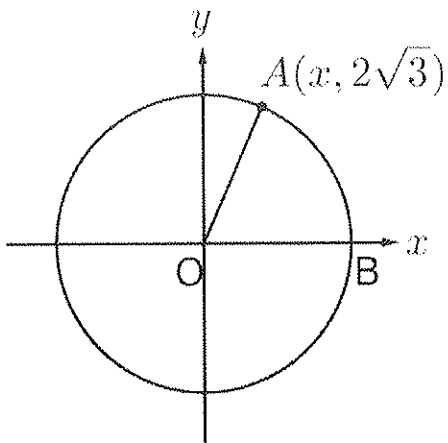
17. If  $4x(5 - 2x) + 2(3x - 1) = ax^2 + bx + c$ , find  $a + b + c$ .

18.



In the figure above  $\overline{AC} \parallel \overline{DE}$ , and segment  $AD$  intersects segment  $CE$  at  $B$ . What is the length of segment  $CE$ ?

19.



In the  $xy$ -plane above,  $O$  is the center of the circle, and the measure of  $\angle AOB$  is  $\frac{\pi}{3}$ . What is the value of  $x$ ?

20.

$$\begin{aligned}(a + b)x + (a - b)y &= 4 \\ 9x + 6y &= 12\end{aligned}$$

What must be the value of  $\frac{a}{b}$  so that system of equations above has infinitely many solutions?

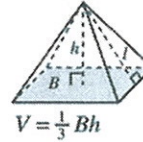
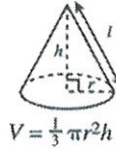
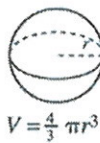
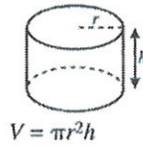
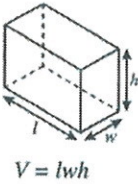
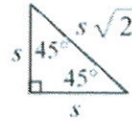
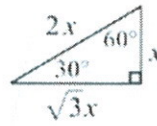
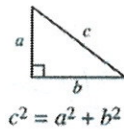
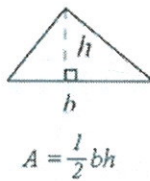
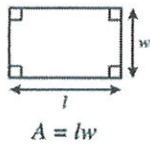
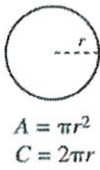
Section 4

Math Test – Calculator  
 Allotted Time: 55 Minutes  
 Number of Questions: 38

Calculator IS allowed.



Reference Formulas



The number of degrees of arc in a circle is 360.  
 The number of radians of arc in a circle is  $2\pi$ .  
 The sum of the measures in degrees of the angles of a triangle is 180.

**No Test Material On This Page**

21. The classrooms in the school have 20 or 25 seats. Which of the following expressions represents the number of students in the school, if the number of classrooms with 20 seats is  $d$ , and the number of classrooms with 25 seats is  $s$ ?

- A)  $5(4s + 5d)$
- B)  $5(4d + 5s)$
- C)  $(20 + 25)sd$
- D)  $(s + d)20 \times 25$

22. There are 50 students in the group. Fifteen of them are girls. What is the expected number of girls in the school, if the total number of students is 1,100?

- A) 300
- B) 330
- C) 360
- D) 390

23.

$$h = 12 + 4.8v$$

The height of an object,  $h$ , depends on its velocity,  $v$ . What is  $v$  when  $h$  is 84?

- A) 15
- B) 16
- C) 17
- D) 18

**Questions 24 and 25 refer to the following information.**

The weight of pears, 24 kg, is directly proportional to the number of pears, 18.

24. What is the weight of 24 pears?

- A) 18
- B) 24
- C) 32

D) 42

25. Five percent of pears are rotten. How much kilograms of pears can be sold if there are 18 pears?

- A) 22.2 kg
- B) 22.4 kg
- C) 22.6 kg
- D) 22.8 kg

26. If 3 times the number  $x$  is subtracted from 16, the result is 1. What number results if 4 times  $x$  is subtracted from 30?

- A) 5
- B) 10
- C) 15
- D) 20

27.

$$y = (x + 4)(x - 2)$$

The equation above represents the parabola in the  $xy$ -plane. Which of the following forms of the equation displays the  $y$ -intercept of the parabola as constant or coefficient?

- A)  $y = x^2 + 2(x - 4)$
- B)  $y = (x - \sqrt{8})(x + \sqrt{8}) + 2x$
- C)  $y = (x + 1)^2 - 9$
- D)  $y = x^2 + 2x - 8$

28. Sarah has  $\$k$ . She bought 12 shirts which price is  $\$15$  each. If  $\$20$  remained to her, what is the value of  $k$ ?

- A)  $\$200$
- B)  $\$250$
- C)  $\$300$
- D)  $\$350$



29. There are  $x$  cows and  $y$  hens on the farm. The number of their legs is less than 100, and the total number of cows and hens is less than 30. Which of the following systems of inequalities represents this relationship?

- A)  $4x + 2y < 100$   
 $x + y < 30$
- B)  $2x + 4y < 100$   
 $x + y < 30$
- C)  $\frac{x}{4} + \frac{y}{2} < 100$   
 $4x + 2y < 30$
- D)  $x + y < 100$   
 $4x + 2y < 100$

30. If  $f(x) = 2x - 3$ , what is the value of  $f^2(x)$ ?

- A)  $(2x - 3)^2$
- B)  $4x^2 - 9$
- C)  $4x - 9$
- D)  $4x - 3$

31. Men's hundred meters world record is 9.58 m/s. Which of the following is closest to the average speed in kilometers per hour?

- A)  $30 \frac{km}{h}$
- B)  $35 \frac{km}{h}$
- C)  $40 \frac{km}{h}$
- D)  $45 \frac{km}{h}$

32. On January 1, 2010, the population of the city was 2,300,000. The population is

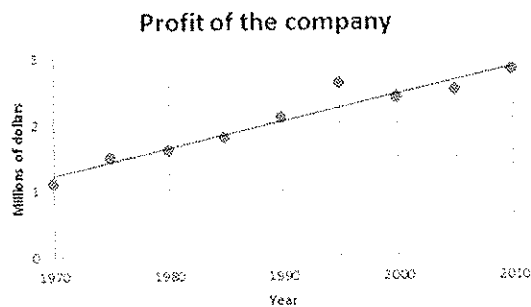
increased for 20,000 people each year. If  $t$  represents the time, in years, after January 1, 2010, which of the following inequalities describes the set of years where the population is at or above 3,000,000?

- A)  $3,000,000 - 20,000 \leq t$
- B)  $3,000,000 - 2,300,000 \geq t$
- C)  $2,300,000 + 20,000 \leq t$
- D)  $2,300,000 + 20,000t \geq 3,000,000$

33. How many 6-digit numbers can be formed using only 0, 1, 2, 3, 4, and 5 with no repeats?

- A) 30
- B) 36
- C) 300
- D) 600

34.



According to the line of best fit in the scatterplot above, which of the following best approximates the year in which the profit was estimated to be \$2,500,000?

- A) 1992
- B) 1997
- C) 2002
- D) 2007

35. The distance traveled by the satellite in one orbit around the Earth is about 100,000 km. A satellite makes one

complete orbit around the Earth in a week. Of the following, which is closest to the average speed of a satellite, in kilometers per hour, as it orbits the Earth?

- A)  $600 \frac{km}{h}$   
 B)  $700 \frac{km}{h}$   
 C)  $800 \frac{km}{h}$   
 D)  $900 \frac{km}{h}$

36. Cars on the parking lot

	Blue	Red
Old	18	12
New	6	14

The table above summarizes the number of 50 cars on the parking lot. If one of blue cars is chosen at random for a crash test, what is the probability that the car chosen is new?

- A)  $\frac{1}{2}$   
 B)  $\frac{1}{3}$   
 C)  $\frac{1}{4}$   
 D)  $\frac{1}{5}$

37. Sarah is 160 cm tall. Joshua is 15% taller than Sarah. How tall is Joshua?

- A) 175 cm  
 B) 178 cm  
 C) 180 cm  
 D) 184 cm

38. A survey was taken of the weight of students in the school, and it was found that the mean weight was 56 kg and the

median weight was 65 kg. Which of the following situations could explain the difference between the mean and median weight in the school?

- A) The students have weights that are close to each other  
 B) There are a few students whose weights are less than the rest  
 C) There are a few students whose weights are much more than the rest  
 D) Many students have weights between 56 kg and 65 kg

**Questions 39 and 40 refer to the following information.**

A researcher chose 50 families at random from the two towns and asked each family how many children they have. The results are shown in the table below.

Number of children	Town A	Town B
0	4	2
1	7	8
2	9	6
3	5	9

There are a total of 600 families at Town A and 900 families at Town B.

39. What is the median number of children for all the families surveyed?

- A) 0  
 B) 1  
 C) 2  
 D) 3

40. Based on the survey data, which of the following most accurately compares the expected total number of families with 2 children at two towns?

- A) The total number of families with 2 children is expected to be equal at two towns
- B) The total number of families with 2 children at Town A is expected to be 3 more than at Town B
- C) The total number of families with 2 children at Town B is expected to be 3 more than at Town A
- D) The total number of families with 2 children at Town B is expected to be 300 more than at Town A

41. Sarah estimates that Joshua is  $x$  cm high, where  $x > 170$  cm. The goal is for the estimate to be within 5 cm of the Joshua's actual height. If Sarah meets the goal and Joshua is  $y$  cm high, which of the following inequalities represents the relationship between the estimated height and the actual height?

- A)  $x + y < 5$
- B)  $y > x + 5$
- C)  $y < x - 5$
- D)  $-5 < y - x < 5$

Questions 42 and 43 refer to the following information.

$$V = \frac{B}{2r^2}$$

At a large distance  $r$  from the source of light, the visibility  $V$  is related to the brightness of the source of light  $B$  by the formula above.

42. Which of the following expresses the square distance from the source of light in terms of the visibility and brightness?

A)  $r^2 = \frac{VB}{2}$

B)  $r^2 = \frac{B}{2V}$

C)  $r^2 = \frac{2}{VB}$

D)  $r^2 = \frac{V}{2B}$

43. For the same source of light, Observer A measures its visibility to be 4 times the visibility measured by Observer B. The distance of Observer A from the source of light is what fraction of the distance of Observer B from the source of light?

A)  $\frac{1}{2}$

B)  $\frac{1}{4}$

C)  $\frac{1}{8}$

D)  $\frac{1}{16}$

44. What is the center of the circle:  
 $x^2 + y^2 - 6x - 4y = 7$ ?

A) (2, 3)

B) (3, 2)

C) (-2, 3)

D) (3, -2)

45. The graph of the linear function  $f$  has intercepts at  $(a, 0)$  and  $(0, b)$  in the  $xy$ -plane. If  $ab = -1$ , which of the following is true about the slope of the graph  $f$ ?

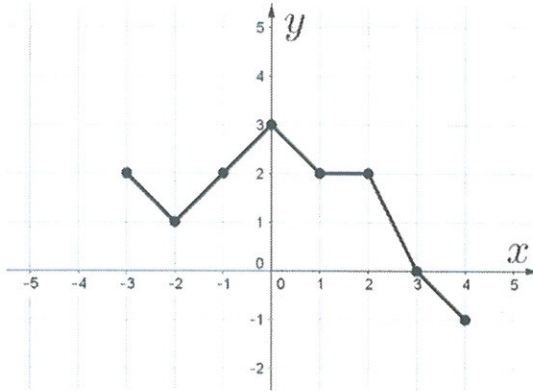
A) It is positive

B) It is negative

C) It equals zero

D) It is undefined

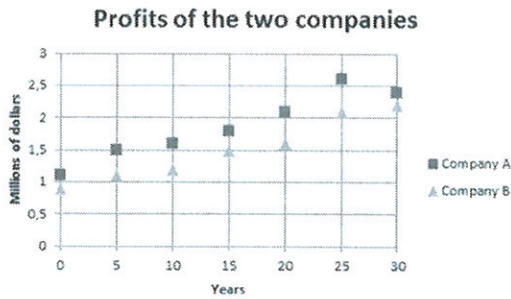
46.



The complete graph of the function  $f$  is shown in the  $xy$ -plane above. Which of the following are equal to 2?

- I.  $f(-2)$
  - II.  $f(-1)$
  - III.  $f(2)$
- A) III only  
 B) I and II only  
 C) II and III only  
 D) I, II and III

47.



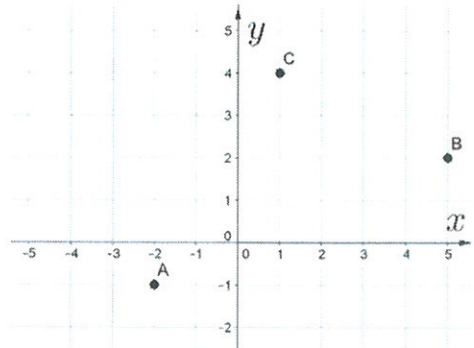
The graph above shows the profits of the two companies at 5 years intervals. Which of the following statements correctly compares the average rates at which profits of the two companies change?

- A) In every 5-year interval, the magnitude of the rate of change of profit of the

Company A is greater than that of the Company B

- B) In every 5-year interval, the magnitude of the rate of change of profit of the Company B is greater than that of the Company A
- C) In the intervals from 0 to 5 years and from 5 to 10 years, the rates of change of profit of the Company A are of greater magnitude, whereas in the intervals from 20 to 25 years and from 25 to 30 years the rates of change of profit of the Company B are of greater magnitude
- D) In the intervals from 0 to 5 years and from 5 to 10 years, the rates of change of profit of the Company B are of greater magnitude, whereas in the intervals from 20 to 25 years and from 25 to 30 years the rates of change of profit of the Company A are of greater magnitude

48.



What is the equation of line which passes through the point C, perpendicular to line  $\overline{AB}$ ?

- A)  $7x + 3y - 19 = 0$   
 B)  $3x - 7y - 1 = 0$   
 C)  $3x - 7y + 25 = 0$   
 D)  $5x - 3y - 4 = 0$

49.

$$y = ax^2 + bx + c$$
$$y = 5$$

In the system of equations above,  $a$ ,  $b$  and  $c$  are constants. For which of the following values of  $a$ ,  $b$  and  $c$  does the system of equations have exactly one real solution?

- A)  $a = 0, b = 1, c = 2$
- B)  $a = 1, b = 0, c = 2$
- C)  $a = 2, b = 1, c = 0$
- D)  $a = 1, b = 1, c = 1$

50. The area of a regular hexagon is  $24\sqrt{3}$ .  
What is the area of a circle circumscribed around a hexagon?

- A)  $2\pi$
- B)  $4\pi$
- C)  $8\pi$
- D)  $16\pi$

**Student-Produced Responses**

51. The level of water is increasing at a rate of 2.4 cm per hour. How long will it take, in hours, for the level of water to increase by 36 cm?

52. If  $p$  yards and 6 inches is equal to 150 inches, what is the value of  $p$ ?

53. In the  $xy$ -plane, the point  $(-2, 4)$  lies on the graph of the line  $f(x) = mx - 6$ .  
What is the value of  $m$ ?

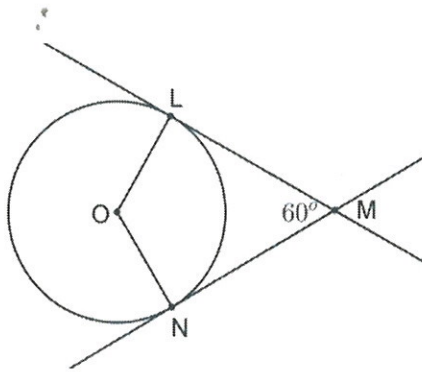
54. There are 80 hens and ducks on the farm. If there are 16 hens more than ducks, how many ducks are there?

55.

$$l = 6h + 45$$

When the rain starts, the level of river starts to increase by the constant rate per hour. The equation above models the level of the river, in centimeters, after  $h$  hours. According to the model, what was the initial level of the river?

56.



In the figure above, point  $O$  is the center of the circle, line segments  $LM$  and  $MN$  are tangent to the circle at points  $L$  and  $N$ , respectively, and the segments intersect at point  $M$  as shown. If  $OM = 10$ , what is the circumference of the circle (to the nearest tenth)?

**Questions 57 and 58 refer to the following information.**

The current price of an item is \$800. The price can be predicted using the formula below, where  $P_{\text{next year}}$  is the expected price next year,  $P_{\text{this year}}$  is the price this year, and  $P$  is the maximum price in the last 10 years.

$$P_{\text{next year}} = P_{\text{this year}} + 0.25(P_{\text{this year}}) \left( 1 - \frac{P_{\text{this year}}}{P} \right)$$

57. According to the formula, what will be the price of an item two years from now if  $P = 1,000$ ? (Round your answer to the nearest whole number)

58. If the expected price of an item next year is \$1,200 and the price this year is \$1,000, what was the maximum price in the last 10 years? (Round your answer to the nearest whole number)

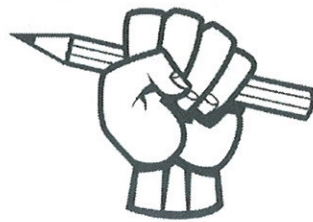
**No Test Material On This Page**

Test 1 Answer Key

1	A	21	B	41	D
2	B	22	B	42	B
3	B	23	A	43	A
4	A	24	C	44	B
5	B	25	D	45	A
6	A	26	B	46	C
7	B	27	D	47	A
8	B	28	A	48	A
9	A	29	A	49	A
10	D	30	C	50	D
11	A	31	B	51	15
12	B	32	D	52	4
13	D	33	D	53	-5
14	B	34	C	54	32
15	C	35	A	55	45
16	2	36	C	56	31.4
17	16	37	D	57	874
18	10.5	38	B	58	5000
19	2	39	C		
20	5	40	A		



# TEST 2



**ANSWER SHEET**

**Section 3**

- 1 A B C D  
     
 2 A B C D  
     
 3 A B C D

- 4 A B C D  
     
 5 A B C D  
     
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**Section 4**

- 21 A B C D  
     
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 23 A B C D  
     
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 26 A B C D

- 27 A B C D  
     
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Section 3

Math Test – No Calculator

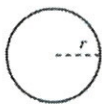
Allotted Time: 25 Minutes

Number of Questions: 20

Calculator **NOT** permitted.

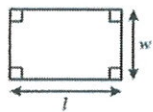


Reference Formulas



$$A = \pi r^2$$

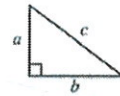
$$C = 2\pi r$$



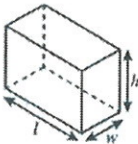
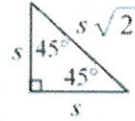
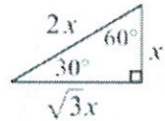
$$A = lw$$



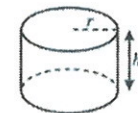
$$A = \frac{1}{2}bh$$



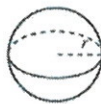
$$c^2 = a^2 + b^2$$



$$V = lwh$$



$$V = \pi r^2 h$$



$$V = \frac{4}{3}\pi r^3$$



$$V = \frac{1}{3}\pi r^2 h$$



$$V = \frac{1}{3}Bh$$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is  $2\pi$ .

The sum of the measures in degrees of the angles of a triangle is 180.

**No Test Material On This Page**

1. If  $\frac{1}{3}x^2 - 2x + 3 = 0$ , what is the value of  $\sqrt{16 + x^2}$ ?

A) 2  
 B) 3  
 C) 4  
 D) 5

2.

$$\begin{aligned} 2x + 3y &= 11 \\ 3x - 2y &= -3 \end{aligned}$$

If ordered pair  $(x, y)$  is a solution of the system of equations above, what is the value of  $x + y$ ?

A) 2  
 B) 3  
 C) 4  
 D) 5

3. George is the owner and the only employee in his café. He estimates the profit of his café using the formula  $24ph - r$ , where  $h$  is the number of working hours,  $p$  is the price of a drink and  $r$  is the rent he pays. Which of the following is the best interpretation of the number 24 in the expression?

A) The number of drinks sold per hour  
 B) The number of working hours per day  
 C) The number of guests in the café  
 D) The number of working days

4.

$$9 - 24x^2 + 16x^4$$

Which of the following is equivalent to the expression shown above?

A)  $(3 + 4x^2)^2$   
 B)  $(3 - 4x^2)^2$   
 C)  $(3 + 4x)^4$

D)  $(3 - 4x)^4$

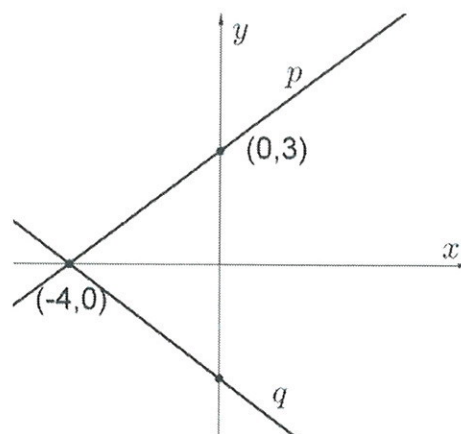
5.

$$\sqrt{5x^2 - 9} - k = 0$$

If  $x > 0$  and  $k = -6$ , what is the value of  $x$ ?

A) -3  
 B) -1  
 C) 1  
 D) 3

6.



Line  $p$  is reflected over  $x$ -axis into line  $q$ . What is the equation of line  $q$ ?

A)  $y = \frac{3}{4}x + 3$   
 B)  $y = -\frac{3}{4}x + 3$   
 C)  $y = \frac{3}{4}x - 3$   
 D)  $y = -\frac{3}{4}x - 3$

7. If  $3x - 2y - 4z = 3$ , what is the value of  $\frac{27^x}{9^y 81^z}$ ?

A) 25  
 B) 26  
 C) 27  
 D) 28

8. Sarah has 90 pears. She wants to put them in bags, so that each bag contains an equal number of pears. If the number of pears in each bag is greater than or equal to 4, what is the maximum number of bags she needs?

A) 20  
B) 21  
C) 22  
D) 23

9. Which of the following lines passes through  $(1, -2)$  and is parallel to the line  $4x - 2y + 5 = 0$ ?

A)  $y = 2x + 4$   
B)  $y = 2x - 4$   
C)  $y = -2x + 4$   
D)  $y = -2x - 4$

10. Which of the following lines DO NOT pass through the 2<sup>nd</sup> quadrant?

E)  $-4x + 3y = -7$   
F)  $-4x + 5y = 11$   
G)  $5x + 4y = 17$   
H)  $6x + 5y = -13$

11. Calculate  $(1 + i)^8$

A)  $2i$   
B) 4  
C)  $8i$   
D) 16

- 12.

$$P = \frac{F}{A + F} \times 100$$

The formula above shows the percentage ( $P$ ) of votes ( $F$ ) for BREXIT. Which of the following expresses the percentage of votes against BREXIT ( $A$ ) in terms of other variables?

A)  $A = \frac{P(100-F)}{F}$

B)  $A = \frac{F(100-P)}{P}$

C)  $A = \frac{(100-P)}{FP}$

D)  $A = \frac{(100-F)}{FP}$

13. How many intersection points with x-axis does parabola  $y = 5x^2 + 20x + 20$  have?

A) 0  
B) 1  
C) 2  
D) 3

14. The population of rabbits in the forest increases 8% each year. If the initial population of rabbits is 600, which of the following functions  $f$  models the population  $t$  years later?

A)  $f(t) = 600(0.2)^t$   
B)  $f(t) = 600(0.92)^t$   
C)  $f(t) = 600(1.08)^t$   
D)  $f(t) = 600(1.8)^t$

- 15.

$$\frac{x^3 - 1}{x^2 - 1}$$

Which of the following is equivalent to the expression above?

A)  $x$   
B)  $\frac{x^2+x+1}{x+1}$   
C)  $x - 1$   
D) 1



Student-Produced Responses

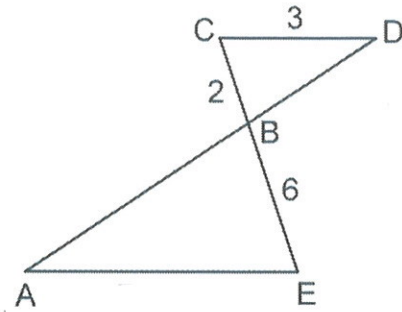
16. Mia bought 38 eggs. If she bought at least one 6-pack and at least one 10-pack, what is one possible number of 10 packs?

17.

$$5x(4x - 2) + 6(3x + 1) = kx^3 + 20x^2 + 8x + 6$$

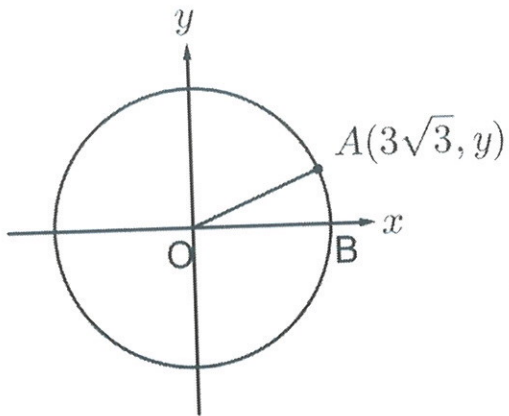
What must be the value of  $k$  so that equation above is true?

