For all questions, answer E. "NOTA" means none of the above answers is correct.

1. A pair of shoes cost $5.85 after a 10% discount. What was the original cost of the shoes before the discount?

   A. $6.44   B. $6.50   C. $58.50   D. $65.00   E. NOTA

2. The Richter Scale measures the intensity level of earthquakes. As the level of intensity of an earthquake increases by one unit on the Richter Scale, the actual intensity increases exponentially by a factor of ten. On October 1, 1987, there was an earthquake in Whittier, California that registered a 5.9 on the Richter scale. Three days later, a magnitude 5.6 aftershock occurred. How many times stronger was the original earthquake than the aftershock?

   A. 10^3 B. $10^{59/56}$ C. $\sqrt[10]{1000}$ D. 10   E. NOTA

3. An ecologist goes to Lake Okeechobee to run an experiment to determine the number of fish present in the lake. She initially goes out on day 1 and randomly tags 120 fish. She goes out on day 2 and collects 550 fish, of which 80 have been tagged the previous day. Using this information, what is the best estimate for the total number of fish in the lake?

   A. 367   B. 590   C. 825   D. 200   E. NOTA

4. Brian wants to paint a mural of the Croatian National Soccer Team. The top part of the mural is going to be 10 ft. tall and it will start at the ground. If he wants to place the bottom of his ladder 6 ft. from the base of the wall (which is perpendicular to the ground), what is the minimum possible length of the ladder (in feet) that will assure the top of the ladder reaches the top of the mural?

   A. $2\sqrt{34}$ B. 16   C. 8   D. $4\sqrt{7}$ E. NOTA

5. The whispering gallery in the Capitol building is in the shape of an ellipse! Because of this, there is an amazing application that occurs. If you and a friend each stand on the location of the one of the two foci of the ellipse, you will be able to hear one another talk while you are far away from each other. Anisha and Paula, who both love to talk, decide to go to the Capitol Building to take part in this phenomenon. Suppose the equation for the whispering gallery is given by $\dfrac{x^2}{3600} + \dfrac{y^2}{10000} = 1$ (all units are in feet). How far away (in feet) from each other should Paula and Anisha stand so they can hear each other whisper?

   A. $20\sqrt{34}$ B. $40\sqrt{34}$ C. 80   D. 160   E. NOTA

6. According to Hooke's Law, the force that is acted upon an object is directly proportional to the displacement of the object. If a certain spring has a force of 25 kilograms applied, it is displaced 10 centimeters downward. What is the force (in kilograms) that has to be applied to the same spring for it to be displaced 38 centimeters downward?

   A. 95   B. $\dfrac{76}{5}$ C. $\dfrac{125}{19}$ D. 53   E. NOTA

7. Dudley is going on a road trip from Washington, DC to St. Louis, MO and back in his Batmobile. Luckily, this is exactly a 500 mile drive. He completed the Washington, DC to St. Louis leg of his trip going 50 mph. His speedometer died on the way back, but miraculously, Dudley is a genius and knows that his average speed for the entire trip was 90mph. How fast was Dudley going (in miles per hour) on the way back, assuming he traveled at a constant speed?

   A. 140   B. 200   C. 450   D. 1025   E. NOTA

For questions 8-9, use the information provided below

The table below shows some American and Metric hat sizes as well as ladies' head measurements for those sizes. Relationships among the variables (columns) in the table are linear.

American Hat Sizes	Ladies' Head Measurements in Inches	Metric Hat Sizes
$6\dfrac{3}{8}$	$19\dfrac{1}{2}$	51
$6\dfrac{1}{2}$	20	52
$6\dfrac{7}{8}$	$21\dfrac{1}{2}$	55
$7\dfrac{5}{8}$	$24\dfrac{1}{2}$	61
$7\dfrac{3}{4}$	25	62
$7\dfrac{7}{8}$	$25\dfrac{1}{2}$	63

8. What is the head measurement for a lady that wears an American hat size of 9?

   A. 26   B. 30   C. $31\dfrac{1}{2}$ D. $29\dfrac{1}{4}$ E. NOTA

9. A formula relating American hat sizes to ladies' head measurements if x represents American hat size
    and y represents Ladies' Head Measurements in inches can be written as $y = Ax + B$. What is the sum
    of A and B?