18.



In the figure above  $\overline{AE} \parallel \overline{CD}$ , and segment  $AD$  intersects segment  $CE$  at  $B$ . What is the length of segment  $AE$ ?

19.



In the  $xy$ -plane above,  $O$  is the center of the circle, and the measure of  $\angle AOB$  is  $\frac{\pi}{6}$ . What is the value of  $x$ ?

20.

$$\begin{aligned}(2a - 3b)x + 4by &= 5 \\ 4x + 8y &= 10\end{aligned}$$

What must be the value of  $\frac{a}{b}$  so that system of equations above has infinitely many solutions?

## Section 4

Math Test – Calculator

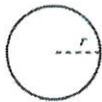
Allotted Time: 55 Minutes

Number of Questions: 38

Calculator IS allowed.

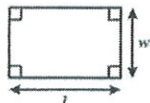


## Reference Formulas



$$A = \pi r^2$$

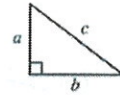
$$C = 2\pi r$$



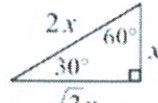
$$A = lw$$



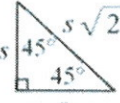
$$A = \frac{1}{2}bh$$



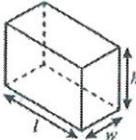
$$c^2 = a^2 + b^2$$



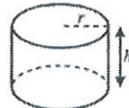
$$\sqrt{3}x$$



$$s$$



$$V = lwh$$



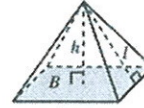
$$V = \pi r^2 h$$



$$V = \frac{4}{3}\pi r^3$$



$$V = \frac{1}{3}\pi r^2 h$$



$$V = \frac{1}{3}Bh$$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is  $2\pi$ .

The sum of the measures in degrees of the angles of a triangle is 180.

21. The hotel has rooms with 2 and 5 beds. Which of the following represents the number of beds in the hotel, if the number of 2-bedrooms is  $m$ , and the number of 5-bedrooms is  $n$ ?

A)  $2m + 5n$   
 B)  $2n + 5m$   
 C)  $(2 + 5)mn$   
 D)  $(m + n) \times 2 \times 5$

22. There are 57 red and blue marbles in the bag. Sarah randomly picked 6 marbles. Two of them were red. What is the expected number of blue marbles in the bag?

A) 19  
 B) 25  
 C) 32  
 D) 38

23.

$$P = 15,000 + 50d$$

The profit of the hotel,  $P$ , depends on the number of sunny days,  $d$ . What is  $d$  when  $P$  is 20,000?

A) 70  
 B) 80  
 C) 90  
 D) 100

**Questions 24 and 25 refer to the following information.**

The distance passed, 150 km, is directly proportional to the number of hours of driving, 3.

24. What is the distance passed after 5 hours?

A) 240  
 B) 250  
 C) 260

D) 270

25. Seventy-five percent of journey was on a highway. How many kilometers did car travel on a highway?

A) 110 km  
 B) 112.5 km  
 C) 115 km  
 D) 117.5 km

26. If 7 is subtracted from 5 times the number  $x$ , the result is 3. What number results if 2 times  $x$  is added to 4?

A) 2  
 B) 4  
 C) 6  
 D) 8

27.

$$y = x^2 + 8x + 15$$

The equation above represents the parabola in the  $xy$ -plane. Which of the following forms of the equation displays the coordinates of the vertex of the parabola as constants or coefficients?

A)  $y = (x + 4)^2 - 1$   
 B)  $y = (x + 3)(x + 5)$   
 C)  $y = x(x + 8) + 15$   
 D)  $y = x^2 + 8\left(x + \frac{15}{8}\right)$

28. Joshua has  $k$  candies. He eats 4 candies every hour. After 8 hours Joshua has 12 candies. What is the value of  $k$ ?

A) 40  
 B) 42  
 C) 44  
 D) 46

29. There are  $x$  cars and  $y$  bicycles on the parking lot. The total number of their wheels is less than 80, and the total number of vehicles is less than 20. Which of the following systems of inequalities represents this relationship?

- A)  $x + y < 80$   
 $4x + 2y < 20$
- B)  $x + y < 20$   
 $4x + 2y < 80$
- C)  $2x + 4y < 20$   
 $4x + 2y < 80$
- D)  $x + y < 20$   
 $\frac{x}{4} + \frac{y}{2} < 80$

30. If  $f(x) = 5 - 2x$ , what is the value of  $f^{-1}(x)$ ?

- A)  $2x - 5$
- B)  $\frac{5-x}{2}$
- C)  $\frac{x-5}{2}$
- D)  $5 + 2x$

31. George passes 60 meters in one minute. What is his average speed in kilometers per hour?

- A)  $3 \frac{km}{h}$
- B)  $3.2 \frac{km}{h}$
- C)  $3.4 \frac{km}{h}$
- D)  $3.6 \frac{km}{h}$

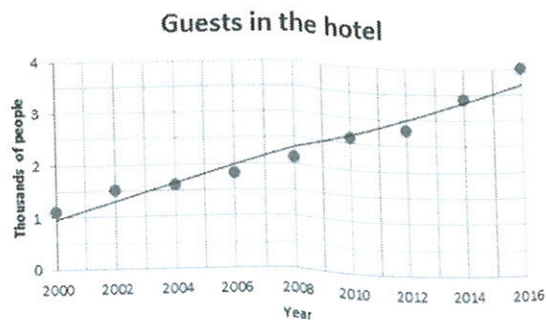
32. A taxi driver charges \$5 for start and \$3 for every additional mile. If  $d$  represents the distance in miles, which of the following inequalities describes the set of miles where the cost is at or above \$20?

- A)  $5 + 3d \geq 20$
- B)  $5 - 3d \geq 20$
- C)  $20 - 5d \geq 3$
- D)  $3 + 5d \geq 20$

33. How many 3-digit numbers can be formed using digits 2, 3, 4, 5 and 6 with no repeats?

- A) 15
- B) 60
- C) 125
- D) 243

34.



According to the line of best fit in the scatterplot above, which of the following best approximates the year in which the number of guests in the hotel was estimated to be 2,500?

- A) 2006
- B) 2007
- C) 2008
- D) 2009

35. The distance traveled by the Moon in one orbit around the Earth is about 2,592,000 km. The Moon makes one complete orbit

around the Earth in 30 days. Of the following, which is closest to the average speed of the Moon, in kilometers per hour, as it orbits the Earth?

- A)  $3,600 \frac{km}{h}$   
 B)  $3,700 \frac{km}{h}$   
 C)  $3,800 \frac{km}{h}$   
 D)  $3,900 \frac{km}{h}$

36. Workers in the factory

	Males	Females
White	42	15
Black	66	27

The table above summarizes the number of 150 workers in the factory. If one of females is chosen at random for a survey, what is the probability that the female chosen is black?

- A)  $\frac{27}{150}$   
 B)  $\frac{27}{93}$   
 C)  $\frac{27}{42}$   
 D)  $\frac{42}{150}$
37. Ethan weighs 85 kg. Mike is 20% lighter than Liam. How heavy is Liam?
- A) 65 kg  
 B) 66 kg  
 C) 67 kg  
 D) 68 kg
38. A survey was taken of the height of students in the school, and it was found that the median height was 168 cm and the

mean height was 175 cm. Which of the following situations could explain the difference between the mean and median height in the school?

- A) The students have heights that are close to each other  
 B) There are a few students whose heights are less than the rest  
 C) There are a few students whose heights are much more than the rest  
 D) Many students have heights between 168 cm and 175 cm

**Questions 39 and 40 refer to the following information.**

A researcher chose 40 people at random from the two streets and asked each of them how many pets he/she has. The results are shown in the table below.

Number of pets	Street A	Street B
0	7	6
1	6	8
2	5	5
3	2	1

There are a total of 300 people at Street A and 200 people at Street B.

39. What is the median number of pets for all the people surveyed?
- A) 0  
 B) 1  
 C) 2  
 D) 3
40. Based on the survey data, which of the following most accurately compares the expected total number of people with 2 pets at two streets?

- A) The total number of people with 2 pets is expected to be equal at two streets
- B) The total number of people with 2 pets at Street A is expected to be 25 more than at Street B
- C) The total number of people with 2 pets at Street B is expected to be 25 more than at Street A
- D) The total number of people with 2 pets at Street A is expected to be 100 more than at Street B

41. Noah estimates that Emma weighs  $x$  kg, where  $x > 50$  kg. The goal is for the estimate to be within 10 kg of the Emma's actual weight. If Noah meets the goal and Emma weighs  $y$  kg, which of the following inequalities represents the relationship between the estimated weight and the actual weight?

- A)  $x + y < 10$
- B)  $y > x + 10$
- C)  $y < x - 10$
- D)  $-10 < x - y < 10$

**Questions 42 and 43 refer to the following information.**

$$T = \frac{H}{6\pi r^2}$$

At a large distance  $r$  from the Sun, the temperature  $T$  of the planet is related to the heat  $H$  of the Sun by the formula above.

42. Which of the following expresses the square distance from the Sun in terms of the temperature and heat?

A)  $r^2 = \frac{HT}{6\pi}$

B)  $r^2 = \frac{H}{6\pi T}$

C)  $r^2 = \frac{6\pi}{HT}$

D)  $r^2 = \frac{T}{6\pi H}$

43. The temperature of Planet A is 9 times the temperature of Planet B. The distance of Planet A from the Sun is what fraction of the distance of Planet B from the Sun?

A)  $\frac{1}{2}$

B)  $\frac{1}{3}$

C)  $\frac{1}{4}$

D)  $\frac{1}{5}$

44. What is the radius of the circle:

$$x^2 + y^2 + 8x + 4y = 5?$$

A) 4

B) 5

C) 6

D) 8

45. The graph of the linear function  $f$  has intercepts at  $(a, 0)$  and  $(0, b)$  in the  $xy$ -plane. If  $ab = 1$ , which of the following is true about the slope of the graph  $f$ ?

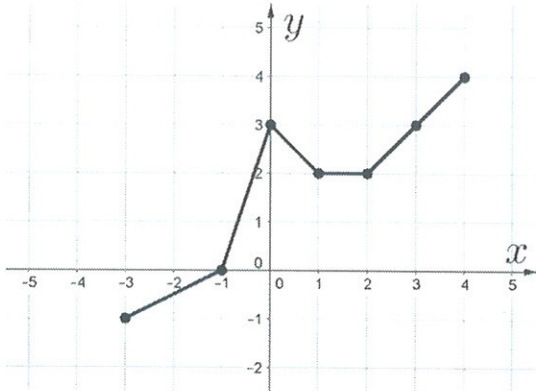
A) It is positive

B) It is negative

C) It equals zero

D) It is undefined

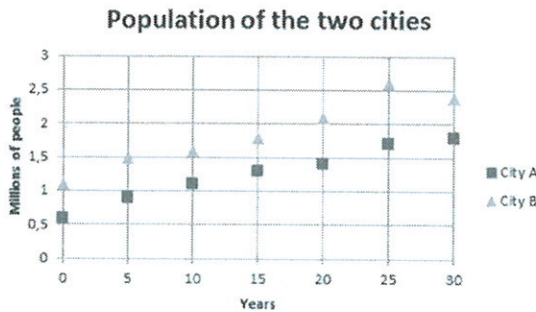
46.



The complete graph of the function  $f$  is shown in the  $xy$ -plane above. Which of the following are equal to 3?

- I.  $f(-3)$
  - II.  $f(2)$
  - III.  $f(3)$
- A) III only  
 B) I and II only  
 C) II and III only  
 D) I, II and III

47.



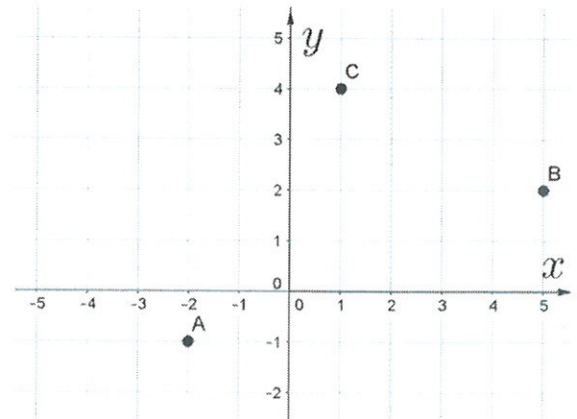
The graph above shows the population of the two cities at 5-year intervals. Which of the following statements correctly compares the average rates at which populations of the two cities change?

- A) In every 5-year interval, the magnitude of the rate of change of population of

the City A is greater than that of the City B

- B) In every 5-year interval, the magnitude of the rate of change of population of the City B is greater than that of the City A
- C) In the intervals from 0 to 5 years and from 5 to 10 years, the rates of change of population of the City A are of greater magnitude, whereas in the intervals from 20 to 25 years and from 25 to 30 years the rates of change of population of the City B are of greater magnitude
- D) In the intervals from 0 to 5 years and from 5 to 10 years, the rates of change of population of the City B are of greater magnitude, whereas in the intervals from 20 to 25 years and from 25 to 30 years the rates of change of population of the City A are of greater magnitude

48.



What is the equation of line which passes through the point C, parallel to line  $\overline{AB}$ ?

- A)  $7x + 3y - 19 = 0$   
 B)  $3x - 7y - 1 = 0$   
 C)  $3x - 7y + 25 = 0$   
 D)  $5x - 3y - 4 = 0$



49.

$$y = ax^2 + bx + c$$
$$y = 5$$

In the system of equations above,  $a$ ,  $b$  and  $c$  are constants. For which of the following values of  $a$ ,  $b$  and  $c$  does the system of equations have no real solution?

- A)  $a = 0, b = 1, c = 2$
- B)  $a = 1, b = 0, c = 9$
- C)  $a = 2, b = 1, c = 0$
- D)  $a = 1, b = 1, c = 1$

50. The area of a regular hexagon is  $54\sqrt{3}$ . What is the circumference of a circle circumscribed around a hexagon?

- A)  $3\pi$
- B)  $6\pi$
- C)  $12\pi$
- D)  $24\pi$

**Student-Produced Responses**

51. The price of an ounce of gold is increasing at a rate of \$8.5 per year. How long will it take, in years, for the price of an ounce of gold to increase by \$51?

52. If  $d$  days and 4 hours is equal to 100 hours, what is the value of  $d$ ?

53. In the  $xy$ -plane, the point  $(3, -4)$  lies on the graph of the line  $f(x) = \frac{2}{3}x - n$ . What is the value of  $n$ ?

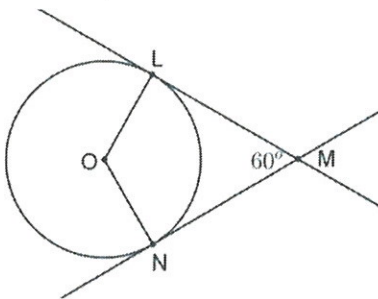
54. There are 24 students in the class and 8 girls more than boys. How many boys are there?

55.

$$a = 2,000 - 300t$$

Sarah spends the same amount of money in the shopping mall every week. The equation above models the amount  $a$ , in dollars, remained to Sarah after  $t$  weeks. According to the model, how many dollars does Sarah spend every week?

56.



In the figure above, point  $O$  is the center of the circle, line segments  $LM$  and  $MN$  are tangent to the circle at points  $L$  and  $N$ , respectively, and the segments intersect at point  $M$  as shown. If  $LM = 4\sqrt{3}$ , what is the length of the minor arc  $\widehat{LN}$ ?

Questions 57 and 58 refer to the following information.

The current level of water in the tank is 6 inches. The level of water can be predicted using the formula below, where  $L_{\text{tomorrow}}$  is the expected level of water tomorrow,  $L_{\text{today}}$  is the level of water today, and  $L$  is the maximum level of water in the last 10 days.

$$L_{\text{tomorrow}} = L_{\text{today}} + 0.8(L_{\text{today}}) \left( 1 - \frac{L_{\text{today}}}{P} \right)$$

57. According to the formula, what will be the level of water two days from now if  $L = 12$ ? (Round your answer to the nearest whole number)

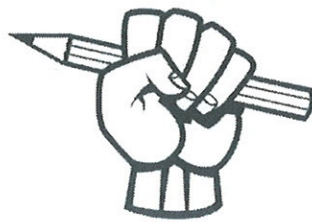
58. If the level of water tomorrow is 8 inches and the level of water today is 6 inches, what was the maximum level of water in the last 10 days? (Round your answer to the nearest whole number)

**No Test Material On This Page**

Test 2 Answer Key

1	D	21	A	41	D
2	C	22	D	42	B
3	A	23	D	43	B
4	B	24	B	44	B
5	D	25	B	45	B
6	D	26	D	46	A
7	C	27	A	47	B
8	C	28	C	48	C
9	B	29	B	49	B
10	A	30	B	50	C
11	D	31	D	51	6
12	B	32	A	52	4
13	B	33	B	53	6
14	C	34	D	54	8
15	B	35	A	55	300
16	2	36	C	56	8.38
17	0	37	D	57	12
18	9	38	C	58	14
19	3	39	B		
20	2.5 or 5/2	40	B		

# TEST 3



**ANSWER SHEET**

**Section 3**

- 1  A  B  C  D  
 2  A  B  C  D  
 3  A  B  C  D

- 4  A  B  C  D  
 5  A  B  C  D  
 6  A  B  C  D

- 7  A  B  C  D  
 8  A  B  C  D  
 9  A  B  C  D

- 10  A  B  C  D  
 11  A  B  C  D  
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- 13  A  B  C  D  
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**Section 4**

- 21  A  B  C  D  
 22  A  B  C  D  
 23  A  B  C  D  
 24  A  B  C  D  
 25  A  B  C  D  
 26  A  B  C  D

- 27  A  B  C  D  
 28  A  B  C  D  
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 32  A  B  C  D

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 38  A  B  C  D

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Section 3

Math Test – No Calculator

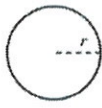
Allotted Time: 25 Minutes

Number of Questions: 20

Calculator **NOT** permitted.

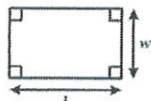


Reference Formulas



$$A = \pi r^2$$

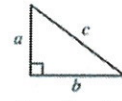
$$C = 2\pi r$$



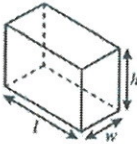
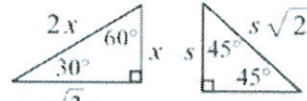
$$A = lw$$



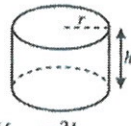
$$A = \frac{1}{2}bh$$



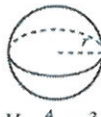
$$c^2 = a^2 + b^2$$



$$V = lwh$$



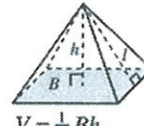
$$V = \pi r^2 h$$



$$V = \frac{4}{3}\pi r^3$$



$$V = \frac{1}{3}\pi r^2 h$$



$$V = \frac{1}{3}Bh$$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is  $2\pi$ .

The sum of the measures in degrees of the angles of a triangle is 180.



1. If  $x^4 - 16 = 0$ , what is the value of  $\sqrt{20 - x^2}$ ?

- A) 2
- B) 3
- C) 4
- D) 5

2.

$$\begin{aligned} -2x + 5y &= 14 \\ 5x - y &= -12 \end{aligned}$$

If ordered pair  $(x, y)$  is a solution of the system of equations above, what is the value of  $|x - y|$ ?

- A) 3
- B) 4
- C) 5
- D) 6

3. George is the owner and the only employee in his café. He estimates the profit of his café using the formula  $16pn - r$ , where  $n$  is the number of drinks sold per hour,  $p$  is the price of a drink and  $r$  is the rent he pays. Which of the following is the best interpretation of the number 16 in the expression?

- A) The total number of drinks sold
- B) The number of working hours
- C) The number of guests in the café
- D) The number of working days

4.

$$x^6 + 4x^3 + 4$$

Which of the following is equivalent to the expression shown above?

- A)  $(x + 2)^6$
- B)  $(x^2 + 2)^3$
- C)  $(x^3 + 2)^2$

D)  $(x + 2)^3$

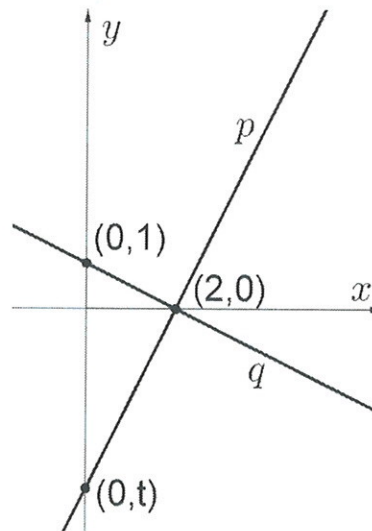
5.

$$\sqrt{19 + x^4} - k = 0$$

If  $x < 0$  and  $k = 10$ , what is the value of  $x$ ?

- A) -3
- B) -1
- C) 1
- D) 3

6.



In the  $xy$ -plane above, line  $p$  is perpendicular to line  $q$ . What is the value of  $t$ ?

- A) -5
- B) -4
- C) -3
- D) -2

7. If  $3x + 2y - 4z = 2$ , what is the value of

$$\frac{125^x 25^y}{625^z} ?$$

- A) 25  
B) 26  
C) 27  
D) 28

8. Noah has 70 marbles. He wants to give an equal number of marbles to each of his friends. If he gives 6 or more marbles to each friend, what is the maximum number of friends who will get marbles from Noah?

- A) 8  
B) 9  
C) 10  
D) 11

9. Which of the following lines passes through  $(-3, 4)$  and is perpendicular to the line  $-2x + 3y + 4 = 0$ ?

- A)  $y = \frac{3}{2}x + \frac{1}{2}$   
B)  $y = \frac{3}{2}x - \frac{1}{2}$   
C)  $y = -\frac{3}{2}x + \frac{1}{2}$   
D)  $y = -\frac{3}{2}x - \frac{1}{2}$

10. Which of the following lines DO NOT pass through the 3<sup>rd</sup> quadrant?

- A)  $-4x + 3y = -7$   
B)  $-4x + 5y = 11$   
C)  $5x + 4y = 17$   
D)  $6x + 5y = -13$

11. Calculate  $(1 - i)^{10}$

- A)  $-16i$   
B) 16  
C)  $-32i$   
D) 32

12.

$$P = \frac{B}{B + G}$$

The formula above shows the percentage ( $P$ ) of boys ( $B$ ) among the students in the class. Which of the following expresses the number of girls ( $G$ ) in term of other variables?

- A)  $G = \frac{B(1-P)}{P}$   
B)  $G = \frac{P(1-B)}{B}$   
C)  $G = \frac{1-P}{PB}$   
D)  $G = \frac{1-B}{PB}$

13. What is the sum of all values of  $x$  that satisfy  $16x^4 - 81 = 0$ ?

- A) 0  
B) 1  
C) 2  
D) 4

14. The level of the river increases 2% every hour. If the initial level of the river is 56 cm, which of the following functions  $f$  models the level of the river  $t$  hours later?

- A)  $f(t) = 56(0.8)^t$   
B)  $f(t) = 56(0.98)^t$   
C)  $f(t) = 56(1.02)^t$   
D)  $f(t) = 56(1.2)^t$

15.

$$\frac{3 - 4x}{2x + 5}$$

Which of the following is equivalent to the expression above?

- A)  $\frac{13}{2x+5} - 2$   
 B)  $2 - \frac{13}{2x+5}$   
 C)  $-2$   
 D)  $2$

**Student-Produced Responses**

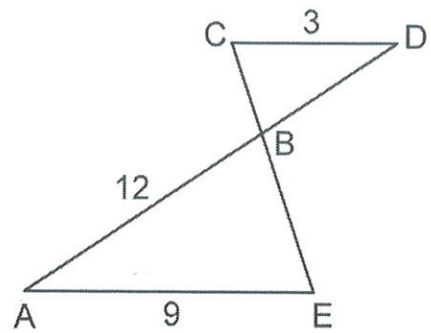
16. There are 16 wheels on the parking lot. Ethan has a parking lot for cars and bicycles. If there is at least one car, and at least one bicycle on the parking lot, what is one possible number for the number of bicycles?