    A. -6 B. -2 C. 2   D. 8   E. NOTA

10. Whitney is taking Modeling 101. On her first modeling quiz, she received a grade of 75%. On her
    second modeling quiz, she received an 85%. She has her upcoming final exam, and wants to know what
    grade she needs to receive a C (which in this class, requires a 50% average on all coursework). If
    quizzes all hold the same weight, and her final is 60% of her grade, what grade must she achieve on her
    final?

    A. 30%   B. 40%   C. 50%   D. 60%   E. NOTA

11. The pH factor determines whether a substance is alkaline, neutral or acidic depending if pH is greater
    than, equal to or less than 7 respectively. If H^+ is the hydrogen ion concentration in moles, pH is
    determined by the formula $pH = -\log(H^+)$. For tomato juice, $H^+ = 6.3 \times 10^{-5}$ moles. In which of the
    following intervals does pH fall for tomato juice?

    A. [1,2]   B. [4,5]   C. [5,6]   D. [11,12]   E. NOTA

12. Pure gold is 24K while an alloy of only half gold is 12K. Goldie Hawn is making a 100g alloy solution
    of 90% gold when she scares herself by looking in the mirror and knocks in 50g of tin. What would the
    karat rating of Goldie's Gold be (to the nearest whole Karat)?

    A. 11   B. 14   C. 16   D. 22   E. NOTA

Use the following information for problems 13-14: The following matrix shows the winners in a league play
of 7 football teams. Each team played each other team exactly one time. A 1 indicates that the team in the row
beat the team in the column. Placing is based on the highest number of wins. Ties are broken based on who beat
the team they were tied with (for example, if team H and team J were tied in total wins, but team J beat team H,
then team J places higher).

$$\begin{array}{c} ......A...B...C...D...E...F...G \\ \begin{array}{c} A \\ B \\ C \\ D \\ E \\ F \\ G \end{array} \begin{bmatrix} - & 0 & 0 & 1 & 0 & 1 & 1 \\ 1 & - & 0 & 1 & 0 & 0 & 1 \\ 1 & 1 & - & 0 & 1 & 1 & 1 \\ 0 & 0 & 1 & - & 0 & 0 & 1 \\ 1 & 1 & 0 & 1 & - & 0 & 1 \\ 0 & 1 & 0 & 1 & 1 & - & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & - \end{bmatrix} \end{array}$$

13. What is the win percentage for team E (to the nearest percent)?

    A. 29   B. 33   C. 57   D. 67   E. NOTA

14. What team ended the season in third place?

    A. Team A   B. Team B   C. Team E   D. Team F   E. NOTA

15. The minute hand on Big Ben in London is 9 feet long. What is the arc length traversed by the tip of the minute hand in 33 minutes (in feet)?

    A. $\dfrac{33\pi}{5}$ B. $\dfrac{33\pi}{10}$ C. $\dfrac{99\pi}{5}$ D. $\dfrac{99\pi}{10}$ E. NOTA

16. I've been working on the railroad. Luckily, John comes and helps me out. We have to hammer in railroad spikes. The track consists of 2 railroad spikes every yard, and the track is 10 miles long. If I can hammer 1 railroad spike per minute, and John can hammer 3 railroad spikes per minute, how many live-long days (1 live-long day = 24 hours) will it take us to complete our railroad?

    A. Between 1 and 2
    B. Between 2 and 3
    C. Between 3 and 4
    D. Between 4 and 5
    E. NOTA

17. A perfectly parabolic antenna has a cross-section of width 12 meters and depth of 2 meters. The receiver for the antenna is placed at the focus of the parabola to get the best reception. How far from the vertex of the parabola (in meters) should the receiver be placed for best reception?