17.

$$ax(bx - c) + 2(dx + 5) = mx^2 + nx + k$$

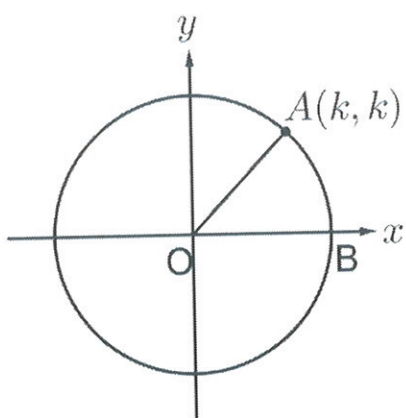
The equation above is true. What is the value of  $k$ ?

18.



In the figure above  $\overline{AE} \parallel \overline{CD}$ , and segment  $AD$  intersects segment  $CE$  at  $B$ . What is the length of segment  $AD$ ?

19.



In the  $xy$ -plane above,  $O$  is the center of the circle, and the measure of  $\angle AOB$  is  $\frac{\pi}{a}$ . What is the value of  $a$ ?

20.

$$\begin{aligned} 6ax + (a - 2b)y &= 20 \\ 3x - y &= 10 \end{aligned}$$

What must be the value of  $\frac{b}{a}$  so that system of equations above has infinitely many solutions?

## Section 4

Math Test – Calculator

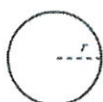
Allotted Time: 55 Minutes

Number of Questions: 38

Calculator IS allowed.

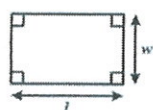


## Reference Formulas

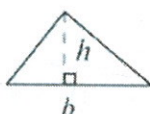


$$A = \pi r^2$$

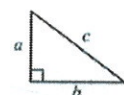
$$C = 2\pi r$$



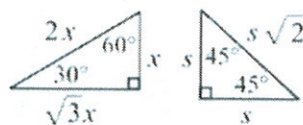
$$A = lw$$



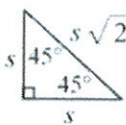
$$A = \frac{1}{2}bh$$



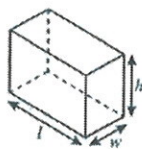
$$c^2 = a^2 + b^2$$



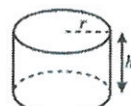
$$\sqrt{3}x$$



$$s$$



$$V = lwh$$



$$V = \pi r^2 h$$



$$V = \frac{4}{3}\pi r^3$$



$$V = \frac{1}{3}\pi r^2 h$$



$$V = \frac{1}{3}Bh$$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is  $2\pi$ .

The sum of the measures in degrees of the angles of a triangle is 180.

21. There are  $c$  cows and  $h$  hens on the farm. Which of the following represents the total number of their legs on the farm?
- A)  $4(c + h)$   
 B)  $2(c + h)$   
 C)  $2(2c + h)$   
 D)  $2(c + 2h)$
22. A soccer player scored 2 goals in 5 games. What is the expected number of goals in 35 games?
- A) 14  
 B) 15  
 C) 16  
 D) 17
23.  $g = 4 + 0.25h$   
 The number of goals scored,  $g$ , depends on the number of hours of training,  $h$ . What is  $h$  when  $g$  is 12?
- A) 30  
 B) 31  
 C) 32  
 D) 33
- Questions 24 and 25 refer to the following information.**
- The number of visitors on an art exhibition, 320, is directly proportional to the number of free beers per visitor, 2.
24. How many visitors are expected if the number of free beers per visitor is 3?
- A) 480  
 B) 490  
 C) 500  
 D) 510
25. Fifteen percent of the visitors do not drink beer. How many visitors drink beer if the number of free beers per visitor is 2?
- A) 270  
 B) 271  
 C) 272  
 D) 273
26. If 6 times the number  $x$  is added to 9, the result is 27. What number results if 4 is subtracted from 2 times  $x$ ?
- A) 2  
 B) 3  
 C) 4  
 D) 5
27. Find vertex of the parabola  $y = x^2 - 4x + 5$ .
- A)  $(-2, 1)$   
 B)  $(2, 1)$   
 C)  $(2, -1)$   
 D)  $(-2, -1)$
28. Ethan has  $k$  apples. He gives 4 apples to each of his 7 friends. If he has 16 apples left over, what is the value of  $k$ ?
- A) 34  
 B) 44  
 C) 54  
 D) 64
29. Hotel has  $x$  2-bedrooms and  $y$  3-bedrooms. The total number of rooms is less than 25, and the total number of beds is less than 70. Which of the following systems of inequalities represents this relationship?
- A)  $3x + 2y < 25$   
 $x + y < 70$

B)  $3x + 2y < 70$

$x + y < 25$

C)  $2x + 3y < 70$

$x + y < 25$

D)  $\frac{x}{2} + \frac{y}{3} < 70$

$x + y < 25$

30. If  $f(x) = 3 + 5x$  and  $f \cdot g = 1$ , what is the value of  $g(x)$ ?

A)  $\frac{x-3}{5}$

B)  $\frac{x+3}{5}$

C)  $3 - 5x$

D)  $5x - 3$

31. The speed limit in the city is  $50 \frac{km}{h}$ . Which of the following is closest to the speed in miles per hour? Note:  $1 \text{ mi} \approx 1.6 \text{ km}$

A)  $30 \frac{mi}{h}$

B)  $45 \frac{mi}{h}$

C)  $60 \frac{mi}{h}$

D)  $80 \frac{mi}{h}$

32. Sarah's starting salary is \$800. She also gets \$15 for every item sold in the shop. If  $k$  represents the number of items sold, which of the following inequalities describes the set of items where the total salary is at or above \$1,000?

A)  $800 + 15k \geq 1,000$

B)  $800 - 15k \geq 1,000$

C)  $15 - 800k \geq 1,000$

D)  $800k + 15 \geq 1,000$

33. How many different groups of 3 people can be formed of 10 people?

A) 110

B) 120

C) 130

D) 140

34.



According to the line of best fit in the scatterplot above, which of the following best approximates the year in which the annual salary was estimated to be \$35,000?

A) 2006

B) 2008

C) 2015

D) 2016

35. The distance traveled by Venus in one orbit around the Sun is about 422,500,000 miles. Venus makes one complete orbit around the Sun in 7 Earth months. Of the following, which is closest to the average speed of Venus, in miles per hour, as it orbits the Sun?

A)  $60,000 \frac{mi}{h}$

B)  $70,000 \frac{mi}{h}$

C)  $80,000 \frac{mi}{h}$

D)  $90,000 \frac{mi}{h}$

36. Students in the class who plays guitar or piano

	Girls	Boys
Guitar	6	9
Piano	4	5

The table above summarizes the number of 24 students. If one of girls is chosen at random for a concert, what is the probability that a girl chosen plays guitar?

- A)  $\frac{3}{5}$   
 B)  $\frac{2}{5}$   
 C)  $\frac{6}{25}$   
 D)  $\frac{4}{25}$
37. Olivia earns \$2,400 monthly. Next month, her salary will be increased by 12%. What is Olivia's new salary?
- A) \$2,688  
 B) \$2,744  
 C) \$2,888  
 D) \$2,944
38. A survey was taken of the age of guests in the hotel, and it was found that the mean age was 23 years and the median age was 35 years. Which of the following situations could explain the difference between the mean and median age of guests in the hotel?
- A) The guests in the hotel have ages that are close to each other  
 B) There are a few guests in the hotel much younger than the rest  
 C) There are a few guests in the hotel much older than the rest

- D) Many guests in the hotel are between 23 and 35 years old

**Questions 39 and 40 refer to the following information.**

A researcher chose 80 employees at random from the two factories and asked each of them how many days of absence they have. The results are shown in the table below.

Number of days	Factory A	Factory B
0	14	5
1	9	9
2	11	18
3	6	8

There are a total of 400 employees at Factory A and 520 employees at Factory B.

39. What is the median number of days of absence for all the employees surveyed?
- A) 0  
 B) 1  
 C) 2  
 D) 3
40. Based on the survey data, which of the following most accurately compares the expected total number of employees with 1 day of absence at two factories?
- A) The total number of employees with 1 day of absence is expected to be equal at two factories  
 B) The total number of employees with 1 day of absence at Factory A is expected to be 27 more than at Factory B



- C) The total number of employees with 1 day of absence at Factory B is expected to be 27 more than at Factory A
- D) The total number of employees with 1 day of absence at Factory A is expected to be 120 less than at Factory B

41. Mia estimates that the bridge is  $x$  m long, where  $x > 200$  m. The goal is for the estimate to be within 20 m of the bridge actual length. If Mia meets the goal and the bridge is  $y$  m long, which of the following inequalities represents the relationship between the estimated length and the actual length?

- A)  $x + y < 20$
- B)  $y > x + 20$
- C)  $y < x - 20$
- D)  $-20 < y - x < 20$

**Questions 42 and 43 refer to the following information.**

$$P = \frac{F}{8r^2}$$

At a distance  $r$  from the orchard, the price of fruit  $P$  is related to the freshness of the fruit  $F$  by the formula above.

42. Which of the following expresses the square distance from the orchard in terms of the price and freshness?

- A)  $r^2 = \frac{PF}{8}$
- B)  $r^2 = \frac{F}{8P}$
- C)  $r^2 = \frac{8}{FP}$
- D)  $r^2 = \frac{P}{8F}$

43. For the same orchard, Merchant A set the price to be 25 times the price set by Merchant B. The distance of Merchant A from the orchard is what fraction of the distance of Merchant B from the orchard?

- A)  $\frac{1}{2}$
- B)  $\frac{1}{3}$
- C)  $\frac{1}{4}$
- D)  $\frac{1}{5}$

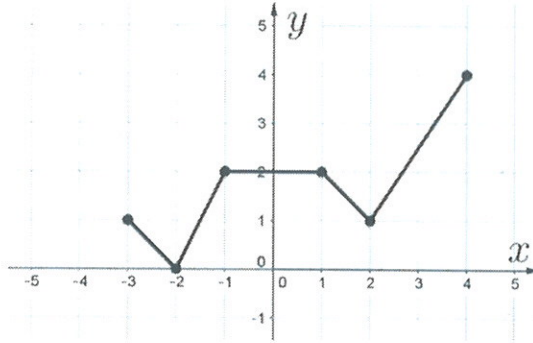
44. What is the center of the circle:  
 $x^2 + y^2 + 4x - 2y = 15$ ?

- A) (2, 1)
- B) (-2, 1)
- C) (2, -1)
- D) (-2, -1)

45. The graph of the linear function  $f$  has intercepts at  $(a, 0)$  and  $(0, b)$  in the  $xy$ -plane. If  $\frac{a}{b} = -1$ , which of the following is true about the slope of the graph  $f$ ?

- A) It is positive
- B) It is negative
- C) It equals zero
- D) It is undefined

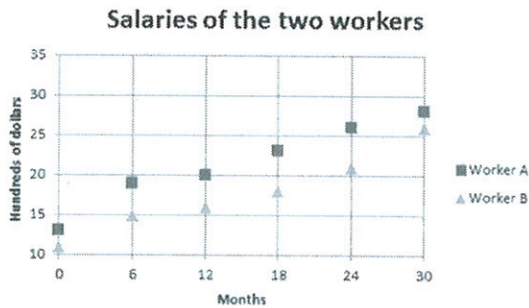
46.



The complete graph of the function  $f$  is shown in the  $xy$ -plane above. Which of the following are equal to 1?

- I.  $f(-3)$
  - II.  $f(-1)$
  - III.  $f(2)$
- A) III only  
 B) I and III only  
 C) II and III only  
 D) I, II and III

47.

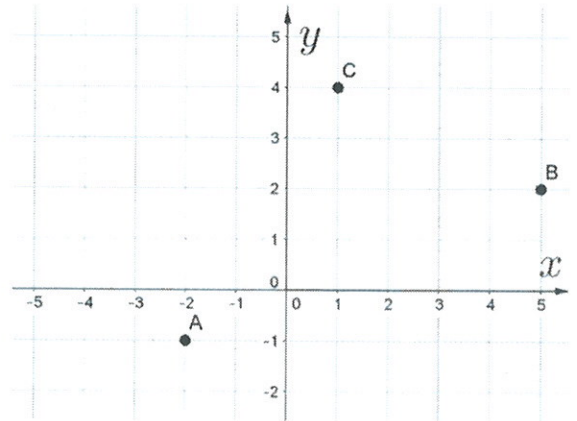


The graph above shows the salaries of the two workers at 6 months intervals. Which of the following statements correctly compares the average rates at which salaries of the two workers change?

- A) In every 6-months interval, the magnitude of the rate of change of salary of Worker A is greater than that of Worker B

- B) In every 6-months interval, the magnitude of the rate of change of salary of Worker B is greater than that of Worker A
- C) In the intervals from 0 to 6 months and from 6 to 12 months, the rates of change of salary of Worker A are of greater magnitude, whereas in the intervals from 24 to 30 months and from 30 to 36 months the rates of change of salary of Worker B are of greater magnitude
- D) In the intervals from 0 to 6 months and from 6 to 12 months, the rates of change of salary of Worker B are of greater magnitude, whereas in the intervals from 24 to 30 months and from 30 to 36 months the rates of change of salary of Worker A are of greater magnitude

48.



What must be the coordinates of D so that ABCD is a parallelogram?

- A) (6,1)  
 B) (-6,1)  
 C) (6,-1)  
 D) (-6,-1)

49.

$$y = ax^2 + bx + c$$
$$y = 1$$

In the system of equations above,  $a$ ,  $b$  and  $c$  are constants. For which of the following values of  $a$ ,  $b$  and  $c$  does the system of equations have two real solutions?

- A)  $a = 0, b = 1, c = 2$
- B)  $a = 1, b = 0, c = 2$
- C)  $a = 1, b = 2, c = 0$
- D)  $a = 2, b = 0, c = 1$

50. The area of a square is 8. What is the area of a circle circumscribed around a square?

- A)  $2\pi$
- B)  $4\pi$
- C)  $8\pi$
- D)  $16\pi$

**Student-Produced Responses**

51. The salary of worker is increasing at a rate of \$125 per month. How long will it take, in months, for the salary of worker to increase by \$500?

52. If  $w$  weeks and 5 days is equal to 40 days, what is the value of  $w$ ?

53. In the  $xy$ -plane, the point  $(2, 5)$  lies on the graph of the line  $\frac{x}{a} + \frac{y}{6} = 1$ . What is the value of  $a$ ?

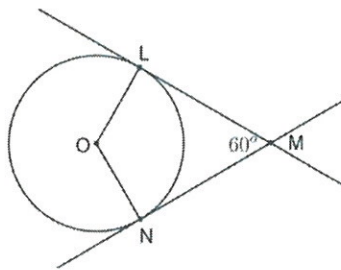
54. There are 110 red and blue marbles in a bag and 12 red marbles more than blue marbles. How many red marbles are there?

55.

$$l = 6h + 45$$

When the rain starts, the level of river starts to increase by the constant rate per hour. The equation above models the level of the river, in centimeters, after  $h$  hours. According to the model, what is the constant rate at which level of river increase?

56.



In the figure above, point  $O$  is the center of the circle, line segments  $LM$  and  $MN$  are tangent to the circle at points  $L$  and  $N$ , respectively, and the segments intersect at point  $M$  as shown. If the area of  $LMNO$  is  $4\sqrt{3}$ , what is the circumference of the circle?

**Questions 57 and 58 refer to the following information.**

The current number of rabbits in the forest is 40. The number of rabbits can be predicted using the formula below, where  $R_{\text{next month}}$  is the expected number of rabbits next month,  $R_{\text{this month}}$  is the number of rabbits this month, and  $R$  is the maximum number of rabbits in the last 10 months.

$$R_{\text{next month}} = R_{\text{this month}} + 0.6(R_{\text{this month}}) \left( 1 - \frac{R_{\text{this month}}}{R} \right)$$

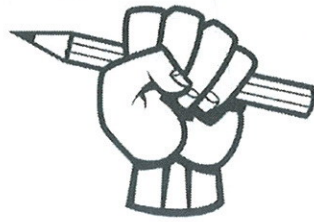
57. According to the formula, what will be the number of rabbits two months from now if  $R = 60$ ? (Round your answer to the nearest whole number)

58. If the number of rabbits next month is 48 and the number of rabbits this month is 40, what was the maximum number of rabbits in the last 10 months? (Round your answer to the nearest whole number)

Test 3 Answer Key

1	C	21	C	41	D
2	B	22	A	42	B
3	B	23	C	43	D
4	C	24	A	44	B
5	A	25	C	45	A
6	B	26	A	46	B
7	A	27	B	47	A
8	D	28	B	48	B
9	D	29	C	49	C
10	C	30	A	50	B
11	C	31	A	51	4
12	A	32	A	52	5
13	A	33	B	53	12
14	C	34	C	54	61
15	A	35	C	55	6
16	2, 4, or 6	36	A	56	12.6
17	10	37	A	57	57
18	16	38	B	58	60
19	4	39	C		
20	4.5 or $9/2$	40	C		

# TEST 4



**ANSWER SHEET****Section 3**1 A B C D  
   2 A B C D  
   3 A B C D  
   4 A B C D  
   5 A B C D  
   6 A B C D  
   7 A B C D  
   8 A B C D  
   9 A B C D  
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   12 A B C D  
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   14 A B C D  
   15 A B C D  
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/  .    0    1    2    3    4    5    6    7    8    9    17 

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/  .    0    1    2    3    4    5    6    7    8    9    18 

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/  .    0    1    2    3    4    5    6    7    8    9    19 

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/  .    0    1    2    3    4    5    6    7    8    9    20 

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/  .    0    1    2    3    4    5    6    7    8    9    **Section 4**21 A B C D  
   22 A B C D  
   23 A B C D  
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## Section 3

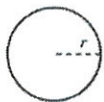
Math Test – No Calculator

Allotted Time: 25 Minutes

Number of Questions: 20

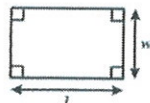
Calculator **NOT** permitted.

## Reference Formulas



$$A = \pi r^2$$

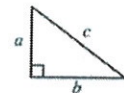
$$C = 2\pi r$$



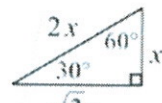
$$A = lw$$



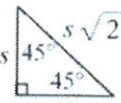
$$A = \frac{1}{2}bh$$



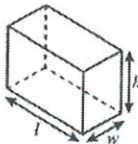
$$c^2 = a^2 + b^2$$



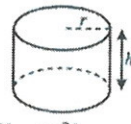
$$\sqrt{3}x$$



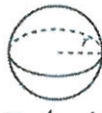
$$s$$



$$V = lwh$$



$$V = \pi r^2 h$$



$$V = \frac{4}{3}\pi r^3$$



$$V = \frac{1}{3}\pi r^2 h$$



$$V = \frac{1}{3}Bh$$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is  $2\pi$ .

The sum of the measures in degrees of the angles of a triangle is 180.

**No Test Material On This Page**

1. If  $\frac{x^2-3x-4}{x+1} = 0$ , what is the value of  $5 - \frac{x}{2}$ ?

- A) 2
- B) 3
- C) 4
- D) 5

2.

$$\begin{aligned} -6x + 7y &= 10 \\ 2x + 5y &= -18 \end{aligned}$$

If ordered pair  $(x, y)$  is a solution of the system of equations above, what is the value of  $\frac{x}{y}$ ?

- A) 2
- B) 3
- C) 4
- D) 5

3. George is the owner and the only employee in his café. He estimates the profit of his café using the formula  $nph - 2,000$ , where  $n$  is the number of drinks sold per hour,  $p$  is the price of a drink and  $h$  is the number of working hours. Which of the following is the best interpretation of the number 2,000 in the expression?

- A) The total number of drinks sold
- B) The number of working hours
- C) The number of guests in the café
- D) The rent George pays

4.

$$x^8 - 2x^4 + 1$$

Which of the following is equivalent to the expression shown above?

- A)  $(x - 1)(x + 1)(x^2 + 1)$

- B)  $(x - 1)^4$
- C)  $(x - 1)^8$
- D)  $(x - 1)^2(x + 1)^2(x^2 + 1)^2$

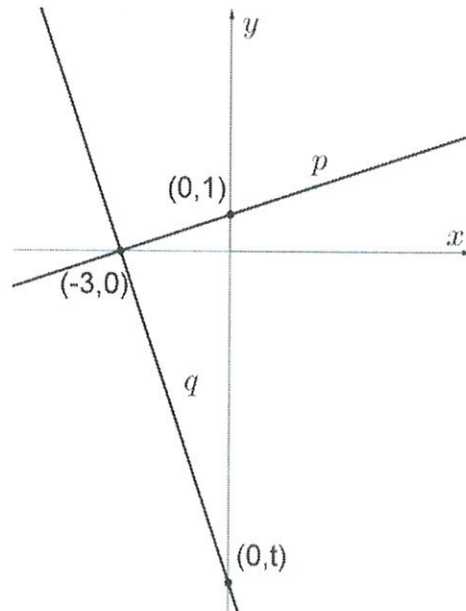
5.

$$\sqrt{2x^3 - 5} + k = 0$$

If  $k = 7$ , what is the value of  $x$ ?

- A) -3
- B) -1
- C) 1
- D) 3

6.



In the  $xy$ -plane above, line  $p$  is perpendicular to line  $q$ . What is the value of  $t$ ?

- A) -7
- B) -8
- C) -9
- D) -10

7. If  $5x + 3y + 4z = -4$ , what is the value of  $\frac{1}{32^x 8^y 16^z}$ ?

- A) 15
- B) 16
- C) 17
- D) 18

8. There are 420 students going on a trip. What is the maximum number of buses that can be fulfilled with students, if the number of seats in each bus is greater than or equal to 35?

- A) 10
- B) 11
- C) 12
- D) 13

9. How many different lines is determined by the points  $A(4,3)$ ,  $B(-1,3)$ ,  $C(-2,-5)$  and  $D(1,-1)$ ?

- A) 1
- B) 2
- C) 4
- D) 6

10. Which of the following lines DO NOT pass through the 4<sup>th</sup> quadrant?

- A)  $-4x + 3y = -7$
- B)  $-4x + 5y = 11$
- C)  $5x + 4y = 17$
- D)  $6x + 5y = -13$

11. Which of the following is equivalent to  $\sqrt{1+i}$ ?

- A)  $1 + \sqrt{i}$
- B)  $\sqrt{2i}$
- C)  $\sqrt[3]{2i}$
- D)  $\sqrt[4]{2i}$

12.

$$P = \frac{F}{M+F} \times 100$$

The formula above shows the percentage ( $P$ ) of females ( $F$ ) in the company. Which of the following expresses the percentage of males ( $M$ ) in terms of other variables?

- A)  $M = \frac{100-F}{FP}$
- B)  $M = \frac{100-P}{FP}$
- C)  $M = \frac{P(100-F)}{F}$
- D)  $M = \frac{F(100-P)}{P}$

13. Which of the following equations do not have solution?

- A)  $2x - 5 = 0$
- B)  $2x^2 + 8x - 9 = 0$
- C)  $x^3 + 8 = 0$
- D)  $x^4 + x^2 + 5 = 0$

14. Michael's salary decreases 5% every month. If the initial salary is \$4,000, which of the following functions  $f$  models the salary  $t$  months later?

- A)  $f(t) = 4000(0.5)^t$
- B)  $f(t) = 4000(0.95)^t$
- C)  $f(t) = 4000(1.05)^t$
- D)  $f(t) = 4000(1.5)^t$

15.

$$\frac{4x + 7}{x - 2}$$

Which of the following is equivalent to the expression above?

- A)  $4 + \frac{15}{x-2}$   
 B)  $4 - \frac{15}{x-2}$   
 C)  $-4$   
 D)  $4$

**Student-Produced Responses**

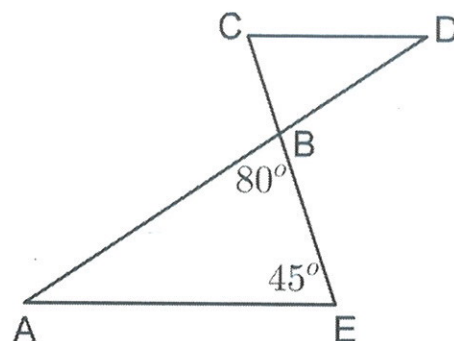
16. Sarah has parrots and cats. The total number of their legs is 14. If she has at least one parrot, and at least one cat, what is one possible number of parrots?

17.

$$ax(2x - 3) + b(4x + 1) = 8x^2 + 7x + 3$$

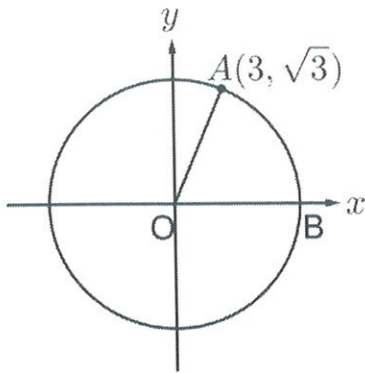
If the equation above is true for all values of  $x$ , what is the value of  $a + b$ ?

18.



In the figure above  $\overline{AE} \parallel \overline{CD}$ , and segment  $\overline{AD}$  intersects segment  $\overline{CE}$  at  $B$ . What is the measure of  $\angle D$ ?

19.



In the  $xy$ -plane above,  $O$  is the center of the circle, and the measure of  $\angle AOB$  is  $\frac{\pi}{a}$ . What is the value of  $a$ ?

20.

$$\begin{aligned}(a^2 + b^2)x + (a^2 - b^2)y &= 8 \\ 6x - 5y &= 4\end{aligned}$$

What must be the value of  $a^2$  so that system of equations above has infinitely many solutions?

## Section 4

Math Test – Calculator

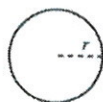
Allotted Time: 55 Minutes

Number of Questions: 38

Calculator IS allowed.

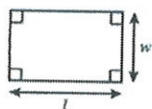


## Reference Formulas



$$A = \pi r^2$$

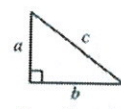
$$C = 2\pi r$$



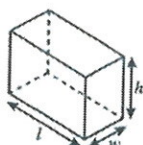
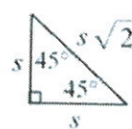
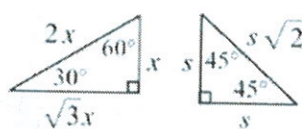
$$A = lw$$



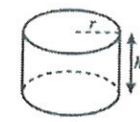
$$A = \frac{1}{2}bh$$



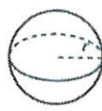
$$c^2 = a^2 + b^2$$



$$V = lwh$$



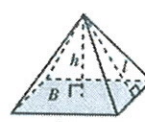
$$V = \pi r^2 h$$



$$V = \frac{4}{3}\pi r^3$$



$$V = \frac{1}{3}\pi r^2 h$$



$$V = \frac{1}{3}Bh$$

The number of degrees of arc in a circle is 360.

The number of radians of arc in a circle is  $2\pi$ .

The sum of the measures in degrees of the angles of a triangle is 180.

**No Test Material On This Page**



21. There are  $s$  bicycles and  $t$  cars on the parking lot. Which of the following represents the total number of their wheels?

- A)  $s + t$
- B)  $(s + t) \times 4 \times 2$
- C)  $2(2s + t)$
- D)  $2(s + 2t)$

22. In the sample of 200 bulbs, 8 are broken. What is the expected number of broken bulbs in the pack of 750 bulbs?

- A) 25
- B) 30
- C) 35
- D) 40

23.

$$w = 16 + 5m$$

The number of kilograms gained,  $w$ , depends on the number of meals,  $m$ . What is  $m$  when  $w$  is 86?

- A) 11
- B) 12
- C) 13
- D) 14

**Questions 24 and 25 refer to the following information.**

The number of happy people, 76, is directly proportional to the number of candies each of them ate, 2.

24. How many people will be happy if the number of candies eaten per person is increased to 5?

- A) 180
- B) 190

- C) 200
- D) 210

25. Twenty-five percent of happy people like only chocolate candies. How many happy people like only chocolate candies?

- A) 16
- B) 17
- C) 18
- D) 19

26. If 2 is added to 5 times the number  $x$ , the result is 27. What number results if 1 is added to 3 times  $x$ ?

- A) 12
- B) 14
- C) 16
- D) 18

27. Find  $y$ -intercept of the parabola  $y = (x + 2)(x - 6)$ .

- A) 2
- B) -4
- C) -6
- D) -12

28. There are  $k$  birds on the tree. Every minute 6 birds fly away. After 5 minutes, 12 birds left over. What is the value of  $k$ ?

- A) 40
- B) 42
- C) 44
- D) 46

29. There are  $x$  six-packs and  $y$  four-packs of coke. The total number of packs is less than 30, and the total number of bottles of coke is less than 150. Which of the following systems of inequalities represents this relationship?

- A)  $4x + 6y < 30$   
 $x + y < 150$
- B)  $6x + 4y < 30$   
 $x + y < 150$
- C)  $\frac{x}{4} + \frac{y}{6} < 150$   
 $x + y < 30$
- D)  $6x + 4y < 150$   
 $x + y < 30$

30. If  $f(x + 4) = 3x - 2$ , find  $f(x)$ .

- A)  $3x + 2$   
 B)  $3x - 6$   
 C)  $3x + 8$   
 D)  $3x - 14$

31. The top speed of housefly is 4.5 mph. What is the speed in kilometers per hour? Note:  $1 \text{ mi} \approx 1.6 \text{ km}$

- A)  $7.2 \frac{\text{km}}{\text{h}}$   
 B)  $7.4 \frac{\text{km}}{\text{h}}$   
 C)  $7.6 \frac{\text{km}}{\text{h}}$   
 D)  $7.8 \frac{\text{km}}{\text{h}}$

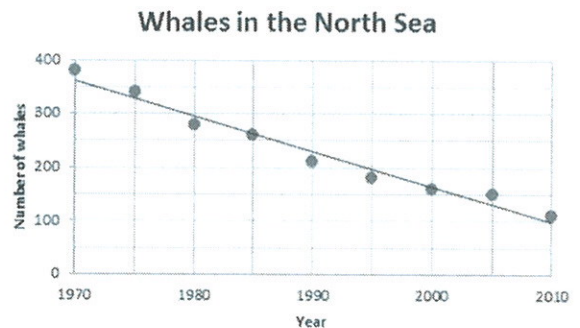
32. The level of water in the pool is 40 cm. It increases 5 cm every hour. If  $t$  represents the time, in hours, which of the following inequalities describes the set of hours where the level of water is at or above 60 cm?

- A)  $40 - 5t \geq 60$   
 B)  $40 + 5t \geq 60$   
 C)  $5t - 40 \geq 60$   
 D)  $40t - 5 \geq 60$

33. There are 6 blue and 9 red marbles in a bag. Three marbles are picked at random. What is the probability of picking 2 blue and 1 red marble?

- A) 20%  
 B) 25%  
 C) 30%  
 D) 35%

34.



According to the line of best fit in the scatterplot above, which of the following best approximates the year in which the number of whales in the North Sea was estimated to be 250?

- A) 1987  
 B) 1990  
 C) 1993  
 D) 1997

35. The distance sailed by the ship between two ports is 400 miles. The ship sails one week. Of the following, which is closest to the average speed of the ship, in miles per hour, as it sails between two ports?

- A)  $1 \frac{\text{mi}}{\text{h}}$   
 B)  $2 \frac{\text{mi}}{\text{h}}$   
 C)  $3 \frac{\text{mi}}{\text{h}}$   
 D)  $4 \frac{\text{mi}}{\text{h}}$

36. Apples in a bag

	Red	Green
Big	24	9
Small	8	19

The table above summarizes the number of 60 apples. If one of green apples is chosen at random, what is the probability that an apple chosen is small?

- A)  $\frac{19}{9}$   
 B)  $\frac{8}{19}$   
 C)  $\frac{8}{60}$   
 D)  $\frac{19}{28}$
37. Oliver's car is 5 m long. It is 18% longer than Carter's car. How long is Carter's car?
- A) 4 m  
 B) 4.1 m  
 C) 4.82 m  
 D) 4.92 m
38. A survey was taken of the salaries of employees in the company, and it was found that the median salary was \$2,600 and the mean salary was \$4,300. Which of the following situations could explain the difference between the mean and median salary of employees in the company?
- A) The employees in the company have salaries that are close to each other  
 B) There are a few employees in the company whose salaries are less than the rest  
 C) There are a few employees in the company whose salaries are much more than the rest

- D) Many employees in the company have salaries between \$2,600 and \$4,300

**Questions 39 and 40 refer to the following information.**

A researcher chose 60 guests at random from the two hotels and asked each of them how many credit cards he/she has. The results are shown in the table below.

Number of credit cards	Hotel A	Hotel B
0	12	7
1	8	9
2	6	10
3	4	4

There are a total of 420 guests at Hotel A and 300 guests at Hotel B.

39. What is the median number of credit cards for all the guests surveyed?
- A) 0  
 B) 1  
 C) 2  
 D) 3
40. Based on the survey data, which of the following most accurately compares the expected total number of guests with 3 credit cards at two hotels?
- A) The total number of guests with 3 credit cards is expected to be equal at two hotels  
 B) The total number of guests with 3 credit cards at Hotel A is expected to be 16 more than at Hotel B  
 C) The total number of guests with 3 credit cards at Hotel B is expected to be 16 more than at Hotel A

- D) The total number of guests with 3 credit cards at Hotel A is expected to be 120 more than at Hotel B

41. Liam estimates that the tree is  $x$  m high, where  $x > 20$  m. The goal is for the estimate to be within 2 m of the tree actual height. If Liam meets the goal and the tree is  $y$  m high, which of the following inequalities represents the relationship between the estimated height and the actual height?

- A)  $x + y < 2$   
 B)  $y > x + 2$   
 C)  $y < x - 2$   
 D)  $-2 < y - x < 2$

Questions 42 and 43 refer to the following information.

$$W = \frac{A}{3\pi r^2}$$

At a distance  $r$  from the meadow, the weight  $W$  of cow is related to the area  $A$  of the meadow by the formula above.

42. Which of the following expresses the square distance from the meadow in terms of the weight and area?

- A)  $r^2 = \frac{WA}{3\pi}$   
 B)  $r^2 = \frac{A}{3\pi W}$   
 C)  $r^2 = \frac{3\pi}{WA}$   
 D)  $r^2 = \frac{W}{3\pi A}$

43. For the same meadow, Cow A is 4 times heavier than Cow B. The distance of Cow A from the meadow is what fraction of the distance of Cow B from the meadow?

- A)  $\frac{1}{2}$   
 B)  $\frac{1}{3}$   
 C)  $\frac{1}{4}$   
 D)  $\frac{1}{5}$

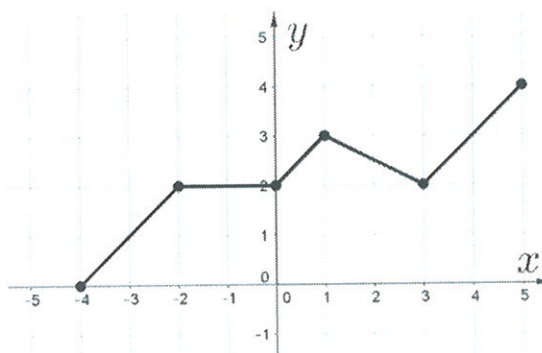
44. What is the radius of the circle  $x^2 + y^2 + 4x + 6y = 87$ ?

- A) 4  
 B) 6  
 C) 8  
 D) 10

45. The graph of the linear function  $f$  has intercepts at  $(-a, 0)$  and  $(0, b)$  in the  $xy$ -plane. If  $a - b = 0$ , which of the following is true about the slope of the graph  $f$ ?

- A) It is positive  
 B) It is negative  
 C) It equals zero  
 D) It is undefined

46.

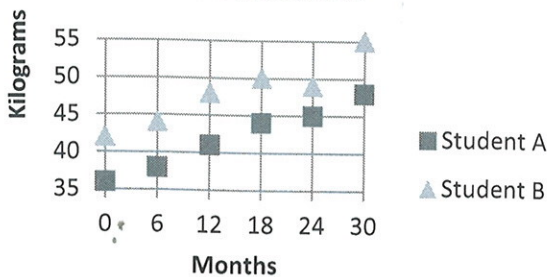


The complete graph of the function  $f$  is shown in the  $xy$ -plane above. Which of the following are equal to 2?

- I.  $f(-2)$
  - II.  $f(0)$
  - III.  $f(3)$
- A) III only
  - B) I and II only
  - C) II and III only
  - D) I, II and III

47.

### The weights of the two students

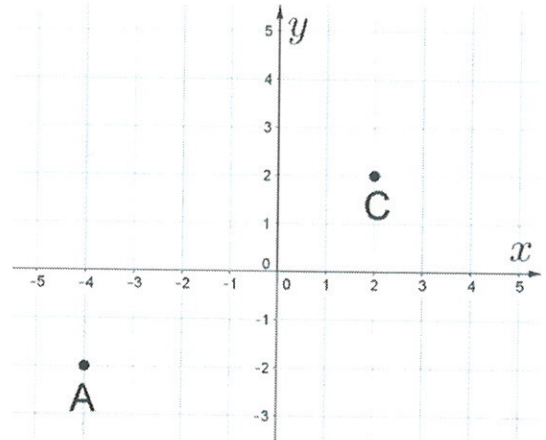


The graph above shows the weights of the two students at 6 months intervals. Which of the following statements correctly compares the average rates at which weights of the two students change?

- A) In every 6-month interval, the magnitude of the rate of change of weight of Student A is greater than that of Student B
- B) In every 6-month interval, the magnitude of the rate of change of weight of Student B is greater than that of Student A
- C) In the intervals from 0 to 6 months and from 6 to 12 months, the rates of change of weight of Student A are of greater magnitude, whereas in the intervals from 24 to 30 months and from 30 to 36 months the rates of change of weight of Student B are of greater magnitude

- D) In the intervals from 0 to 6 months and from 6 to 12 months, the rates of change of weight of Student B are of greater magnitude, whereas in the intervals from 24 to 30 months and from 30 to 36 months the rates of change of weight of Student A are of greater magnitude

48.



Points A and C are the opposite vertices of a square ABCD. What is the equation of line  $\overline{BD}$ ?

- A)  $y = \frac{3}{2}x + \frac{3}{2}$
- B)  $y = -\frac{3}{2}x + \frac{3}{2}$
- C)  $y = \frac{3}{2}x - \frac{3}{2}$
- D)  $y = -\frac{3}{2}x - \frac{3}{2}$

49.

$$\begin{aligned} y &= ax^2 + bx + c \\ y &= 1 \end{aligned}$$

In the system of equations above,  $a$ ,  $b$  and  $c$  are constants. For which of the following values of  $a$ ,  $b$  and  $c$  does the system of equations have no real solution?

- A)  $a = 0, b = 1, c = 2$
- B)  $a = 1, b = 0, c = 2$

- C)  $a = 1, b = 2, c = 0$   
D)  $a = 2, b = 0, c = 1$

50. The area of a square is 32. What is the circumference of a circle circumscribed around a square?

- A)  $2\pi$   
B)  $4\pi$   
C)  $8\pi$   
D)  $16\pi$

**Student-Produced Responses**

51. The weight of a man is decreasing at a rate of 1.8 kg per week. How long will it take, in weeks, for the weight of a man to decrease by 9 kg?

52. If  $p$  pounds and 4 ounces are equal to 100 ounces, what is the value of  $p$ ?

53. In the  $xy$ -plane, the point  $(-3, -5)$  lies on the graph of the function  $f(x) = kx^2 - 3x + 4$ . What is the value of  $k$ ?

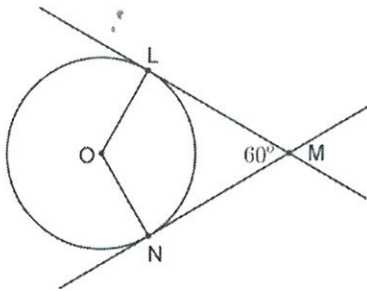
54. There are 48 red and green apples in a bag and 10 red apples more than green apples. How many green apples are there?

55.

$$a = 2,000 - 300t$$

Sarah spends the same amount of money in the shopping mall every week. The equation above models the amount  $a$ , in dollars, remained to Sarah after  $t$  weeks. According to the model, what was the initial amount Sarah had?

56.



In the figure above, point  $O$  is the center of the circle, line segments  $LM$  and  $MN$  are tangent to the circle at points  $L$  and  $N$ , respectively, and the segments intersect at point  $M$  as shown. If the perimeter of  $LMNO$  is  $12(1 + \sqrt{3})$ , what is the length of the minor arc  $\widehat{LN}$ ?

Questions 57 and 58 refer to the following information.

The current number of cars in the town is 1500. The number of cars can be predicted using the formula below, where  $C_{\text{next year}}$  is the expected number of cars next year,  $C_{\text{this year}}$  is the number of cars this year, and  $C$  is the maximum number of cars in the last 10 years.

$$C_{\text{next year}} = C_{\text{this year}} + 0.4(C_{\text{this year}}) \left(1 - \frac{C_{\text{this year}}}{C}\right)$$

57. According to the formula, what will be the number of cars two years from now if  $C = 3000$ ? (Round your answer to the nearest thousand)

58. If the number of cars next year is 1900 and the number of cars this year is 1500, what was the maximum number of cars in the last 10 years? (Round your answer to the nearest thousand)

Test 4 Answer Key

1	B	21	D	41	D
2	A	22	B	42	B
3	D	23	D	43	A
4	D	24	B	44	D
5	D	25	D	45	A
6	C	26	C	46	D
7	B	27	D	47	B
8	C	28	B	48	D
9	C	29	D	49	B
10	B	30	D	50	C
11	D	31	B	51	5
12	D	32	B	52	6
13	D	33	C	53	-2
14	B	34	A	54	19
15	A	35	B	55	2000
16	1, 3, or 5	36	D	56	12.6
17	7	37	B	57	1323
18	55	38	C	58	4500
19	3	39	B		
20	1	40	B		



# FULL SOLUTIONS

# TEST 1

1. The answer is A.

$$\frac{3-x}{2} = 5$$

$$2 \times \frac{3-x}{2} = 2 \times 5$$

$$\begin{aligned} 3-x &= 10 \\ -x &= 10-3 \\ -x &= 7 \\ x &= -7 \end{aligned}$$

$$\frac{2x-1}{5} = \frac{2(-7)-1}{5} = \frac{-14-1}{5} = \frac{-15}{5} = -3$$

2. The answer is B.

$$\begin{aligned} x+2y &= 4 \\ 4x-3y &= 5 \end{aligned}$$

$$\begin{aligned} -4x-8y &= -16 \\ 4x-3y &= 5 \end{aligned}$$

$$\begin{aligned} -4x-8y+4x-3y &= -16+5 \\ -11y &= -11 \\ y &= 1 \end{aligned}$$

$$\begin{aligned} x+2y &= 4 \\ x+2 \times 1 &= 4 \\ x &= 4-2 \\ x &= 2 \end{aligned}$$

$$xy = 2 \times 1 = 2$$

3. The answer is B.

$h$  - the number of working hours  
 $n$  - the number of drinks sold per hour  
 $r$  - the rent George pays  
 4 - the price of a drink

4. The answer is A.

Use formula  $a^2 + 2ab + b^2 = (a+b)^2$

$$25x^4 + 10x^2 + 1 = (5x)^2 + 2(5x^2)(1) + 1^2 = (5x^2 + 1)^2$$

5. The answer is B.

$$\sqrt{6 - 3x^2} - k = 0$$

$$\sqrt{6 - 3x^2} - \sqrt{3} = 0$$

$$\sqrt{6 - 3x^2} = \sqrt{3}$$

$$\sqrt{6 - 3x^2}^2 = \sqrt{3}^2$$

$$6 - 3x^2 = 3$$

$$-3x^2 = 3 - 6$$

$$-3x^2 = -3$$

$$3x^2 = 3$$

$$x^2 = 1$$

$$x = \pm\sqrt{1}$$

$$x = \pm 1$$

$$x < 0 \Rightarrow x = -1$$

6. The answer is A.

Point  $(-5,0)$  is reflected over  $y$ -axis into point  $(5,0)$ . Therefore, line  $q$  passes through the points  $(0,3)$  and  $(5,0)$ . Use equation of line which passes through the 2 points to determine the equation of line  $q$ .

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

$$A(0,3), B(5,0) \Rightarrow x_1 = 0, y_1 = 3, x_2 = 5, y_2 = 0$$

$$y - 3 = \frac{0 - 3}{5 - 0}(x - 0)$$

$$y - 3 = -\frac{3}{5}x$$

$$5y - 15 = -3x$$

$$3x + 5y = 15$$

7. The answer is B.

$$\frac{4^x 8^y}{16^z} = \frac{(2^2)^x (2^3)^y}{(2^4)^z} = \frac{2^{2x} 2^{3y}}{2^{4z}} = \frac{2^{2x+3y}}{2^{4z}} = 2^{2x+3y-4z} = 2^5 = 32$$

8. The answer is B.

$b$  – number of bottles in a pack

$p$  – number of packs

$$bp \leq 110$$

$$6 \leq b \leq \frac{110}{p}$$

$$6 \leq \frac{110}{p}$$

$$p \leq \frac{110}{6}$$

$$p \leq 18\frac{1}{3}$$

Maximum number of packs is 18.

9. The answer is A.

$$A(-2,5), B(1,-4) \Rightarrow x_1 = -2, y_1 = 5, x_2 = 1, y_2 = -4$$

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-4 - 5}{1 - (-2)} = \frac{-9}{1 + 2} = \frac{-9}{3} = -3$$

10. The answer is D.

If a line has a negative slope and its y-intercept is negative, then it doesn't pass through the 1<sup>st</sup> quadrant.

$$6x + 5y = -13$$

$$5y = -6x - 13$$

$$y = -\frac{6}{5}x - \frac{13}{5}$$

$$m = -\frac{6}{5} < 0, n = -\frac{13}{5} < 0 \Rightarrow \text{line doesn't pass through the 1}^{\text{st}} \text{ quadrant}$$

11. The answer is A.

$$i^{25} - i^{22} + i^{14} - i^5 = i^{4 \times 6 + 1} - i^{4 \times 5 + 2} + i^{4 \times 3 + 2} - i^{4 + 1} =$$

$$= i^{4 \times 6} i - i^{4 \times 5} i^2 + i^{4 \times 3} i^2 - i^4 i = (i^4)^6 i - (i^4)^5 (-1) + (i^4)^3 (-1) - i =$$

$$= i + 1 - 1 - i = 0$$

12. The answer is B.

$$P = \frac{W}{W + B}$$

$$P(W + B) = W$$

$$PW + PB = W$$

$$PB = W - PW$$

$$PB = W(1 - P)$$

$$B = \frac{W(1-P)}{P}$$

13. The answer is D.

$$3x^2 - kx + 4 = 0$$

$$a = 3, b = -k, c = 4$$

$$D = b^2 - 4ac = (-k)^2 - 4 \times 3 \times 4 = k^2 - 48$$

$$k^2 - 48 = 0$$

$$k^2 = 48$$

$$k = \pm\sqrt{48} = \pm\sqrt{16 \times 3} = \pm 4\sqrt{3}$$

14. The answer is B.

After 1 year:

$$\begin{aligned} 2,000,000 - 2\% \times 2,000,000 &= 2,000,000(1 - 2\%) = 2,000,000 \left(1 - \frac{2}{100}\right) = \\ &= 2,000,000(1 - 0.02) = 2,000,000 \times 0.98 = 2,000,000(0.98)^1 \end{aligned}$$

After 2 years:

$$\begin{aligned} 2,000,000 \times 0.98 - 2\% \times 2,000,000 \times 0.98 &= 2,000,000 \times 0.98(1 - 2\%) = \\ &= 2,000,000 \times 0.98 \left(1 - \frac{2}{100}\right) = 2,000,000 \times 0.98(1 - 0.02) = \\ &= 2,000,000 \times 0.98 \times 0.98 = 2,000,000(0.98)^2 \end{aligned}$$

$$\text{After } t \text{ years: } 2,000,000(0.98)^t$$

15. The answer is C.

$$\begin{aligned} \frac{x^2 - 3x - 10}{x^2 - 7x + 10} &= \frac{x^2 - 5x + 2x - 10}{x^2 - 5x - 2x + 10} = \frac{x(x - 5) + 2(x - 5)}{x(x - 5) - 2(x - 5)} = \frac{(x - 5)(x + 2)}{(x - 5)(x - 2)} = \\ &= \frac{x + 2}{x - 2} \end{aligned}$$

16. The answer is 2.

$x$  – number of 4-packs

$y$  – number of 6-packs

$$4x + 6y = 24$$

Minimum number of 4-packs is 1, and maximum number of 4-packs is 3.

$$x = 1 \Rightarrow 4 \times 1 + 6y = 24 \Rightarrow y = \frac{10}{3}$$

$$x = 2 \Rightarrow 4 \times 2 + 6y = 24 \Rightarrow y = \frac{8}{3}$$

$$x = 3 \Rightarrow 4 \times 3 + 6y = 24 \Rightarrow y = 2$$

Therefore, one possible number of 6-packs is 2.