    A. 18   B. $\dfrac{3}{8}$ C. $\dfrac{3}{2}$ D. $\dfrac{9}{2}$ E. NOTA

18. Gary recently lost his graphing calculator. However, he has spent his last $100 on a sweater from the Smithsonian so he is not able to buy another. This is quite unfortunate, since Gary has to determine the real root to the equation $y = x^3 + 2x - 4$ immediately to gain access to the Smithsonian Fancy Sweater Club. Gary grabs a paper and pencil and is able to determine an interval that the root falls between, so the club members take pity on him and grant him access. In which of the following intervals does Gary determine that the root of the equation falls?

    A. [-1,0]   B. [0,1]   C. [1,2]   D. [2,3]   E. NOTA

19. Euler Airlines is trying to determine the best location for their hub airport. Three of their biggest US cities which they fly to are Denver, New York and New Orleans. They want to place their hub equidistant from these three cities. John Q. Thales (the CEO of Euler Airlines) makes a triangle connecting the three cities and determines the location that meets the above criteria. At which point in the triangle is Mr. Thales going to place the hub?

    A. Circumcenter   B. Incenter   C. Orthocenter   D. Centroid   E. NOTA

20. Newton's Law of Cooling models the cooling (or heating) of an object which is placed in a surrounding medium (for example, a hot pizza that is taken out of the oven and allowed to cool on the kitchen counter). The formula for Newton's Law of Cooling is:

$$\text{Object's current temperature} = T + (I - T)e^{KX}$$

where T is the surrounding temperature, I is the initial temperature, X is the time elapsed, and K is a constant of heating or cooling. A can of Mountain Dew: Code Red is left out on a table for 10 minutes. If the Mountain Dew was 35°F to start with, the temperature of the room was 70°F, and the temperature is now 40°F, then according to Newton's Law of Cooling, what is Mountain Dew's constant of heating?

A. $10\ln\left(\dfrac{6}{7}\right)$ B. $\dfrac{1}{10}\ln\left(\dfrac{6}{7}\right)$ C. $\dfrac{1}{10}\ln\left(\dfrac{7}{6}\right)$ D. $10\ln\left(\dfrac{7}{6}\right)$ E. NOTA

21. Josephine develops her own rules for playing the game of poker. One of her rules is that you can have a hand called a "jojo" where all 5 cards are the same color. The probability you are dealt a "jojo" from a standard 52 card playing deck can be written in the form $\dfrac{j \bullet {}_{26}C_l}{{}_{52}C_n}$. What is the value of $j + l + n$?

A. 12   B. 14   C. 8   D. 10   E. NOTA

Use the following information for problems 22-23: B.B. is going into business selling designer handbags. She has done her background research and has determined that the equation that governs the price she sells the bags for is p(x) = 200 – x, where x is representing the number of bags sold. She has also determined that the equation that governs the cost of making the bags is $C(x) = 2x^2 + 80x + 900$. B.B. also knows that her revenue equation is $R(x) = x \cdot p(x)$ and her profit equation is $P(x) = R(x) - C(x)$.

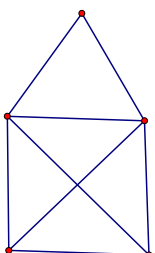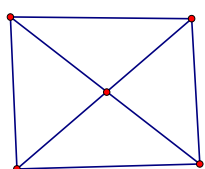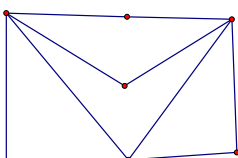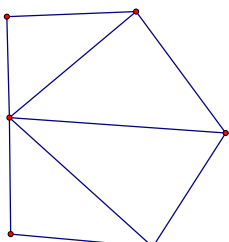22. How many handbags will B.B. have sold the first time she makes zero <u>profit</u>?