17. The answer is 16.

$$4x(5 - 2x) + 2(3x - 1) = 20x - 8x^2 + 6x - 2 = -8x^2 + 26x - 2$$

$$a + b + c = -8 + 26 - 2 = 16$$

18. The answer is 10.5

$$\triangle ABE \sim \triangle DBC$$

$$\frac{AE}{CD} = \frac{BE}{BC} \Rightarrow \frac{10}{4} = \frac{BE}{3} \Rightarrow 4BE = 3 \times 10 \Rightarrow BE = 7.5$$

$$CE = BC + BE = 3 + 7.5 = 10.5$$

19. The answer is 2.

$$OA^2 = x^2 + y^2$$

$$(2x)^2 = x^2 + (2\sqrt{3})^2$$

$$4x^2 = x^2 + 12$$

$$3x^2 = 12$$

$$x^2 = 4$$

$$x = 2$$

20. The answer is 5.

$$(a + b)x + (a - b)y = 4$$

$$9x + 6y = 12$$

$$3(a + b)x + 3(a - b)y = 12$$

$$9x + 6y = 12$$

$$3(a + b) = 9$$

$$3(a - b) = 6$$

$$a + b = 3$$

$$a - b = 2$$

$$2a = 5$$

$$a = \frac{5}{2}$$

$$b = \frac{1}{2}$$

$$\frac{a}{b} = \frac{\frac{5}{2}}{\frac{1}{2}} = 5$$

21. The answer is B.

$20d$  – number of students in the classrooms with 20 seats

$25s$  – number of students in the classrooms with 25 seats

$20d + 25s$  – total number of students

$$20d + 25s = 5(4d + 5s)$$

22. The answer is B.

$$\frac{\{\text{students in the group}\}}{\{\text{girls in the group}\}} = \frac{\{\text{students in the school}\}}{\{\text{girls in the school}\}}$$

$$\frac{50}{15} = \frac{1,100}{x}$$

$$50x = 15 \times 1,100$$

$$x = \frac{15 \times 1,100}{50} = 330$$

23. The answer is A.

$$h = 12 + 4.8v$$

$$84 = 12 + 4.8v$$

$$72 = 4.8v$$

$$v = \frac{72}{4.8} = 15$$

24. The answer is C.

$$24:18 = x:24$$

$$18x = 24 \times 24$$

$$x = \frac{24 \times 24}{18} = \frac{24}{6} \times \frac{24}{3} = 4 \times 8 = 32$$

25. The answer is D.



5% of 18 pears = 5% of 24 kg =  $5\% \cdot 24 \text{ kg} = 0.05 \cdot 24 \text{ kg} = 1.2 \text{ kg}$  of pears are rotten  
 Therefore,  $24 \text{ kg} - 1.2 \text{ kg} = 22.8 \text{ kg}$  of pears can be sold.

26. The answer B.

$$\begin{aligned} 16 - 3x &= 1 \\ -3x &= 1 - 16 \\ -3x &= -15 \\ x &= \frac{-15}{-3} = 5 \\ 30 - 4x &= 30 - 4 \times 5 = 10 \end{aligned}$$

27. The answer is D.

The  $y$ -intercept of the parabola represented by  $y = (x + 4)(x - 2)$  in the  $xy$ -plane is the value of  $y$  for which  $x$  is equal to 0. The standard form of the equation,  $y = x^2 + 2x - 8$ , shows that  $x$  equals 0 if and only if  $y = -8$ . Thus, the standard form,  $y = x^2 + 2x - 8$ , displays the  $y$ -intercept of the parabola as the constant  $-8$ .

28. The answer is A.

$$\begin{aligned} k - 12 \times 15 &= 20 \\ k - 180 &= 20 \\ k &= 180 + 20 \\ k &= 200 \end{aligned}$$

29. The answer is A.

$x$  – the number of cows  
 $y$  – the number of hens  
 $4x$  – the number of cows' legs  
 $2y$  – the number of hens' legs  
 $x + y < 30$  – the number of cows and hens is less than 30  
 $4x + 2y < 100$  – the total number of legs is less than 100

30. The answer is C.

$$f^2(x) = f(f(x)) = f(2x - 3) = 2(2x - 3) - 3 = 4x - 6 - 3 = 4x - 9$$

31. The answer is B.

$$9.58 \frac{m}{s} = 9.58 \times \frac{\frac{1}{1,000} km}{\frac{1}{3,600} h} = 9.58 \times \frac{3,600 km}{1,000 h} = 9.58 \times 3.6 \frac{km}{h} = 34.48 \frac{km}{h}$$

32. The answer is D.

2,300,000 – initial population

20,000 – increase in population each year

20,000t – increase in population after t years

We want the population to be at or above 3,000,000.

$$2,300,000 + 20,000t \geq 3,000,000$$

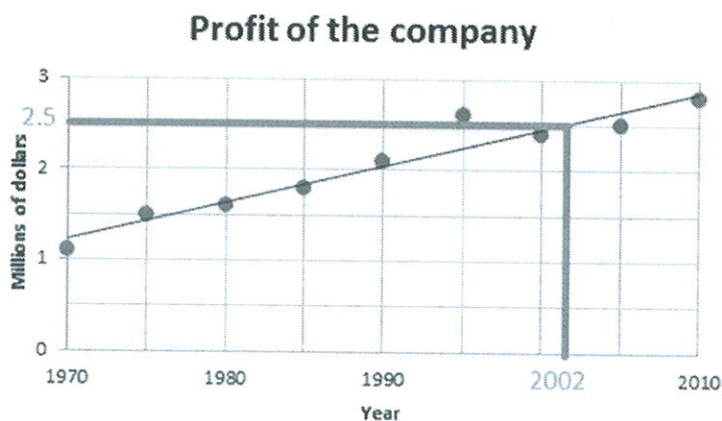
33. The answer is D.

Numbers are permutations of 6 digits:  $P(6)$ . We must subtract permutations which start with 0. Those are permutations of digits 1, 2, 3, 4 and 5. There are  $P(5)$  such permutations.

$$\begin{aligned} P(6) - P(5) &= 6! - 5! = 6 \times 5 \times 4 \times 3 \times 2 \times 1 - 5 \times 4 \times 3 \times 2 \times 1 = \\ &= 720 - 120 = 600 \end{aligned}$$

34. The answer is C.

Look at the graph below. The profit of \$2,500,000 was made in 2002.



35. The answer is A.

$$100,000 \frac{km}{week} = 100,000 \frac{km}{(7 \times 24)h} = \frac{100,000 km}{7 \times 24 h} = \frac{100,000 km}{168 h} = 595.24 \frac{km}{h}$$

36. The answer is C.

According to the table, there are  $18 + 6 = 24$  blue cars, and 6 of them are new. Therefore, if one of blue cars is chosen at random, the probability that it is new is  $\frac{6}{24} = \frac{1}{4}$ .

37. The answer is D.

$$15\% \text{ of } 160 \text{ cm} = 15\% \times 160 \text{ cm} = 0.15 \times 160 \text{ cm} = 24 \text{ cm}$$

$$\text{Joshua's height: } 160 \text{ cm} + 24 \text{ cm} = 184 \text{ cm}$$

38. The answer is B.

The example in the question has a median that is larger than mean, so small outliers are present in the data. Therefore, there are a few students whose weights are less than the rest.

39. The answer is C.

There are a total of 50 data points provided, so the median will be the average of the 25<sup>th</sup> and 26<sup>th</sup> data points. When the data points are set in order:

- values 1 through 6 will be 0
- values 7 through 21 will be 1
- values 22 through 36 will be 2
- values 37 through 50 will be 3

Therefore, both the 25<sup>th</sup> and 26<sup>th</sup> values are 2, and hence the median is 2.

40. The answer is A.

Since 9 of 25 families at Town A have 2 children, the same ratio holds for all 600 families at Town A. Also, since 6 of 25 families at Town B have 2 children, the same ratio holds for all 900 families at Town B.

Therefore, approximately  $\frac{9}{25} \times 600 = 216$  families at Town A and  $\frac{6}{25} \times 900 = 216$  families at Town B are expected to have 2 children.

Thus, the total number of families with 2 children at Town A and Town B is expected to be equal.

41. The answer is D.

The estimate  $x$  could be greater or less than actual height  $y$ . In both cases difference must be less than 5. So we have  $y - x < 5$  or  $x - y < 5$ . Therefore, the absolute value of the difference is less than 5.

$$|y - x| < 5 \Leftrightarrow -5 < y - x < 5 \Leftrightarrow -5 < x - y < 5$$

42. The answer is B.

$$V = \frac{B}{2r^2}$$

$$2r^2V = B$$

$$r^2 = \frac{B}{2V}$$

43. The answer is A.

$$V_A = 4V_B$$

$$\frac{B}{2r_A^2} = 4 \times \frac{B}{2r_B^2}$$

$$\frac{2r_A^2}{B} = \frac{2r_B^2}{4B}$$

$$r_A^2 = \frac{r_B^2}{4}$$

$$\frac{r_A^2}{r_B^2} = \frac{1}{4}$$

$$\left(\frac{r_A}{r_B}\right)^2 = \left(\frac{1}{2}\right)^2$$

$$\frac{r_A}{r_B} = \frac{1}{2}$$

44. The answer is B.

$$x^2 + y^2 - 6x - 4y = 7$$

$$x^2 - 6x + y^2 - 4y = 7$$

$$x^2 - 6x + 9 - 9 + y^2 - 4y + 4 - 4 = 7$$

$$x^2 - 6x + 9 + y^2 - 4y + 4 = 7 + 9 + 4$$

$$(x - 3)^2 + (y - 2)^2 = 20$$

C(3, 2)

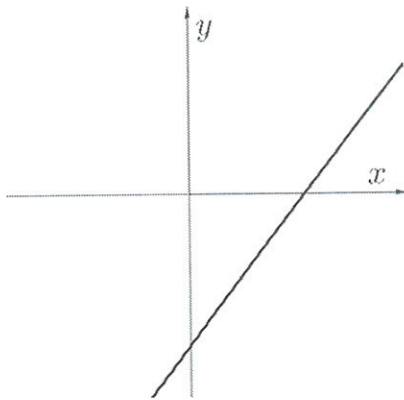
45. The answer is A.

$a$  –  $x$ -intercept

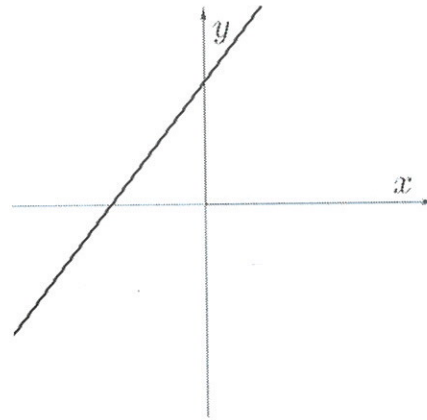
$b$  –  $y$ -intercept

$$ab = -1 \Rightarrow (a > 0 \wedge b < 0) \vee (a < 0 \wedge b > 0)$$

$$a > 0 \wedge b < 0$$



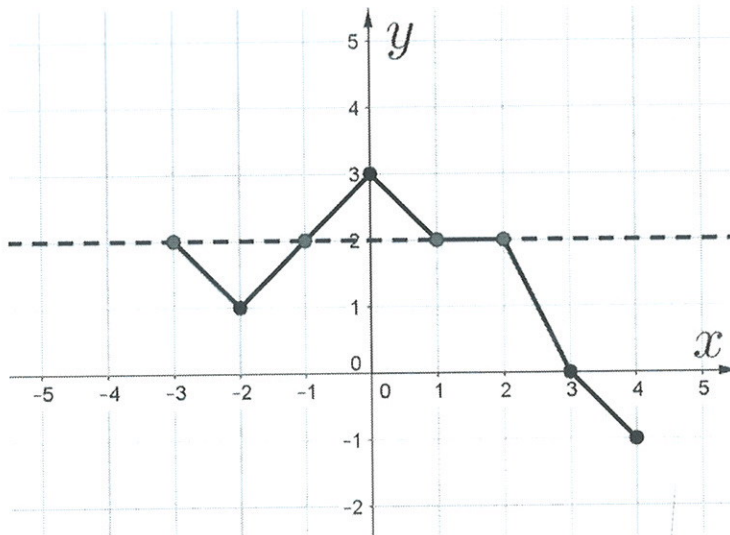
$$a < 0 \wedge b > 0$$



In both cases the slope is positive.

46. The answer is C.

Points on the graph which lie on the line  $y = 2$  are the solutions:  $f(-3)$ ,  $f(-1)$ ,  $f(1)$  and  $f(2)$ . Therefore, II and III only are the solutions.



47. The answer is A.

Each red dot is above the corresponding green dot. Therefore, in every 5-year interval, the magnitude of the rate of change of profit of the Company A is greater than that of the Company B.

48. The answer is A.

$$A(-2, -1), B(5, 2)$$

$$m_{AB} = \frac{2 - (-1)}{5 - (-2)} = \frac{3}{7}$$

Denote with  $p$  a line perpendicular to  $\overline{AB}$ . The product of slopes of  $p$  and  $\overline{AB}$  equals to  $-1$ .

$$m_p \times m_{AB} = -1$$

$$m_p = -\frac{1}{\frac{3}{7}} = -\frac{7}{3}$$

Write equation of line  $p$  which passes through the point  $C(1, 4)$ , which slope is  $-\frac{7}{3}$ .

$$y - y_1 = m(x - x_1)$$

$$y - 4 = -\frac{7}{3}(x - 1)$$

$$y - 4 = -\frac{7}{3}x + \frac{7}{3}$$

$$3y - 12 = -7x + 7$$

$$7x + 3y - 12 - 7 = 0$$

$$7x + 3y - 19 = 0$$

49. The answer is A.

Substitute the values of  $a$ ,  $b$  and  $c$  in the system of equations.

$$a = 0, b = 1, c = 2$$

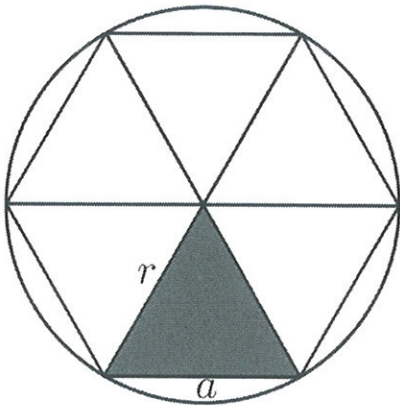
$$5 = 0 \times x^2 + 1 \times x + 2$$

$$5 = x + 2$$

$$x = 3$$

Therefore, for  $a = 0$ ,  $b = 1$  and  $c = 2$  the system of equations has exactly one real solution.

50. The answer is D.



A hexagon consists of 6 equilateral triangles. Therefore,  $a = r$ .

$$A_{\text{hexagon}} = \frac{6a^2\sqrt{3}}{4}$$

$$24\sqrt{3} = \frac{6a^2\sqrt{3}}{4}$$

$$4 \times 24\sqrt{3} = 6a^2\sqrt{3}$$

$$a^2 = \frac{4 \times 24\sqrt{3}}{6\sqrt{3}} = 16 \Rightarrow a = 4$$

$$r = a = 4$$

$$A_{circle} = r^2\pi = 4^2\pi = 16\pi$$

51. The answer is 15.

$h$  – number of hours

$$2.4h = 36$$

$$h = \frac{36}{2.4} = \frac{360}{24} = 15$$

52. The answer is 4.

1 yard = 3 feet =  $(3 \times 12)$  inches = 36 inches

$$p \times 36 + 6 = 150$$

$$36p = 144$$

$$p = \frac{144}{36} = 4$$

53. The answer is -5.

$$(-2, 4) \Rightarrow x = -2, y = 4$$

$$f(x) = mx - 6 \Rightarrow y = mx - 6 \Rightarrow 4 = m(-2) - 6$$

$$4 = -2m - 6$$

$$2m = -6 - 4$$

$$2m = -10$$

$$m = -5$$

54. The answer is 32.

$x$  – number of hens

$y$  – number of ducks

$$x + y = 80$$

$$x - 16 = y \Rightarrow x = y + 16$$

$$y + 16 + y = 80$$

$$2y = 64$$

$$y = 32$$

55. The answer is 45.

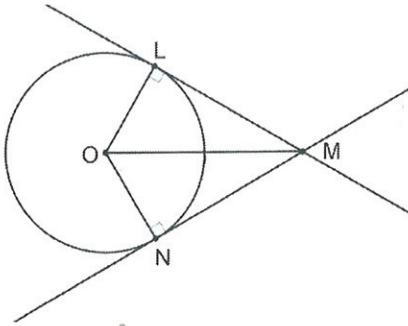
$l$  – current level of the river

$h$  – number of hours

6 – the constant rate at which level of the river increase

45 – initial level of the river

56. The answer is 31.4.



$$OL = ON = r$$

$LM = MN$  – tangents are equal

$$OM = OM$$

$\triangle OLM \cong \triangle ONM$  (SSS Postulate)

$$\triangle OLM \cong \triangle ONM \Rightarrow \angle LMO \cong \angle OMN \Rightarrow m\angle LMO = m\angle OMN = 30^\circ$$

Angle between tangent line and radius is a right angle.

$$m\angle OLM = 90^\circ$$

$$m\angle MOL + m\angle OLM + m\angle LMO = 180^\circ$$

$$m\angle MOL + 90^\circ + 30^\circ = 180^\circ$$

$$m\angle MOL = 60^\circ$$

$\triangle OLM$  is  $30^\circ - 60^\circ - 90^\circ$  triangle. Therefore,  $OM = 2OL$ .

$$r = OL = \frac{OM}{2} = \frac{10}{2} = 5$$

$$C = 2r\pi = 2 \times 5\pi = 10\pi = 31.4$$

57. The answer is 874.

$$P_{next\ year} = P_{this\ year} + 0.25(P_{this\ year}) \left(1 - \frac{P_{this\ year}}{P}\right)$$



$$P_{next\ year} = 800 + 0.25(800) \left(1 - \frac{800}{1,000}\right) = 800 + 200 \times 0.2 = 840$$

Price of an item two years from now:

$$P_{next\ year} = 840 + 0.25(840) \left(1 - \frac{840}{1,000}\right) = 840 + 210 \times 0.16 = 873.6 \approx 874$$

58. The answer is 5000.

$$P_{next\ year} = P_{this\ year} + 0.25(P_{this\ year}) \left(1 - \frac{P_{this\ year}}{P}\right)$$

$$1,200 = 1,000 + 0.25(1,000) \left(1 - \frac{1,000}{P}\right)$$

$$200 = 250 \left(1 - \frac{1,000}{P}\right)$$

$$1 - \frac{1,000}{P} = \frac{200}{250}$$

$$1 - \frac{1,000}{P} = \frac{4}{5}$$

$$5P - 5,000 = 4P$$

$$P = 5,000$$

# TEST 2

1. The answer is D.

$$\frac{1}{3}x^2 - 2x + 3 = 0$$

$$3 \times \frac{1}{3}x^2 - 3 \times 2x + 3 \times 3 = 0$$

$$x^2 - 6x + 9 = 0$$

$$(x - 3)^2 = 0$$

$$x - 3 = \pm\sqrt{0}$$

$$x - 3 = 0$$

$$x = 3$$

$$\sqrt{16 + x^2} = \sqrt{16 + 3^2} = \sqrt{16 + 9} = \sqrt{25} = 5$$

2. The answer is C.

$$2x + 3y = 11$$

$$3x - 2y = -3$$

$$4x + 6y = 22$$

$$9x - 6y = -9$$

$$4x + 6y + 9x - 6y = 22 - 9$$

$$13x = 13$$

$$x = 1$$

$$2x + 3y = 11$$

$$2 \times 1 + 3y = 11$$

$$3y = 11 - 2$$

$$3y = 9$$

$$y = 3$$

$$x + y = 1 + 3 = 4$$

3. The answer is A.

$h$  - the number of working hours

$p$  - the price of a drink

$r$  - the rent George pays

24 - the number of drinks sold per hour

4. The answer is B.

Use formula  $a^2 - 2ab + b^2 = (a - b)^2$

$$9 - 24x^2 + 16x^4 = 3^2 - 2(3)(4x^2) + (4x^2)^2 = (3 - 4x^2)^2$$

5. The answer is D.

$$\sqrt{5x^2 - 9} - k = 0$$

$$\sqrt{5x^2 - 9} - (-6) = 0$$

$$\sqrt{5x^2 - 9} = -6$$

$$\sqrt{5x^2 - 9}^2 = (-6)^2$$

$$5x^2 - 9 = 36$$

$$5x^2 = 36 + 9$$

$$5x^2 = 45$$

$$x^2 = \frac{45}{5}$$

$$x^2 = 9$$

$$x = \pm\sqrt{9}$$

$$x = \pm 3$$

$$x > 0 \Rightarrow x = 3$$

6. The answer is D.

Point (0,3) is reflected over  $y$ -axis into point (0,-3). Therefore, line  $q$  passes through the points (-4,0) and (0,-3). Use the equation of line which passes through the 2 points to determine the equation of line  $q$ .

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

$$A(-4,0), B(0,-3) \Rightarrow x_1 = -4, y_1 = 0, x_2 = 0, y_2 = -3$$

$$y - 0 = \frac{-3 - 0}{0 - (-4)}(x - (-4))$$

$$y - 0 = \frac{-3 - 0}{0 + 4}(x + 4)$$

$$y = -\frac{3}{4}(x + 4)$$

$$y = -\frac{3}{4}x - 3$$

7. The answer is C.

$$\frac{27^x}{9^y 81^z} = \frac{(3^3)^x}{(3^2)^y (3^4)^z} = \frac{3^{3x}}{3^{2y} 3^{4z}} = \frac{3^{3x}}{3^{2y+4z}} = 3^{3x-(2y+4z)} = 3^{3x-2y-4z} = 3^3 = 27$$

8. The answer is C.

$p$  - number of pears in a bag

$b$  – number of bags

$$bp \leq 90$$

$$4 \leq p \leq \frac{90}{b}$$

$$4 \leq \frac{90}{b}$$

$$b \leq \frac{90}{4}$$

$$b \leq 22\frac{1}{2}$$

Maximum number of bags is 22.

9. The answer is B.

$$4x - 2y + 5 = 0$$

$$-2y = -4x - 5$$

$$y = \frac{-4}{-2}x - \frac{5}{-2}$$

$$y = 2x + \frac{5}{2}$$

$$m = 2$$

Parallel lines have equal slopes.

$$(1, -2) \Rightarrow x = 1, y = -2$$

$$y = mx + n$$

$$-2 = 2 \times 1 + n$$

$$n = -4$$

$$y = mx + n$$

$$y = 2x - 4$$

10. The answer is A.

If a line has positive slope and its y-intercept is negative, then it doesn't pass through the 2<sup>nd</sup> quadrant.

$$-4x + 3y = -7$$

$$3y = 4x - 7$$

$$y = \frac{4}{3}x - \frac{7}{3}$$

$$m = \frac{4}{3} > 0, n = -\frac{7}{3} < 0 \Rightarrow \text{line doesn't pass through the 2}^{\text{nd}} \text{ quadrant}$$

11. The answer is D.

$$(1 + i)^8 = [(1 + i)^2]^4 = (1 + 2i + i^2)^4 = (1 + 2i - 1)^4 = (2i)^4 = 16i^4 = 16$$

12. The answer is B.

$$P = \frac{F}{A + F} \times 100$$

$$P(A + F) = 100F$$

$$PA + PF = 100F$$

$$PA = 100F - PF$$

$$PA = F(100 - P)$$

$$A = \frac{F(100 - P)}{P}$$

13. The answer is B.

The  $y$ -coordinate of the intersection points is equal to zero. Find the discriminant of the corresponding quadratic equation  $y = 0$ .

$$5x^2 + 20x + 20 = 0$$

$$\frac{5x^2 + 20x + 20}{5} = \frac{0}{5}$$

$$x^2 + 4x + 4 = 0$$

$$a = 1, b = 4, c = 4$$

$$D = b^2 - 4ac = 4^2 - 4 \times 1 \times 4 = 16 - 16 = 0$$

Since  $D = 0$ , the equation has only one solution. Therefore, the number of intersection points of parabola and  $x$ -axis is 1.

14. The answer is C.

After 1 year:

$$\begin{aligned} 600 + 8\% \times 600 &= 600(1 + 8\%) = 600 \left(1 + \frac{8}{100}\right) = 600(1 + 0.08) = \\ &= 600 \times 1.08 = 600 \times 1.08^1 \end{aligned}$$

After 2 years:

$$\begin{aligned} 600 \times 1.08 + 8\% \times 600 \times 1.08 &= 600 \times 1.08(1 + 8\%) = 600 \times 1.08(1 + 0.08) = \\ &= 600 \times 1.08 \times 1.08 = 600 \times 1.08^2 \end{aligned}$$

After  $t$  years:  $600 \times 1.08^t$

15. The answer is B.

$$\frac{x^3 - 1}{x^2 - 1} = \frac{(x - 1)(x^2 + x + 1)}{(x - 1)(x + 1)} = \frac{x^2 + x + 1}{x + 1}$$

16. The answer is 2.

$x$  – number of 6-packs

$y$  – number of 10-packs

$$6x + 10y = 38$$

Minimum number of 6-packs is 1, and maximum number of 6-packs is 4.

$$x = 1 \Rightarrow 6 \times 1 + 10y = 38 \Rightarrow y = \frac{16}{5}$$

$$x = 2 \Rightarrow 6 \times 2 + 10y = 38 \Rightarrow y = \frac{13}{5}$$

$$x = 3 \Rightarrow 6 \times 3 + 10y = 38 \Rightarrow y = \frac{2}{5}$$

$$x = 4 \Rightarrow 6 \times 4 + 10y = 38 \Rightarrow y = \frac{7}{5}$$

Therefore, one possible number of 10-packs is 2.

17. The answer is 0.

$$5x(4x - 2) + 6(3x + 1) = 20x^2 - 10x + 18x + 6 = 20x^2 + 8x + 6$$

$$0x^3 + 20x^2 + 8x + 6 = kx^3 + 20x^2 + 8x + 6 \Rightarrow k = 0$$

18. The answer is 9.

$$\triangle ABE \sim \triangle BCD$$

$$\frac{AE}{CD} = \frac{BE}{BC} \Rightarrow \frac{AE}{3} = \frac{6}{2} \Rightarrow 2AE = 3 \times 6 \Rightarrow AE = 9$$

19. The answer is 3.

$$OA^2 = x^2 + y^2$$

$$(2y)^2 = (3\sqrt{3})^2 + y^2$$

$$4y^2 = 27 + y^2$$

$$3y^2 = 27$$

$$y^2 = 9$$

$$y = 3$$

20. The answer is  $\frac{5}{2}$ .

$$(2a - 3b)x + 4by = 5$$

$$4x + 8y = 10$$

$$2(2a - 3b)x + 8by = 10$$

$$4x + 8y = 10$$

$$2(2a - 3b) = 4$$

$$8b = 8$$

$$b = 1$$

$$2(2a - 3 \times 1) = 4$$

$$2a - 3 = 2$$

$$a = \frac{5}{2}$$

$$\frac{a}{b} = \frac{\frac{5}{2}}{1} = \frac{5}{2}$$

21. The answer is A.

$2m$  – total number of beds in the rooms with 2 beds  
 $2n$  – total number of beds in the rooms with 5 beds  
 $2m + 2n$  – total number of beds

22. The answer is D.

$x$  – number of red marbles  
 $6:2 = 57:x$   
 $6x = 2 \times 57$   
 $x = \frac{2 \times 57}{6} = 19$   
 Number of blue marbles:  $57 - 19 = 38$

23. The answer is D.

$P = 15,000 + 50d$   
 $20,000 = 15,000 + 50d$   
 $5,000 = 50d$   
 $d = \frac{5,000}{50} = 100$

24. The answer is B.

$150:3 = x:5$   
 $3x = 150 \times 5$   
 $x = \frac{150 \times 5}{3} = 50 \times 5 = 250$



25. The answer is B.

$$75\% \text{ of } 150 \text{ km} = 75\% \cdot 150 \text{ km} = 0.75 \cdot 150 \text{ km} = 112.5 \text{ km}$$

26. The answer is D.

$$5x - 7 = 3$$

$$5x = 3 + 7$$

$$5x = 10$$

$$x = \frac{10}{5} = 2$$

$$4 + 2x = 4 + 2 \times 2 = 4 + 4 = 8$$

27. The answer is A.

Write the equation of the parabola in vertex form.

$$y = x^2 + 8x + 15$$

$$y = x^2 + 2 \times 4x + 4^2 - 4^2 + 15$$

$$y = (x + 4)^2 - 16 + 15$$

$$y = (x + 4)^2 - 1$$

28. The answer is C.

$$k - 4 \times 8 = 12$$

$$k - 32 = 12$$

$$k = 32 + 12$$

$$k = 44$$

29. The answer is B.

$x$  – the number of cars

$y$  – the number of bicycles

$4x$  – the number of cars' wheels

$2y$  – the number of bicycles' wheels

$x + y < 20$  – the total number of vehicles is less than 20

$4x + 2y < 80$  – the total number of wheels is less than 80

30. The answer is B.

$$f(x) = 5 - 2x$$

$$x = 5 - 2f^{-1}(x)$$

$$2f^{-1}(x) = 5 - x$$

$$f^{-1}(x) = \frac{5 - x}{2}$$

31. The answer is D.

$$60 \frac{m}{min} = 60 \times \frac{1}{\frac{1,000}{60} h} km = 60 \times \frac{60}{1,000} \frac{km}{h} = \frac{3,600}{1,000} \frac{km}{h} = 3.6 \frac{km}{h}$$

32. The answer is A.

5 – cost of start

3 – cost per mile

$3d$  – cost after  $d$  miles

We want the cost to be at or above 20.

$$5 + 3d \geq 20$$

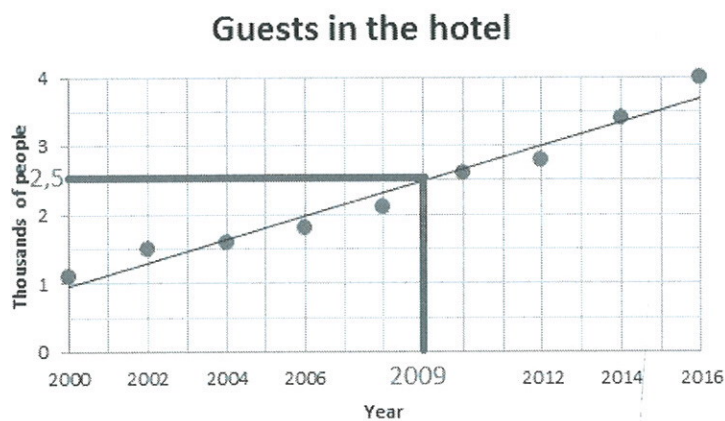
33. The answer is B.

There are 5 digits to choose from and 3 distinct digits must be chosen.

$$V_k^n = V_3^5 = 5 \times 4 \times 3 = 60$$

34. The answer is D.

Look at the graph below. There were 2,500 guests in 2009.



35. The answer is A.

$$2,592,000 \frac{km}{month} = 2,592,000 \frac{km}{(30 \times 24)h} = \frac{2,592,000}{30 \times 24} \frac{km}{h} = 3,600 \frac{km}{h}$$

36. The answer is C.

According to the table, there are  $15 + 27 = 42$  female workers, and 27 of them are black. Therefore, if one of females is chosen at random, the probability that she is black is  $\frac{27}{42}$ .

37. The answer is D.

20% of 85 kg =  $20\% \times 85 \text{ kg} = 0.20 \times 85 \text{ kg} = 17 \text{ kg}$   
Liam's weight:  $85 \text{ kg} - 17 \text{ kg} = 68 \text{ kg}$

38. The answer is C.

The example in the question has a mean that is larger than median, so large outliers are present in the data. Therefore, there are a few students whose heights are much more than the rest.

39. The answer is B.

There are a total of 40 data points provided, so the median will be the average of the 20<sup>th</sup> and 21<sup>th</sup> data points. When the data points are set in order:

- values 1 through 13 will be 0
- values 14 through 27 will be 1
- values 28 through 37 will be 2
- values 38 through 40 will be 3

Therefore, both the 20<sup>th</sup> and 21<sup>th</sup> values are 1, and hence the median is 1.

40. The answer is B.

Since 5 of 20 people at Street A have 2 pets, the same ratio holds for all 300 people at Street A. Also, since 5 of 20 people at Street B have 2 pets, the same ratio holds for all 200 people at Street B.

Therefore, approximately  $\frac{5}{20} \times 300 = 75$  people at Street A and  $\frac{5}{20} \times 200 = 50$  people at Street B are expected to have 2 pets.

Thus, the total number of people with 2 pets at Street A is expected to be  $75 - 50 = 25$  more than at Street B.

41. The answer is D.

The estimate  $x$  could be greater or less than actual weight  $y$ . In both cases difference must be less than 10. So we have  $y - x < 10$  or  $x - y < 10$ . Therefore, the absolute value of the difference is less than 5.

$$|y - x| < 10 \Leftrightarrow -10 < y - x < 10 \Leftrightarrow -10 < x - y < 10$$

42. The answer is B.

$$T = \frac{H}{6\pi r^2}$$

$$6\pi r^2 T = H$$

$$r^2 = \frac{H}{6\pi T}$$

43. The answer is B.

$$T_A = 9T_B$$

$$\frac{H}{6\pi r_A^2} = 9 \times \frac{H}{6\pi r_B^2}$$

$$\frac{6\pi r_A^2}{H} = \frac{6\pi r_B^2}{9H}$$

$$r_A^2 = \frac{r_B^2}{9}$$

$$\frac{r_A^2}{r_B^2} = \frac{1}{9}$$

$$\left(\frac{r_A}{r_B}\right)^2 = \left(\frac{1}{3}\right)^2$$

$$\frac{r_A}{r_B} = \frac{1}{3}$$

44. The answer is B.

$$x^2 + y^2 + 8x + 4y = 5$$

$$x^2 + 8x + y^2 + 4y = 5$$

$$x^2 + 8x + 16 - 16 + y^2 + 4y + 4 - 4 = 5$$

$$x^2 + 8x + 16 + y^2 + 4y + 4 = 5 + 16 + 4$$

$$(x + 4)^2 + (y + 2)^2 = 25$$

$$r^2 = 25 \Rightarrow r = 5$$

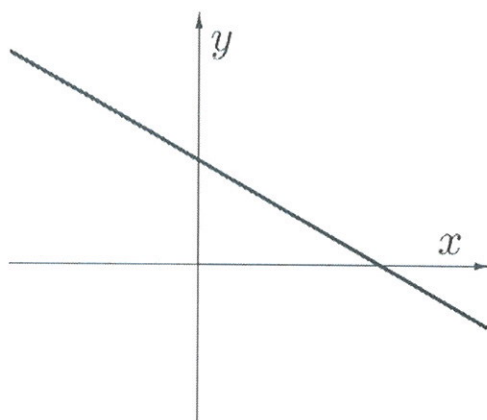
45. The answer is B.

$a$  –  $x$ -intercept

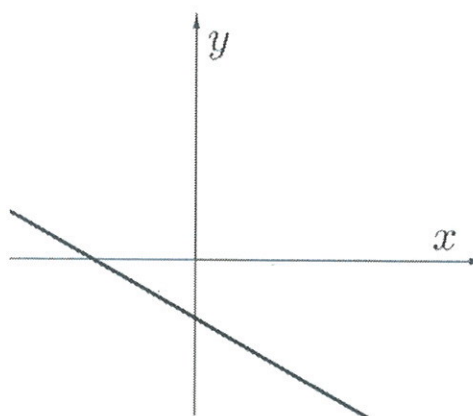
$b$  –  $y$ -intercept

$$ab = 1 \Rightarrow (a > 0 \wedge b > 0) \vee (a < 0 \wedge b < 0)$$

$$a > 0 \wedge b > 0$$



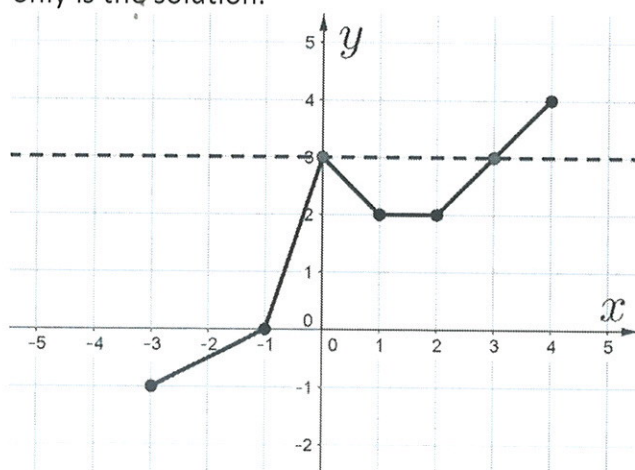
$$a < 0 \wedge b < 0$$



In both cases the slope is negative.

46. The answer is A.

Points on the graph which lie on the line  $y = 3$  are the solutions:  $f(0)$  and  $f(3)$ . Therefore, III only is the solution.



47. The answer is B.

Each green dot is above the corresponding red dot. Therefore, in every 5-year interval, the magnitude of the rate of change of population of the City B is greater than that of the City A.

48. The answer is C.

Find slope of line  $\overline{AB}$ .

$A(-2, -1), B(5, 2)$

$$m_{AB} = \frac{2 - (-1)}{5 - (-2)} = \frac{3}{7}$$

Denote with  $p$  a line perpendicular to  $\overline{AB}$ . The slopes of  $p$  and  $\overline{AB}$  are equal.

$$m_p = m_{AB} = \frac{3}{7}$$

Write equation of line  $p$  which passes through the point  $C(1, 4)$ , which slope is  $\frac{3}{7}$ .

$$y - y_1 = m(x - x_1)$$

$$y - 4 = \frac{3}{7}(x - 1)$$

$$y - 4 = \frac{3}{7}x - \frac{3}{7}$$

$$7y - 28 = 3x - 3$$

$$-3x + 7y - 28 + 3 = 0$$

$$-3x + 7y - 25 = 0$$

$$3x - 7y + 25 = 0$$

49. The answer is B.

Substitute the values of  $a$ ,  $b$  and  $c$  in the system of equations.

$$a = 1, b = 0, c = 9$$

$$5 = 1 \times x^2 + 0 \times x + 9$$

$$5 = x^2 + 9$$

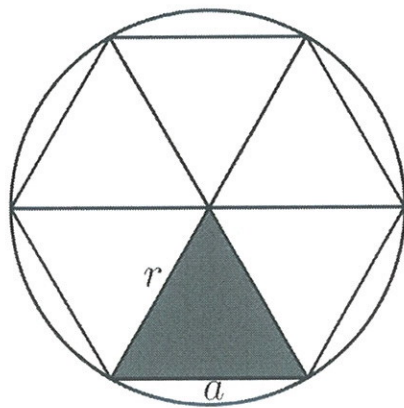
$$5 - 9 = x^2$$

$$-4 = x^2$$

$$x = \pm\sqrt{-4}$$

Therefore, for  $a = 1$ ,  $b = 0$  and  $c = 9$  the system of equations has no real solutions.

50. The answer is C.



A hexagon consists of 6 equilateral triangles. Therefore,  $a = r$ .

$$A_{\text{hexagon}} = \frac{6a^2\sqrt{3}}{4}$$

$$54\sqrt{3} = \frac{6a^2\sqrt{3}}{4}$$

$$4 \times 54\sqrt{3} = 6a^2\sqrt{3}$$

$$a^2 = \frac{4 \times 54\sqrt{3}}{6\sqrt{3}} = 36 \Rightarrow a = 6$$

$$r = a = 6$$

$$A_{\text{circle}} = 2r\pi = 2 \times 6\pi = 12\pi$$

51. The answer is 6.

$y$  – number of years

$$8.5y = 51$$

$$h = \frac{51}{8.5} = \frac{510}{85} = 6$$

52. The answer is 4.

1 day = 24 hours

$$d \times 24 + 4 = 100$$

$$24d = 96$$

$$p = \frac{96}{24} = 4$$

53. The answer is 6.

$$(3, -4) \Rightarrow x = 3, y = -4$$

$$f(x) = \frac{2}{3}x - n \Rightarrow y = \frac{2}{3}x - n \Rightarrow -4 = \frac{2}{3} \times 3 - n$$

$$-4 = 2 - n$$

$$n = 2 + 4$$

$$n = 6$$

54. The answer is 8.

$x$  – number of boys

$y$  – number of girls

$$x + y = 24$$

$$y - 8 = x \Rightarrow y = x + 8$$

$$x + x + 8 = 24$$

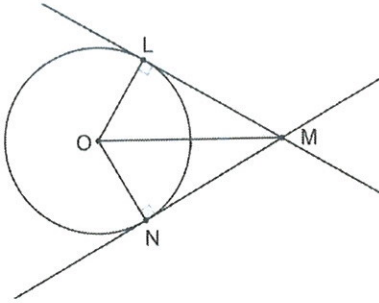
$$2x = 16$$

$$x = 8$$

55. The answer is 300.

- a – current amount of money Sarah has
- 2,000 – initial amount of money
- 300 – amount of money Sarah spends every week
- t – number of weeks

56. The answer is 8.38



$OL = ON = r$   
 $LM = MN$  – tangents are equal  
 $OM = OM$   
 $\triangle OLM \cong \triangle ONM$  (SSS Postulate)

$\triangle OLM \cong \triangle ONM \Rightarrow \angle LMO \cong \angle OMN \Rightarrow m\angle LMO = m\angle OMN = 30^\circ$   
 Angle between tangent line and radius is a right angle.  
 $m\angle OLM = 90^\circ$

$m\angle MOL + m\angle OLM + m\angle LMO = 180^\circ$   
 $m\angle MOL + 90^\circ + 30^\circ = 180^\circ$   
 $m\angle MOL = 60^\circ$

$\triangle OLM$  is  $30^\circ - 60^\circ - 90^\circ$  triangle. Therefore,  $OM = 2OL$ .  
 $LM^2 = OM^2 - OL^2 = (2OL)^2 - OL^2 = 4OL^2 - OL^2 = 3OL^2$

$$OL^2 = \frac{LM^2}{3} = \frac{(4\sqrt{3})^2}{3} = 16$$

$OL = 4$   
 $r = OL = 4$

$m\angle NOL + m\angle OLM + m\angle LMN + m\angle MNO = 180^\circ$   
 $m\angle NOL + 90^\circ + 60^\circ + 90^\circ = 180^\circ$   
 $m\angle NOL = 120^\circ$   
 $\alpha = m\angle NOL = 120^\circ$



$$\widehat{LN} = \frac{2r\pi\alpha}{360^\circ} = \frac{2 \times 4\pi \times 120^\circ}{360^\circ} = \frac{8\pi}{3} = 8.38$$

57. The answer is 12.

The level of water a day from now:

$$L_{tomorrow} = L_{today} + 0.8(L_{today})\left(1 - \frac{L_{today}}{P}\right)$$

$$L_{tomorrow} = 6 + 0.8(6)\left(1 - \frac{6}{12}\right) = 6 + 4.8 \times \frac{1}{2} = 8.4$$

The level of water two days from now:

$$L_{tomorrow} = 8.4 + 0.8(8.4)\left(1 - \frac{6}{12}\right) = 8.4 + 6.72 \times \frac{1}{2} = 11.76 \approx 12$$

58. The answer is 14.

$$L_{tomorrow} = L_{today} + 0.8(L_{today})\left(1 - \frac{L_{today}}{P}\right)$$

$$8 = 6 + 0.8(6)\left(1 - \frac{6}{P}\right)$$

$$2 = 4.8\left(1 - \frac{6}{P}\right)$$

$$1 - \frac{6}{P} = \frac{2}{4.8}$$

$$1 - \frac{6}{P} = \frac{20}{48}$$

$$1 - \frac{6}{P} = \frac{5}{12}$$

$$12P - 72 = 5P$$

$$5P = 72$$

$$P = 14.4 \approx 14$$

# TEST 3

1. The answer is C.

$$x^4 - 16 = 0$$

$$(x^2)^2 - 4^2 = 0$$

$$(x^2 - 4)(x^2 + 4) = 0$$

$$(x^2 - 2^2)(x^2 + 4) = 0$$

$$(x - 2)(x + 2)(x^2 + 4) = 0$$

$$x^2 - 4 = 0 \Rightarrow x^2 = 4$$

$$x^2 + 4 = 0 \Rightarrow x^2 = -4 \Rightarrow x = \pm\sqrt{-4} \Rightarrow \text{no solution}$$

$$x^2 = 4$$

$$\sqrt{20 - x^2} = \sqrt{20 - 4} = \sqrt{16} = 4$$

2. The answer is B.

$$-2x + 5y = 14$$

$$5x - y = -12$$

$$-2x + 5y = 14$$

$$25x - 5y = -60$$

$$-2x + 5y + 25x - 5y = 14 - 60$$

$$23x = -46$$

$$x = -2$$

$$-2x + 5y = 14$$

$$-2(-2) + 5y = 14$$

$$5y = 14 - 4$$

$$5y = 10$$

$$y = 2$$

$$|x - y| = |-2 - 2| = |-4| = 4$$

3. The answer is B.

$p$  - the price of a drink

$n$  - the number of drinks sold per hour

$r$  - the rent George pays

16 - the number of working hours

4. The answer is C.

Use formula  $a^2 + 2ab + b^2 = (a + b)^2$

$$x^6 + 4x^3 + 4 = (x^3)^2 + 2(x^3)(2) + 2^2 = (x^3 + 2)^2$$

5. The answer is A.

$$\sqrt{19 + x^4} - k = 0$$

$$\sqrt{19 + x^4} - 10 = 0$$

$$\sqrt{19 + x^4} = 10$$

$$\sqrt{19 + x^4}^2 = 10^2$$

$$19 + x^4 = 100$$

$$x^4 = 100 - 19$$

$$x^4 = 81$$

$$x = \pm\sqrt[4]{81}$$

$$x = \pm\sqrt[4]{3^4}$$

$$x = \pm 3$$

$$x < 0 \Rightarrow x = -3$$

6. The answer is B.

Find equation of line  $q$ .

$$A(0,1), B(2,0) \Rightarrow x_1 = 0, y_1 = 1, x_2 = 2, y_2 = 0$$

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

$$y - 1 = \frac{0 - 1}{2 - 0}(x - 0)$$

$$y - 1 = -\frac{1}{2}x$$

$$y = -\frac{1}{2}x + 1$$

The product of slopes of perpendicular lines is  $-1$ .

$$m_p m_q = -1$$

$$m_q = -\frac{1}{2}$$

$$m_p = -\frac{1}{m_q} = -\frac{1}{-\frac{1}{2}} = 2$$

The line  $p$  passes through the point  $(2,0)$ .

$$(2,0) \Rightarrow x = 2, y = 0$$

$$m_p = 2$$

$$y = m_p x + n$$

$$0 = 2 \times 2 + n$$

$$n = -4$$

The equation of line  $p$  is  $y = 2x - 4$

The line  $p$  passes through the point  $(0,t)$ .

$$(0,t) \Rightarrow x = 0, y = t$$

$$y = 2x - 4$$

$$t = 2 \times 0 - 4$$

$$t = -4$$

7. The answer is A.

$$\frac{125^x 25^y}{625^z} = \frac{(5^3)^x (5^2)^y}{(5^4)^z} = \frac{5^{3x} 5^{2y}}{5^{4z}} = \frac{5^{3x+2y}}{5^{4z}} = 5^{3x+2y-4z} = 5^2 = 25$$

8. The answer is D.

$m$  – number of marbles given to each friend

$f$  – number of friends

$$fm \leq 70$$

$$6 \leq m \leq \frac{70}{f}$$

$$6 \leq \frac{70}{f}$$

$$f \leq \frac{70}{6}$$

$$f \leq 11\frac{2}{3}$$

Maximum number of friends who will get marbles from Noah is 11.

9. The answer is D.

$$-2x + 3y + 4 = 0$$

$$3y = 2x - 4$$

$$y = \frac{2}{3}x - \frac{4}{3}$$

$$m = \frac{2}{3}$$

Product of slopes of perpendicular lines is  $-1$ .

$$m_p m = -1$$

$$m_p = -\frac{1}{m} = -\frac{1}{\frac{2}{3}} = -\frac{3}{2}$$

$$(-3,4) \Rightarrow x = -3, y = 4$$

$$y = m_p x + n$$

$$4 = -\frac{3}{2}(-3) + n$$

$$4 = \frac{9}{2} + n$$

$$n = 4 - \frac{9}{2} = \frac{8}{2} - \frac{9}{2} = -\frac{1}{2}$$

$$y = m_p x + n$$

$$y = -\frac{3}{2}x - \frac{1}{2}$$

10. The answer is C.

If a line has a negative slope and its y-intercept is positive, then it doesn't pass through the 3<sup>rd</sup> quadrant.

$$5x + 4y = 17$$

$$4y = -5x + 17$$

$$y = -\frac{5}{4}x + \frac{17}{4}$$

$$m = -\frac{5}{4} < 0, n = \frac{17}{4} > 0 \Rightarrow \text{line doesn't pass through the 3}^{\text{rd}} \text{ quadrant}$$

11. The answer is C.

$$(1 - i)^{10} = [(1 - i)^2]^5 = (1 - 2i + i^2)^5 = (1 - 2i - 1)^5 = (-2i)^5 = -32i^5 = -32i^4 i = -32 \times 1 \times i = -32i$$

12. The answer is A.

$$P = \frac{B}{B + G}$$

$$P(B + G) = B$$

$$PB + PG = B$$

$$PG = B - PB$$

$$PG = B(1 - P)$$

$$G = \frac{B(1 - P)}{P}$$

13. The answer is A.

$$16x^4 - 81 = 0$$

$$(4x^2)^2 - 9^2 = 0$$

$$(4x^2 - 9)(4x^2 + 9) = 0$$

$$((2x)^2 - 3^2)(4x^2 + 9) = 0$$

$$(2x - 3)(2x + 3)(4x^2 + 9) = 0$$

$$2x - 3 = 0 \Rightarrow x = \frac{3}{2}$$

$$2x + 3 = 0 \Rightarrow x = -\frac{3}{2}$$

$$4x^2 + 9 = 0 \Rightarrow x^2 = -\frac{9}{4} \Rightarrow x = \pm \sqrt{-\frac{9}{4}} \Rightarrow \text{no solution}$$

$$\frac{3}{2} + \left(-\frac{3}{2}\right) = 0$$

14. The answer is C.

After 1 hour:

$$\begin{aligned} 56 + 2\% \times 56 &= 56(1 + 2\%) = 56\left(1 + \frac{2}{100}\right) = 56(1 + 0.02) = \\ &= 56 \times 1.02 = 56 \times 1.02^1 \end{aligned}$$

After 2 hours:

$$\begin{aligned} 56 \times 1.02 + 2\% \times 56 \times 1.02 &= 56 \times 1.02(1 + 2\%) = 56 \times 1.02(1 + 0.02) = \\ &= 56 \times 1.02 \times 1.02 = 56 \times 1.02^2 \end{aligned}$$

After  $t$  hours:  $56 \times 1.02^t$

15. The answer is A.

$$\frac{3 - 4x}{2x + 5} = -\frac{4x - 3}{2x + 5} = -\frac{4x + 10 - 10 - 3}{2x + 5} = -\frac{2(2x + 5) - 13}{2x + 5} = -2 + \frac{13}{2x + 5}$$

16. The answer is 2, 4, or 6.

$x$  – number of cars

$y$  – number of bicycles

$$4x + 2y = 16$$

Minimum number of cars is 1, and maximum number of cars is 3.

$$x = 1 \Rightarrow 4 \times 1 + 2y = 16 \Rightarrow y = 6$$

$$x = 2 \Rightarrow 4 \times 2 + 2y = 16 \Rightarrow y = 4$$

$$x = 3 \Rightarrow 4 \times 3 + 2y = 16 \Rightarrow y = 2$$

Therefore, one possible number of bicycles is 2, 4 or 6.