A. 0   B. 10   C. 30   D. 200   E. NOTA

23. How many handbags will have to be sold for B.B. to make a maximum profit?

A. 15   B. 6   C. 25   D. There is no maximum profit   E. NOTA

Use the following information for problem 24: Math is critically important in the planning of many networks, including road construction. If roads are planned as *Euler Circuits* it is possible for someone to traverse every edge <u>exactly once</u> and start and end at the same spot! This greatly reduces the time needed to return to the same spot while still travel along all of the roads in the network.

24. Marisol the meter maid is very knowledgeable in mathematics and chooses her routes carefully based on whether or not they represent Euler Circuits. By doing this, she is able to park at one location, walk all of the streets and end at the same location she began – not wasting any unnecessary time or energy. If Marisol is given the option of the following road systems, which should she pick if she only picks networks that represent Euler Circuits?

A.   B.   C.   D.   E. NOTA

25. Shirley loves riding her bike. She has decided to start training for the Ironman Triathlon where she is hoping to excel in the biking section. Currently, Shirley is able to ride her bike (which has tire diameter of 24 inches) at a rate of 60 revolutions per minute. At this rate, how far (in inches) will Shirley travel in three quarters of a day?

A. $2^5 \cdot 3^4 \cdot 5^2 \cdot \pi$ B. $2^8 \cdot 3^5 \cdot 5^2 \cdot \pi$

C. $2^9 \cdot 3^5 \cdot 5^2 \cdot \pi$ D. $2^6 \cdot 3^4 \cdot 5^2 \cdot \pi$ E. NOTA

26. Ted, Barney and Marshall decide to have a very high stakes game of dice rolling in a slap bet. In this game whoever is able to roll a 5 (on a fair, six sided die) first will become the proud owner of 3 slaps. If the order in rolling the die goes Ted, Barney and then Marshall, and rolling continues in that order until someone wins, what is the probability Marshall wins the bet?

A. $\dfrac{25}{216}$ B. $\dfrac{1}{3}$ C. $\dfrac{1}{6}$ D. $\dfrac{25}{191}$ E. NOTA

27. Jeanine is standing at one vertex of the country of Polygonya, where she is on vacation. She can't believe that she doesn't know how many sides there are in Polygonya, which is in the shape of a regular polygon! So at this vertex, she pulls out her trusty protractor, and measures the interior angle to be 160 degrees. Jeanine screams "Eureka! I have determined that Polygonya is made up of exactly _____ sides." (Due to the nature of this being an extremely easy problem otherwise, we have censored part of Jeanine's comment. Please choose the answer below that fills in the blank correctly both making Jeanine's statement true and earning yourself points for this problem)

A. 10   B. 12   C. 14   D. 16   E. NOTA

28. Students in a geography class were taking a poll to see what international destinations had been visited by members of the 34 person class. It was determined that 7 had never left the US, 15 had gone to India, 18 have gone to Poland and 11 have gone to Trinidad and Tobago. Upon further inspection, it was determined that 13 students had been to exactly 2 countries, 2 had been to all 3 of the countries mentioned, 11 have been to India and Poland and 26 have been to <u>at least one of</u> Poland and Trinidad and Tobago. How many students have been to Poland and Trinidad and Tobago, but not to India.

   A. 1   B. 2   C. 3   D. 4   E. NOTA

29. A surveyor has created similar triangles ABC and DEF to determine the distance across a lake. If she knows that AB = 6 miles, AC = 15 miles and DE = 8 miles, what is the distance of DF (in miles)?

   A. 3.2   B. 17   C. 11.25   D. 20   E. NOTA

30. A certain mathlete could not believe they were taking an applications test without a bouncing ball problem on it, especially since this mathlete reviewed the concept of infinite geometric sequences over and over again the night before. If 99% of all application tests contain bouncing ball problems (independent of other tests given), what is the probability that next year's test will contain a bouncing ball problem, given that there is not one on this test?

   A. $\dfrac{99}{100}$ B. $\dfrac{1}{100}$ C. $\dfrac{99}{101}$ D. $\dfrac{1}{101}$