17. The answer is 10.

$$\begin{aligned} ax(bx - c) + 2(dx + 5) &= abx^2 - acx + 2dx + 10 = abx^2 + x(2d - ac) + 10 \\ m &= ab, n = 2d - ac, k = 10 \end{aligned}$$

18. The answer is 16.

$$\begin{aligned} \triangle ABE &\sim \triangle BCD \\ \frac{AE}{CD} &= \frac{AB}{BD} \Rightarrow \frac{9}{3} = \frac{12}{BD} \Rightarrow 9BD = 3 \times 12 \Rightarrow BD = 4 \\ AD &= AB + BD = 12 + 4 = 16 \end{aligned}$$

19. The answer is 4.

$$\tan \angle AOB = \frac{x}{y} = \frac{k}{k} = 1 \Rightarrow \angle AOB = \frac{\pi}{4} \Rightarrow a = 4$$

20. The answer is  $\frac{9}{2}$ .

$$\begin{aligned} 6ax + (a - 2b)y &= 20 \\ 3x - 4y &= 10 \end{aligned}$$

$$\begin{aligned} 6ax + (a - 2b)y &= 20 \\ 6x - 8y &= 20 \end{aligned}$$

$$6a = 6 \Rightarrow a = 1$$

$$a - 2b = -8$$

$$1 - 2b = -8$$

$$b = \frac{9}{2}$$

$$\frac{b}{a} = \frac{\frac{9}{2}}{1} = \frac{9}{2}$$

21. The answer is C.

$4c$  – total number of legs of cows

$2h$  – total number of legs of hens

$4c + 2h$  – total number of legs

$$4c + 2h = 2(2c + h)$$

22. The answer is A.

$$5:2 = 35:x$$

$$5x = 2 \times 35$$

$$x = \frac{2 \times 35}{5} = 14$$



23. The answer is C.

$$\begin{aligned}g &= 4 + 0.25h \\12 &= 4 + 0.25h \\8 &= 0.25h \\h &= \frac{8}{0.25} = 32\end{aligned}$$

24. The answer is A.

$$\begin{aligned}320:2 &= x:3 \\2x &= 320 \times 3 \\x &= \frac{320 \times 3}{2} = 160 \times 3 = 480\end{aligned}$$

25. The answer is C.

15% of 320 visitors =  $15\% \cdot 320$  visitors =  $0.15 \cdot 320$  visitors = 48 visitors do not drink beer  
Therefore,  $320 - 48 = 272$  visitors drink beer

26. The answer is A.

$$\begin{aligned}9 + 6x &= 27 \\6x &= 27 - 9 \\6x &= 18 \\x &= \frac{18}{6} = 3 \\2x - 4 &= 2 \times 3 - 4 = 6 - 4 = 2\end{aligned}$$

27. The answer is B.

Write the equation of the parabola in vertex form.

$$\begin{aligned}y &= x^2 - 4x + 5 \\y &= x^2 - 2 \times 2x + 2^2 - 2^2 + 5 \\y &= (x - 2)^2 - 4 + 5 \\y &= (x - 2)^2 + 1\end{aligned}$$

Therefore, the vertex of parabola is (2, 1).

28. The answer is B.

$$\begin{aligned}k - 4 \times 7 &= 16 \\k - 28 &= 16 \\k &= 16 + 28 \\k &= 44\end{aligned}$$

29. The answer is C.

- $x$  – the number of 2-bedrooms
- $y$  – the number of 3-bedrooms
- $2x$  – the total number of beds in 2-bedrooms
- $3y$  – the total number of beds in 3-bedrooms
- $x + y < 25$  – the total number of rooms is less than 25
- $2x + 3y < 70$  – the total number of beds is less than 70

30. The answer is A.

$$\begin{aligned} f \cdot f^{-1} &= 1 \Rightarrow g = f^{-1} \\ f(x) &= 3 + 5x \\ x &= 3 + 5f^{-1}(x) \\ x - 3 &= 5f^{-1}(x) \\ f^{-1}(x) &= \frac{x - 3}{5} \end{aligned}$$

31. The answer is A.

$$50 \frac{km}{h} = 50 \times \frac{1}{1.6} \frac{mi}{h} = \frac{50}{1.6} \frac{mi}{h} = 31.25 \frac{mi}{h} \approx 30 \frac{mi}{h}$$

32. The answer is A.

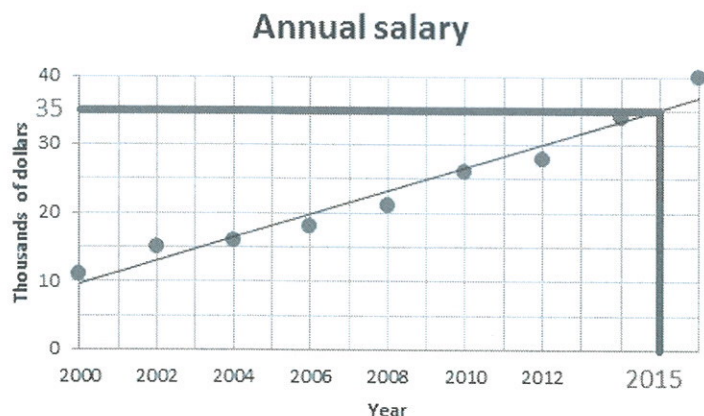
- 800 – starting salary
- 15 – amount of money Sarah earns per item
- 15k – amount of money Sarah earns after  $k$  items sold
- We want the salary to be at or above \$1,000.
- $800 + 15k \geq 1,000$

33. The answer is B.

$$\begin{aligned} C(n, r) &= C(10, 3) = \binom{10}{3} = \frac{10!}{3!(10-3)!} = \frac{10!}{3!7!} = \frac{10 \times 9 \times 8 \times \dots \times 2 \times 1}{3 \times 2 \times 1 \times 7 \times 6 \times \dots \times 2 \times 1} \\ &= \frac{10 \times 9 \times 8}{3 \times 2 \times 1} = 5 \times 3 \times 8 = 120 \end{aligned}$$

34. The answer is C.

Look at the graph below. The annual salary was \$35,000 in 2009.



35. The answer is C.

$$422,500,000 \frac{mi}{7 \text{ months}} = 422,500,000 \frac{mi}{(7 \times 30 \times 24)h} = \frac{422,500,000 \text{ mi}}{7 \times 30 \times 24} \frac{1}{h} = 83,829.3 \frac{mi}{h}$$

36. The answer is A.

According to the table, there are  $6 + 4 = 10$  girls, and 6 of them plays guitar. Therefore, if one of girls is chosen at random, the probability that she plays guitar is  $\frac{6}{10} = \frac{3}{5}$ .

37. The answer is A.

$$12\% \text{ of } \$2,400 = 12\% \times \$2,400 = 0.12 \times \$2,400 = \$288$$

$$\text{Olivia's new salary: } \$2,400 + \$288 = \$2,688$$

38. The answer is B.

The example in the question has a median that is larger than mean, so small outliers are present in the data. Therefore, there are a few guests in the hotel much younger than the rest.

39. The answer is C.

There are a total of 80 data points provided, so the median will be the average of the 40<sup>th</sup> and 41<sup>th</sup> data points. When the data points are set in order:

- values 1 through 19 will be 0
- values 20 through 37 will be 1
- values 38 through 66 will be 2
- values 67 through 80 will be 3

Therefore, both the 40<sup>th</sup> and 41<sup>th</sup> values are 2, and hence the median is 2.

40. The answer is C.

Since 9 of 40 employees at Factory A have 1 day of absence, the same ratio holds for all 400 employees at Factory A. Also, since 9 of 40 people at Factory B have 1 day of absence, the same ratio holds for all 520 people at Factory B.

Therefore, approximately  $\frac{9}{40} \times 400 = 90$  employees at Factory A and  $\frac{9}{40} \times 520 = 117$  employees at Factory B are expected to have 1 day of absence.

Thus, the total number of employees with 1 day of absence at Factory B is expected to be  $117 - 90 = 27$  more than at Factory A.

41. The answer is D.

The estimate  $x$  could be greater or less than actual length  $y$ . In both cases difference must be less than 20. So we have  $y - x < 20$  or  $x - y < 20$ . Therefore, the absolute value of the difference is less than 20.

$$|y - x| < 20 \Leftrightarrow -20 < y - x < 20 \Leftrightarrow -20 < x - y < 20$$

42. The answer is B.

$$P = \frac{F}{8r^2}$$

$$8r^2P = F$$

$$r^2 = \frac{F}{8P}$$

43. The answer is D.

$$P_A = 25P_B$$

$$\frac{F}{8r_A^2} = 25 \times \frac{F}{8r_B^2}$$

$$\frac{8r_A^2}{F} = \frac{8r_B^2}{25F}$$

$$r_A^2 = \frac{r_B^2}{25}$$

$$\frac{r_A^2}{r_B^2} = \frac{1}{25}$$

$$\left(\frac{r_A}{r_B}\right)^2 = \left(\frac{1}{5}\right)^2$$

$$\frac{r_A}{r_B} = \frac{1}{5}$$

44. The answer is B.

$$x^2 + y^2 + 4x - 2y = 15$$

$$x^2 + 4x + y^2 - 2y = 15$$

$$x^2 + 4x + 4 - 4 + y^2 - 2y + 1 - 1 = 15$$

$$x^2 + 4x + 4 + y^2 - 2y + 1 = 15 + 4 + 1$$

$$(x + 2)^2 + (y - 1)^2 = 20$$

$$C(-2, 1)$$

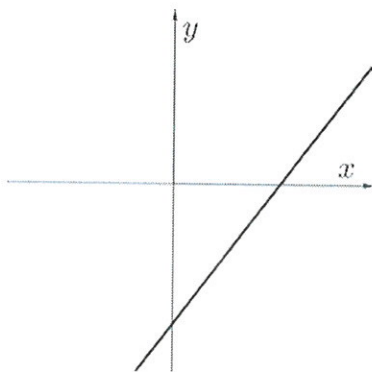
45. The answer is A.

$a$  –  $x$ -intercept

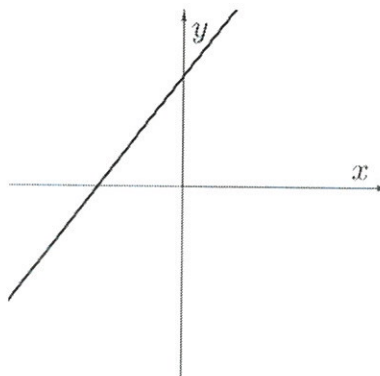
$b$  –  $y$ -intercept

$$ab = -1 \Rightarrow (a > 0 \wedge b < 0) \vee (a < 0 \wedge b > 0)$$

$$a > 0 \wedge b < 0$$



$$a < 0 \wedge b > 0$$

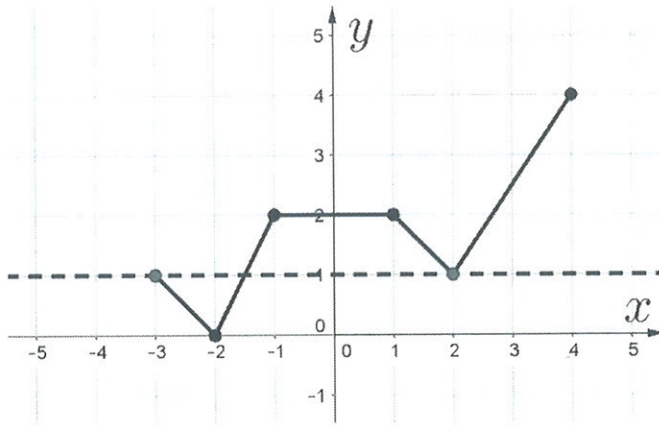


In both cases the slope is positive.

46. The answer is B.

Points on the graph which lie on the line  $y = 1$  are the solutions:  $f(-3)$  and  $f(2)$ .

Therefore, I and III only are the solutions.

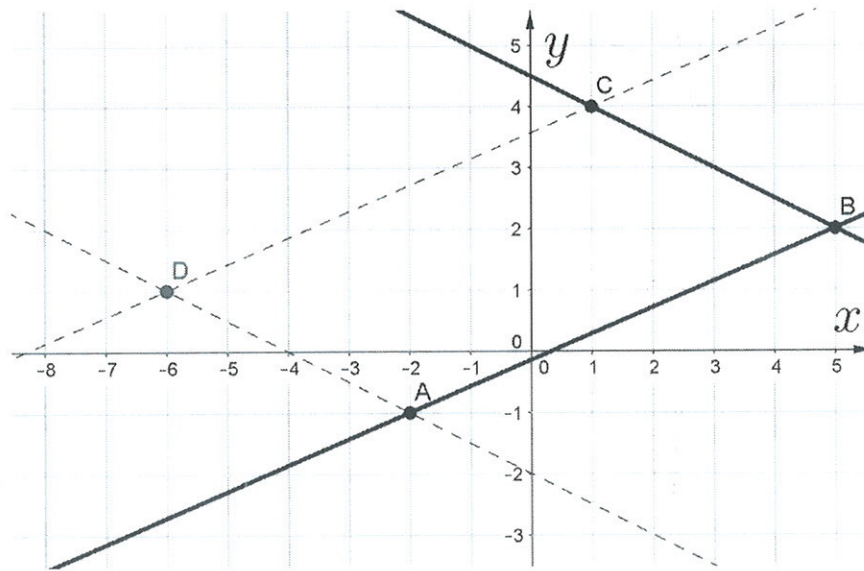


47. The answer is A.

Each red dot is above the corresponding green dot. Therefore, in every 6-months interval, the magnitude of the rate of change of salary of Worker A is greater than that of Worker B.

48. The answer is B.

Draw lines parallel to AB and BC through the points C and A, respectively. So, point D has coordinates  $(-6, 1)$ .



49. The answer is C.

Substitute the values of  $a$ ,  $b$  and  $c$  in the system of equations.

$$a = 1, b = 2, c = 0$$

$$1 = 1 \times x^2 + 2 \times x + 0$$

$$1 = x^2 + 2x$$

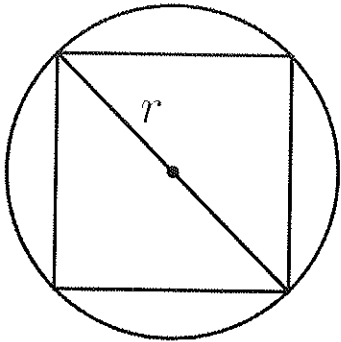
$$x^2 + 2x - 1 = 0$$

$$x_{1,2} = \frac{-2 \pm \sqrt{2^2 - 4 \times 1 \times (-1)}}{2 \times 1} = \frac{-2 \pm \sqrt{4 + 4}}{2} = \frac{-2 \pm \sqrt{4 \times 2}}{2} = \frac{-2 \pm 2\sqrt{2}}{2}$$

$$x_{1,2} = -1 \pm 2\sqrt{2}$$

Therefore, for  $a = 1$ ,  $b = 2$  and  $c = 0$  the system of equations has two real solutions.

50. The answer is B.



The radius of a circle is equal to half of the diagonal of a square:  $r = \frac{d}{2}$ .

$$A_{\text{square}} = a^2$$

$$8 = a^2$$

$$a = \sqrt{8} = \sqrt{4 \times 2} = 2\sqrt{2}$$

$$d^2 = a^2 + a^2 = 2a^2 = 2(2\sqrt{2})^2 = 2 \times 8 = 16$$

$$d = \sqrt{16} = 4$$

$$r = \frac{d}{2} = \frac{4}{2} = 2$$

$$A_{\text{circle}} = r^2\pi = 2^2\pi = 4\pi$$

51. The answer is 4.

$m$  – number of years

$$125m = 500$$

$$h = \frac{500}{125} = 4$$

52. The answer is 5.

1 week = 7 days

$$w \times 7 + 5 = 40$$

$$7w = 35$$

$$p = \frac{35}{7} = 5$$

53. The answer is 12.

$$(2,5) \Rightarrow x = 2, y = 5$$

$$\frac{x}{a} + \frac{y}{6} = 1$$

$$\frac{2}{a} + \frac{5}{6} = 1$$

$$6a \times \frac{2}{a} + 6a \times \frac{5}{6} = 6a \times 1$$

$$12 + 5a = 6a$$

$$a = 12$$

54. The answer is 61.

$x$  – number of red marbles

$y$  – number of blue marbles

$$x + y = 110$$

$$x - 12 = y$$

$$x + x - 12 = 110$$

$$2x = 122$$

$$x = 61$$

55. The answer is 6.

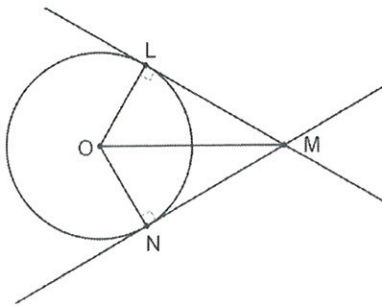
$l$  – current level of the river

$h$  – number of hours

45 – initial level of the river

6 – the constant rate at which level of the river increase

56. The answer is 12.6



$$OL = ON = r$$

$$LM = MN \text{ – tangents are equal}$$

$$OM = OM$$

$$\triangle OLM \cong \triangle ONM \text{ (SSS Postulate)}$$



$$\triangle OLM \cong \triangle ONM \Rightarrow \angle LMO \cong \angle OMN \Rightarrow m\angle LMO = m\angle OMN = 30^\circ$$

Angle between tangent line and radius is a right angle.

$$m\angle OLM = 90^\circ$$

$$m\angle MOL + m\angle OLM + m\angle LMO = 180^\circ$$

$$m\angle MOL + 90^\circ + 30^\circ = 180^\circ$$

$$m\angle MOL = 60^\circ$$

$\triangle OLM$  is  $30^\circ - 60^\circ - 90^\circ$  triangle. Therefore,  $OM = 2OL$ .

$$LM^2 = OM^2 - OL^2 = (2OL)^2 - OL^2 = 4OL^2 - OL^2 = 3OL^2$$

$$LM = OL\sqrt{3}$$

$$A_{\triangle OLM} = \frac{OL \times LM}{2}$$

$$A_{\triangle OLM} = \frac{OL^2\sqrt{3}}{2}$$

$$A_{\triangle OLMN} = 2A_{\triangle OLM}$$

$$A_{\triangle OLMN} = 2 \frac{OL^2\sqrt{3}}{2}$$

$$A_{\triangle OLMN} = OL^2\sqrt{3}$$

$$4\sqrt{3} = OL^2\sqrt{3}$$

$$OL^2 = 4$$

$$OL = 2$$

$$r = OL = 2$$

$$C = 2r\pi = 2 \times 2\pi = 4\pi = 12.6$$

57. The answer is 57.

The number of rabbits next month:

$$R_{next\ month} = R_{this\ month} + 0.6(R_{this\ month}) \left(1 - \frac{R_{this\ month}}{P}\right)$$

$$R_{next\ month} = 40 + 0.6(40) \left(1 - \frac{40}{60}\right) = 40 + 24 \times \frac{1}{3} = 48$$

The number of rabbits two months from now:

$$R_{next\ month} = 48 + 0.6(48) \left(1 - \frac{48}{60}\right) = 48 + 28.8 \times \frac{1}{3} = 57.6 \approx 57$$

58. The answer is 60.

$$R_{\text{next month}} = R_{\text{this month}} + 0.6(R_{\text{this month}}) \left(1 - \frac{R_{\text{this month}}}{P}\right)$$

$$48 = 40 + 0.6(40) \left(1 - \frac{40}{P}\right)$$

$$8 = 24 \left(1 - \frac{40}{P}\right)$$

$$\frac{1}{3} = 1 - \frac{40}{P}$$

$$P = 3P - 120$$

$$-2P = -120$$

$$P = 60$$

# TEST 4

1. The answer is B.

$$\frac{x^2 - 3x - 4}{x + 1} = 0$$

$$x + 1 \neq 0$$

$$x \neq -1$$

$$(x + 1) \frac{x^2 - 3x - 4}{x + 1} = (x + 1)0$$

$$x^2 - 3x - 4 = 0$$

$$x^2 - 4x + x - 4 = 0$$

$$x(x - 4) + 1(x - 4) = 0$$

$$(x - 4)(x + 1) = 0$$

$$x - 4 = 0 \Rightarrow x = 4$$

$$x + 1 = 0 \Rightarrow x = -1 \wedge x \neq -1 \Rightarrow \text{no solution}$$

$$x = 4$$

$$5 - \frac{x}{2} = 5 - \frac{4}{2} = 3$$

2. The answer is A.

$$-6x + 7y = 10$$

$$2x + 5y = -18$$

$$-6x + 7y = 10$$

$$6x + 15y = -54$$

$$-6x + 7y + 6x + 15y = 10 - 54$$

$$22y = -44$$

$$y = -2$$

$$-6x + 7y = 10$$

$$-6x + 7(-2) = 10$$

$$-6x - 14 = 10$$

$$-6x = 10 + 14$$

$$-6x = 24$$

$$x = -\frac{24}{6}$$

$$x = -4$$

$$\frac{x}{y} = \frac{-4}{-2} = 2$$

3. The answer is D.

$n$  - the number of drinks sold per hour  
 $p$  - the price of a drink  
 $h$  - the number of working hours  
 2,000 - the rent George pays

4. The answer is D.

Use formula  $a^2 - 2ab + b^2 = (a - b)^2$

$$x^8 - 2x^4 + 1 = (x^4)^2 - 2(x^4)(1) + 1^2 = (x^4 - 1)^2$$

Use formula  $a^2 - b^2 = (a - b)(a + b)$

$$\begin{aligned} (x^4 - 1)^2 &= ((x^2)^2 - 1^2)^2 = ((x^2 - 1)(x^2 + 1))^2 = (x^2 - 1)^2(x^2 + 1)^2 = \\ &= (x^2 - 1)^2(x^2 + 1)^2 = ((x - 1)(x + 1))^2(x^2 + 1)^2 = \\ &= (x - 1)^2(x + 1)^2(x^2 + 1)^2 \end{aligned}$$

5. The answer is D.

$$\begin{aligned} \sqrt{2x^3 - 5} + k &= 0 \\ \sqrt{2x^3 - 5} + 7 &= 0 \\ \sqrt{2x^3 - 5} &= -7 \\ \sqrt{2x^3 - 5}^2 &= (-7)^2 \\ 2x^3 - 5 &= 49 \\ 2x^3 &= 49 + 5 \\ 2x^3 &= 54 \\ x^3 &= 27 \\ x &= \sqrt[3]{27} \\ x &= \sqrt[3]{3^3} \\ x &= 3 \end{aligned}$$

6. The answer is C.

Find equation of line  $p$ .

$$A(0,1), B(-3,0) \Rightarrow x_1 = 0, y_1 = 1, x_2 = -3, y_2 = 0$$

$$y - y_1 = \frac{y_2 - y_1}{x_2 - x_1}(x - x_1)$$

$$y - 1 = \frac{0 - 1}{-3 - 0}(x - 0)$$

$$y - 1 = \frac{1}{3}x$$

$$y = \frac{1}{3}x + 1$$

The product of slopes of perpendicular lines is  $-1$ .

$$m_p m_q = -1$$

$$m_p = \frac{1}{3}$$

$$m_q = -\frac{1}{m_p} = -\frac{1}{\frac{1}{3}} = -3$$

The line  $q$  passes through the point  $(-3,0)$ .

$$(-3,0) \Rightarrow x = -3, y = 0$$

$$m_q = -3$$

$$y = m_q x + n$$

$$0 = -3(-3) + n$$

$$n = -9$$

The equation of line  $q$  is  $y = -3x - 9$

The line  $q$  passes through the point  $(0,t)$ .

$$(0,t) \Rightarrow x = 0, y = t$$

$$y = -3x - 9$$

$$t = -3 \times 0 - 9$$

$$t = -9$$

7. The answer is B.

$$\frac{1}{32^x 8^y 16^z} = \frac{1}{(2^5)^x (2^3)^y (2^4)^z} = \frac{1}{2^{5x} 2^{3y} 2^{4z}} = \frac{1}{2^{5x+3y+4z}} = \frac{1}{2^{-4}} = 2^4 = 16$$

8. The answer is C.

$s$  – number of seats in a bus

$b$  – number of buses

$$sb \leq 420$$

$$35 \leq s \leq \frac{420}{b}$$

$$35 \leq \frac{420}{b}$$

$$b \leq \frac{420}{35}$$

$$b \leq 12\frac{2}{7}$$

Maximum number of buses is 12.

9. The answer is C.

$$A(4,3), B(-1,3) \Rightarrow x_1 = 4, y_1 = 3, x_2 = -1, y_2 = 3$$

$$m_{AB} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{3 - 3}{-1 - 4} = \frac{0}{-5} = 0$$

$$B(-1, 3), C(-2, -5) \Rightarrow x_1 = -1, y_1 = 3, x_2 = -2, y_2 = -5$$

$$m_{BC} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-5 - 3}{-2 - (-1)} = \frac{-8}{-2 + 1} = \frac{-8}{-1} = 8$$

$$C(-2, -5), D(1, -1) \Rightarrow x_1 = -2, y_1 = -5, x_2 = 1, y_2 = -1$$

$$m_{CD} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1 - (-5)}{1 - (-2)} = \frac{-1 + 5}{1 + 2} = \frac{4}{3}$$

$$A(4, 3), C(-2, -5) \Rightarrow x_1 = 4, y_1 = 3, x_2 = -2, y_2 = -5$$

$$m_{AC} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-5 - 3}{-2 - 4} = \frac{-8}{-6} = \frac{4}{3}$$

$$A(4, 3), D(1, -1) \Rightarrow x_1 = 4, y_1 = 3, x_2 = 1, y_2 = -1$$

$$m_{AD} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1 - 3}{1 - 4} = \frac{-4}{-3} = \frac{4}{3}$$

$$B(-1, 3), D(1, -1) \Rightarrow x_1 = -1, y_1 = 3, x_2 = 1, y_2 = -1$$

$$m_{BD} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1 - 3}{1 - (-1)} = \frac{-4}{1 + 1} = \frac{-4}{2} = -2$$

$$m_{CD} = m_{AC} = m_{AD} = \frac{4}{3} \Rightarrow \text{points A, C and D are collinear}$$

There are 4 lines: BA, BC, BD and ACD.

10. The answer is B.

If a line has positive slope and its  $y$ -intercept is positive, then it doesn't pass through the 4<sup>th</sup> quadrant.

$$-4x + 5y = 11$$

$$5y = 4x + 11$$

$$y = \frac{4}{5}x + \frac{11}{5}$$

$$m = \frac{4}{5} > 0, n = \frac{11}{5} > 0 \Rightarrow \text{line doesn't pass through the 4}^{\text{th}} \text{ quadrant}$$

11. The answer is D.

$$\sqrt{1+i} = k$$

$$(\sqrt{1+i})^2 = k^2$$

$$1+i = k^2$$

$$(1+i)^2 = (k^2)^2$$

$$1 + 2i + i^2 = k^4$$

$$1 + 2i - 1 = k^4$$

$$2i = k^4$$

$$k = \sqrt[4]{2i}$$

12. The answer is D.

$$P = \frac{F}{M + F} \times 100$$

$$P(M + F) = 100F$$

$$PM + PF = 100F$$

$$PM = 100F - PF$$

$$PM = F(100 - P)$$

$$M = \frac{F(100 - P)}{P}$$

13. The answer is D.

$$2x - 5 = 0 \Rightarrow x = \frac{5}{2}$$

$$2x^2 + 8x - 9 = 0 \Rightarrow D = 8^2 - 4 \times 2 \times (-9) > 0 \Rightarrow 2 \text{ real solutions}$$

$$x^3 + 8 = 0 \Rightarrow x^3 = -8 \Rightarrow x = \sqrt[3]{-8} = -2$$

$$x^4 + x^2 + 5 = 0 \Rightarrow D = 1^2 - 4 \times 1 \times 5 < 0 \Rightarrow \text{no solution}$$

14. The answer is B.

After 1 month:

$$4,000 - 5\% \times 4,000 = 4,000(1 - 5\%) = 4,000 \left(1 - \frac{5}{100}\right) = 4,000(1 - 0.05) = 4,000 \times 0.95 = 4,000(0.95)^1$$

After 2 months:

$$4,000 \times 0.95 - 5\% \times 4,000 \times 0.95 = 4,000 \times 0.95(1 - 5\%) = 4,000 \times 0.95 \left(1 - \frac{5}{100}\right) = 4,000 \times 0.95(1 - 0.05) = 4,000 \times 0.95 \times 0.95 = 4,000(0.95)^2$$

$$\text{After } t \text{ months: } 4,000(0.95)^t$$

15. The answer is A.

$$\frac{4x + 7}{x - 2} = \frac{4x - 8 + 8 + 7}{x - 2} = \frac{4(x - 2) + 15}{x - 2} = 4 + \frac{15}{x - 2}$$



16. The answer is 1,3, or 5.

$x$  – number of cats

$y$  – number of parrots

$$4x + 2y = 14$$

Minimum number of cats is 1, and maximum number of cats is 3.

$$x = 1 \Rightarrow 4 \times 1 + 2y = 14 \Rightarrow y = 5$$

$$x = 2 \Rightarrow 4 \times 2 + 2y = 14 \Rightarrow y = 3$$

$$x = 3 \Rightarrow 4 \times 3 + 2y = 14 \Rightarrow y = 1$$

Therefore, one possible number of parrots is 1, 3 or 5.

17. The answer is 7.

$$ax(2x - 3) + b(4x + 1) = 2ax^2 - 3ax + 4bx + b = 2ax^2 + x(4b - 3a) + b$$

$$2ax^2 + x(4b - 3a) + b = 8x^2 + 7x + 3$$

$$2a = 8 \Rightarrow a = 4$$

$$b = 3$$

$$a + b = 4 + 3 = 7$$

18. The answer is  $55^\circ$ .

$$\sphericalangle A + \sphericalangle B + \sphericalangle E = 180^\circ$$

$$\sphericalangle A = 180^\circ - \sphericalangle B - \sphericalangle E = 180^\circ - 80^\circ - 45^\circ = 55^\circ$$

$$\triangle ABE \sim \triangle BCD \Rightarrow \sphericalangle A \cong \sphericalangle D$$

$$\sphericalangle D = \sphericalangle A = 55^\circ$$

19. The answer is 3.

$$\tan \sphericalangle AOB = \frac{x}{y} = \frac{3}{\sqrt{3}} = \sqrt{3} \Rightarrow \sphericalangle AOB = \frac{\pi}{3} \Rightarrow a = 3$$

20. The answer is 1.

$$(a^2 + b^2)x + (a^2 - b^2)y = 8$$

$$6x - 5y = 4$$

$$(a^2 + b^2)x + (a^2 - b^2)y = 8$$

$$12x - 10y = 8$$

$$a^2 + b^2 = 12$$

$$a^2 - b^2 = -10$$

$$2a^2 = 2$$

$$a^2 = 1$$

21. The answer is D.

$2s$  – total number of wheels of bicycles

$4t$  – total number of wheels of cars

$2s + 4t$  – total number of wheels

$$2s + 4t = 2(s + 2t)$$

22. The answer is B.

$$200:8 = 750:x$$

$$200x = 8 \times 750$$

$$x = \frac{8 \times 750}{200} = 30$$

23. The answer is D.

$$w = 16 + 5m$$

$$86 = 16 + 5m$$

$$70 = 5m$$

$$m = \frac{70}{5} = 14$$

24. The answer is B.

$$76:2 = x:5$$

$$2x = 76 \times 5$$

$$x = \frac{76 \times 5}{2} = 38 \times 5 = 190$$

25. The answer is D.

$$25\% \text{ of } 76 = 25\% \cdot 76 = 0.25 \cdot 76 = 19$$

26. The answer is C.

$$5x + 2 = 27$$

$$5x = 27 - 2$$

$$5x = 25$$

$$x = \frac{25}{5} = 5$$

$$3x + 1 = 3 \times 5 + 1 = 15 + 1 = 16$$

27. The answer is D.

Write the equation of the parabola in standard form.

$$y = (x + 2)(x - 6)$$

$$y = x^2 - 6x + 2x - 12$$

$$y = x^2 - 4x - 12$$

The  $y$ -intercept of the parabola represented by  $y = x^2 - 4x - 12$  in the  $xy$ -plane is the value of  $y$  for which  $x$  is equal to 0.

$$y = 0^2 - 4 \times 0 - 12$$

$$y = -12$$

28. The answer is B.

$$k - 6 \times 5 = 12$$

$$k - 30 = 12$$

$$k = 12 + 30$$

$$k = 42$$

29. The answer is D.

$x$  – the number of six-packs

$y$  – the number of four-packs

$6x$  – the total number of bottles in six-packs

$4y$  – the total number of bottles in four-packs

$x + y < 30$  – the total number of packs is less than 30

$6x + 4y < 150$  – the total number of bottles is less than 150

30. The answer is D.

$$x + 4 = t$$

$$x = t - 4$$

$$f(x + 4) = 3x - 2$$

$$f(t) = 3(t - 4) - 2 = 3t - 12 - 2 = 3t - 14$$

$$f(t) = 3t - 14 \Rightarrow f(x) = 3x - 14$$

31. The answer is B.

$$4.5 \frac{mi}{h} = 4.5 \times \frac{1.6 km}{h} = 4.5 \times 1.6 \frac{km}{h} = 7.2 \frac{km}{h}$$

32. The answer is B.

40 – initial level of water

5 – increase in level of water per hour

$5t$  – increase in level of water after  $t$  hours

We want the level of water to be at or above 60 cm.

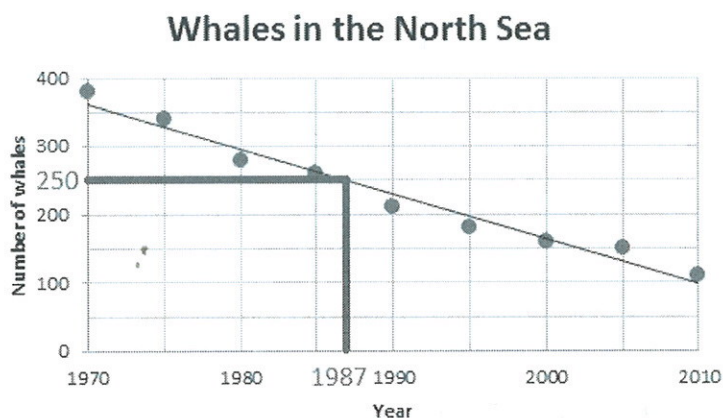
$$40 + 5t \geq 60$$

33. The answer is C.

$$P = \frac{\binom{6}{2} \binom{9}{1}}{\binom{15}{3}} = \frac{\frac{6 \times 5}{2 \times 1} \times \frac{9}{1}}{\frac{15 \times 14 \times 13}{3 \times 2 \times 1}} = \frac{6 \times 5 \times 9}{5 \times 14 \times 13} = \frac{3 \times 9}{7 \times 13} = \frac{27}{91} \approx 0.30 \times 100\% = 30\%$$

34. The answer is A.

Look at the graph below. There were 250 whales in the North Sea in 1987.



35. The answer is B.

$$400 \frac{mi}{week} = 400 \frac{mi}{(7 \times 24)h} = \frac{400}{7 \times 24} \frac{mi}{h} = 2.38 \frac{mi}{h}$$

36. The answer is D.

According to the table, there are  $9 + 19 = 28$  green apples, and 19 of them are small. Therefore, if one of green apples is chosen at random, the probability that it is small is  $\frac{19}{28}$ .

37. The answer is B.

$$18\% \text{ of } 5 \text{ m} = 18\% \times 5 \text{ m} = 0.18 \times 5 \text{ m} = 0.9 \text{ m}$$

$$\text{The length of Carter's car: } 5 \text{ m} - 0.9 \text{ m} = 4.1 \text{ m}$$

38. The answer is C.

The example in the question has a mean that is larger than median, so large outliers are present in the data. Therefore, there are a few employees in the company whose salaries are much more than the rest.

39. The answer is B.

There are a total of 60 data points provided, so the median will be the average of the 30<sup>th</sup> and 31<sup>th</sup> data points. When the data points are set in order:

- values 1 through 19 will be 0
- values 20 through 36 will be 1
- values 37 through 52 will be 2
- values 53 through 60 will be 3

Therefore, both the 30<sup>th</sup> and 31<sup>th</sup> values are 1, and hence the median is 1.

40. The answer is B.

Since 4 of 30 guests at Hotel A have 3 credit cards, the same ratio holds for all 420 guests at Hotel A. Also, since 4 of 30 guests at Hotel B have 3 credit cards, the same ratio holds for all 300 guests at Hotel B.

Therefore, approximately  $\frac{4}{30} \times 420 = 56$  guests at Hotel A and  $\frac{4}{30} \times 300 = 40$  guests at Hotel B are expected to have 3 credit cards.

Thus, the total number of guests with 3 credit cards at Hotel A is expected to be  $56 - 40 = 16$  more than at Hotel B.

41. The answer is D.

The estimate  $x$  could be greater or less than actual height  $y$ . In both cases difference must be less than 2. So we have  $y - x < 2$  or  $x - y < 2$ . Therefore, the absolute value of the difference is less than 2.

$$|y - x| < 2 \Leftrightarrow -2 < y - x < 2 \Leftrightarrow -2 < x - y < 2$$

42. The answer is B.

$$W = \frac{A}{3\pi r^2}$$

$$3\pi r^2 W = A$$

$$r^2 = \frac{A}{3\pi W}$$

43. The answer is A.

$$W_A = 4W_B$$

$$\frac{A}{3\pi r_A^2} = 4 \times \frac{A}{3\pi r_B^2}$$

$$\frac{3\pi r_A^2}{A} = \frac{3\pi r_B^2}{4A}$$

$$r_A^2 = \frac{r_B^2}{4}$$

$$\frac{r_A^2}{r_B^2} = \frac{1}{4}$$

$$\left(\frac{r_A}{r_B}\right)^2 = \left(\frac{1}{2}\right)^2$$

$$\frac{r_A}{r_B} = \frac{1}{2}$$

44. The answer is D.

$$x^2 + y^2 + 4x + 6y = 87$$

$$x^2 + 4x + y^2 + 6y = 87$$

$$x^2 + 4x + 4 - 4 + y^2 + 6y + 9 - 9 = 87$$

$$x^2 + 4x + 4 + y^2 + 6y + 9 = 87 + 4 + 9$$

$$(x + 2)^2 + (y + 3)^2 = 100$$

$$r^2 = 100 \Rightarrow r = 10$$

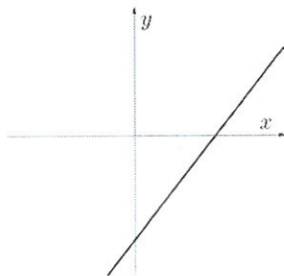
45. The answer is A.

$a$  –  $x$ -intercept

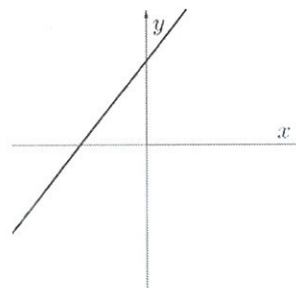
$b$  –  $y$ -intercept

$a - b = 0 \Rightarrow a = b \Rightarrow (-a, 0)$  and  $(0, a)$  are intercepts

$a < 0$



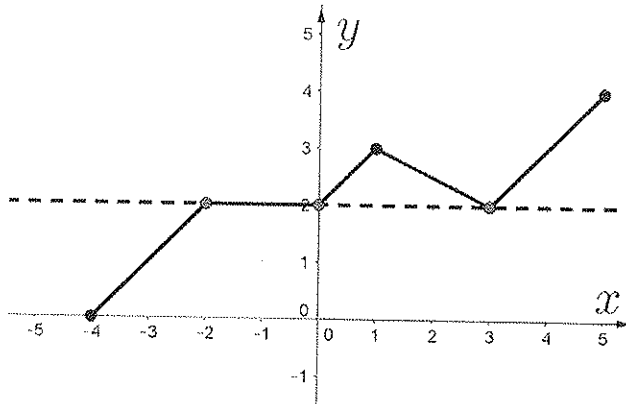
$a > 0$



In both cases the slope is positive.

46. The answer is D.

Points on the graph which lie on the line  $y = 2$  are the solutions:  $f(-2)$ ,  $f(0)$  and  $f(3)$ . Therefore, I, II and III are the solutions.



47. The answer is B.

Each green dot is above the corresponding red dot. Therefore, in every 6-month interval, the magnitude of the rate of change of weight of Student B is greater than that of Student A.

48. The answer is D.

Find midpoint E of segment AC.

$A(-4, -2)$ ,  $C(2, 2)$

$$x_E = \frac{2 + (-4)}{2} = -1, y_E = \frac{2 + (-2)}{2} = 0$$

Find the slope of AC.

$$m_{AC} = \frac{2 - (-2)}{2 - (-4)} = \frac{4}{6} = \frac{2}{3}$$

Product of slopes of perpendicular lines equals to  $-1$ .

$$m_{BD} \times m_{AC} = -1 \Rightarrow m_{BD} = -\frac{1}{m_{AC}} = -\frac{1}{\frac{2}{3}} = -\frac{3}{2}$$

Write equation of line which passes through the point  $E(-1, 0)$  and which slope is  $-\frac{3}{2}$ .

$$y - y_1 = m_{BD}(x - x_1)$$

$$y - 0 = -\frac{3}{2}(x - (-1))$$

$$y = -\frac{3}{2}(x + 1)$$

$$y = -\frac{3}{2}x - \frac{3}{2}$$

49. The answer is B.

Substitute the values of  $a$ ,  $b$  and  $c$  in the system of equations.

$$a = 1, b = 0, c = 2$$

$$1 = 1 \times x^2 + 0 \times x + 2$$

$$1 = x^2 + 2$$

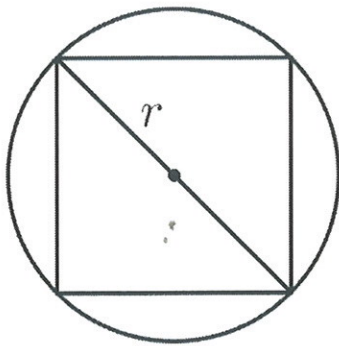
$$1 - 2 = x^2$$

$$-1 = x^2$$

$$x = \pm\sqrt{-1}$$

Therefore, for  $a = 1$ ,  $b = 0$  and  $c = 2$  the system of equations has no real solutions.

50. The answer is C.



The radius of a circle is equal to half of the diagonal of a square:  $r = \frac{d}{2}$ .

$$A_{\text{square}} = a^2$$

$$32 = a^2$$

$$a = \sqrt{32} = \sqrt{16 \times 2} = 4\sqrt{2}$$

$$d^2 = a^2 + a^2 = 2a^2 = 2(4\sqrt{2})^2 = 2 \times 32 = 64$$

$$d = \sqrt{64} = 8$$

$$r = \frac{d}{2} = \frac{8}{2} = 4$$

$$A_{\text{circle}} = 2r\pi = 2 \times 4\pi = 8\pi$$

51. The answer is 5.

$w$  – number of weeks

$$1.8w = 9$$

$$h = \frac{9}{1.8} = \frac{90}{18} = 5$$

52. The answer is 6.

1 pound = 16 ounces

$$p \times 16 + 4 = 100$$



$$16p = 96$$

$$p = \frac{96}{16} = 6$$

53. The answer is -2.

$$(-3, -5) \Rightarrow x = -3, y = -5$$

$$f(x) = kx^2 - 3x + 4$$

$$y = kx^2 - 3x + 4$$

$$-5 = k(-3)^2 - 3(-3) + 4$$

$$-5 = 9k + 9 + 4$$

$$-5 - 9 - 4 = 9k$$

$$-18 = 9k$$

$$k = -\frac{18}{9}$$

$$k = -2$$

54. The answer is 19.

$x$  – number of red apples

$y$  – number of green apples

$$x + y = 48$$

$$x - 10 = y \Rightarrow x = y + 10$$

$$y + 10 + y = 48$$

$$2y = 38$$

$$y = 19$$

55. The answer is 2000.

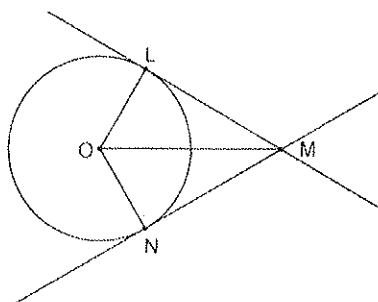
$a$  – current amount of money Sarah has

300 – amount of money spent every week

$t$  – number of weeks

2,000 – initial amount of money

56. The answer is 12.6.



$$OL = ON = r$$

$$LM = MN \text{ - tangents are equal}$$

$$OM = OM$$

$$\triangle OLM \cong \triangle ONM \text{ (SSS Postulate)}$$

$$\triangle OLM \cong \triangle ONM \Rightarrow \angle LMO \cong \angle OMN \Rightarrow m\angle LMO = m\angle OMN = 30^\circ$$

Angle between tangent line and radius is a right angle.

$$m\angle OLM = 90^\circ$$

$$m\angle MOL + m\angle OLM + m\angle LMO = 180^\circ$$

$$m\angle MOL + 90^\circ + 30^\circ = 180^\circ$$

$$m\angle MOL = 60^\circ$$

$\triangle OLM$  is  $30^\circ - 60^\circ - 90^\circ$  triangle. Therefore,  $OM = 2OL$ .

$$LM^2 = OM^2 - OL^2 = (2OL)^2 - OL^2 = 4OL^2 - OL^2 = 3OL^2$$

$$LM = OL\sqrt{3}$$

$$P_{\triangle OLMN} = OL + LM + MN + ON$$

$$P_{\triangle OLMN} = 2OL + 2LM$$

$$P_{\triangle OLMN} = 2(OL + LM)$$

$$12(1 + \sqrt{3}) = 2(OL + OL\sqrt{3})$$

$$12(1 + \sqrt{3}) = 2[OL(1 + \sqrt{3})]$$

$$12(1 + \sqrt{3}) = 2OL(1 + \sqrt{3})$$

$$OL = 6$$

$$r = OL = 6$$

$$m\angle NOL + m\angle OLM + m\angle LMN + m\angle MNO = 180^\circ$$

$$m\angle NOL + 90^\circ + 60^\circ + 90^\circ = 180^\circ$$

$$m\angle NOL = 120^\circ$$

$$\alpha = m\angle NOL = 120^\circ$$

$$\widehat{LN} = \frac{2r\pi\alpha}{360^\circ} = \frac{2 \times 6\pi \times 120^\circ}{360^\circ} = 4\pi = 12.6$$

57. The answer is 1323.

The number of cars next year:

$$C_{next\ year} = C_{this\ year} + 0.4(C_{this\ year}) \left(1 - \frac{C_{this\ year}}{C}\right)$$

$$C_{next\ year} = 1500 + 0.4(1500) \left(1 - \frac{1500}{3000}\right) = 1500 + 600 \times \frac{1}{2} = 1050$$

The number of cars two years from now:

$$C_{next\ year} = 1050 + 0.4(1050) \left(1 - \frac{1050}{3000}\right) = 1050 + 420 \times 0.65 = 1323$$

58. The answer is 4500.

$$C_{next\ year} = C_{this\ year} + 0.4(C_{this\ year}) \left(1 - \frac{C_{this\ year}}{C}\right)$$

$$1900 = 1500 + 0.4(1500) \left(1 - \frac{1500}{C}\right)$$

$$400 = 600 \left(1 - \frac{1500}{C}\right)$$

$$\frac{2}{3} = 1 - \frac{1500}{C}$$

$$2C = 3C - 4500$$

$$-C = -4500$$

$$C = 4500$$