



EST I – Math

Student's Name _____

National ID _____

Test Center _____

Duration: 90 minutes

Test sections: I- Calculator is not required, II – Calculator is required

45 Multiple Choice Questions and 13 Short Constructive Response Questions

Instructions:

- Place your answer on the answer sheet. Mark only one answer for each of the multiple choice questions.
- Write your final result only on the answer sheet for the constructive response questions.
- Avoid guessing. Your answers should reflect your overall understanding of the subject matter.
- Calculator is allowed. When a calculator is used, be aware of switching between radian mode and median mode.
- Formula sheet is available at the end of the booklet for your reference.

Section I
Calculator is not required
(30 minutes)

Questions 1 and 2 refer to the following information.

The magnitude of the electrostatic force F between two point charges in vacuum is given by

$$F = \frac{q_1 q_2}{4\pi\epsilon_0 r^2} \text{ where:}$$

- F is the magnitude of the force exerted
- q_1 is the charge on one body
- q_2 is the charge on the other body
- r is the distance between the two bodies
- ϵ_0 is the permittivity of the vacuum.

1. Isolate r .

- A. $r = \frac{4\pi\epsilon_0 F}{q_1 q_2}$
- B. $r = \sqrt{\frac{q_1 q_2 F}{4\pi\epsilon_0}}$
- C. $r = \frac{1}{2} \sqrt{\frac{q_1 q_2}{\pi\epsilon_0 F}}$
- D. $r = \left(\frac{q_1 q_2}{4\pi\epsilon_0}\right)^2$

2. If the charges are to be separated by a distance of $3r$, an electrostatic force F_1 is created. What is the relationship between F_1 and F ?

- A. $F_1 = 3F$
- B. $F_1 = F/3$
- C. $F_1 = 9F$
- D. $F_1 = F/9$

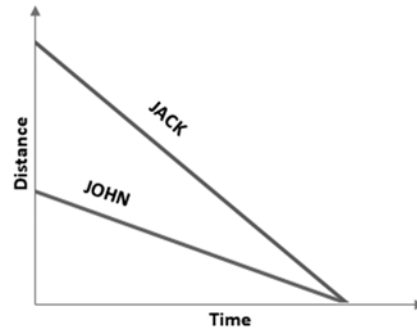
$$\sqrt{1.25} \times \sqrt{1.8}$$

3. The above expression can be written in the form of a rational number k . What is the value of k ?

- A. $\frac{2}{3}$
- B. $\frac{3}{2}$
- C. $\frac{2}{5}$
- D. $\frac{5}{3}$

4. In the xy -plane, the equation of the line (d) passing through $A(1;3)$ and perpendicular to line $3x-2y=6$ is:

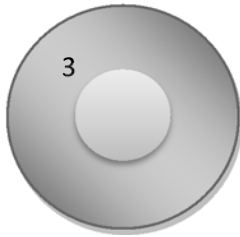
- A. $y = \frac{3}{2}x - \frac{7}{2}$
- B. $y = -\frac{3}{2}x + \frac{11}{2}$
- C. $y = -\frac{2}{3}x + 3$
- D. $y = -\frac{2}{3}x + \frac{11}{3}$



5. Jack and John are meeting at a restaurant. The scheme above represents the drives from their offices to the restaurant. Which of the following statements is true?

- A. It took Jack longer to arrive to the pub since his office is farther away.
- B. It took John longer to arrive to the pub since his office is farther away.
- C. John drove to the pub at a faster speed than Jack.
- D. Jack drove to the pub at a faster speed than John.

6. Which value of x makes the equation $\frac{7}{5}(3x - 2) = 14$ true?
- A. 2
 B. 3
 C. 4
 D. 5
7. A scatter plot shows a strong positive correlation between two variables: A graphed on the x-axis and B graphed on the y-axis. Which of the following statements is justified?
- A. The rise in A caused the rise in B.
 B. The rise in B caused the rise in A.
 C. A&B are correlated, but causation is unknown.
 D. A&B rise proportionally.



8. A game consists of throwing a dart into a target divided into 2 sections: The inner section rewards a player with 5 points, while the outer section gets him 3 points only. Kurt throws 6 darts and hits the inner section x times. What is Kurt's total score in terms of x ?
- A. $8x+24$
 B. $2x+18$
 C. $-2x+18$
 D. $6x+4$

Questions 9 and 10 refer to the following information.

We survey 125 employees at random from each of two companies labeled **A** and **B**, and separated into groups based on how many siblings do they have. The results are shown in the table below.

| Number of siblings | Company A | Company B |
|--------------------|-----------|-----------|
| 0 | 15 | 25 |
| 1 | 45 | 40 |
| 2 | 30 | 25 |
| 3 | 25 | 15 |
| 4 | 10 | 20 |

9. What is the median number of siblings of the sample of employees in company B?
- A. 1
 B. 2
 C. 3
 D. 4
10. Which measure of center is the same in both companies?
- A. Range
 B. Mean
 C. Median
 D. Mode
11. If $f(x) = x^2 - 5x - 6$ and $g(x) = -3 - x$, what is the value of $f(g(-1))$?
- A. 13
 B. 8
 C. 0
 D. 30

$$y = \frac{x^3 - 3x^2 + 2x - 1}{x - 3}$$

12. Which of the following expressions is equivalent to y ?

- A. $y = x^2 + 2 + \frac{5}{x-3}$
- B. $y = x^2 - 2x + 2 + \frac{3}{x-3}$
- C. $y = x^2 - 3 - \frac{8}{x-3}$
- D. $y = x^2 + 2$

13. The graph (C) of the function $f(x) = 2(x + 2)(x - 6)$ is a parabola. If the line $x=k$ is the axis of symmetry of the parabola, what is the value of k ?

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

14. If $\frac{1}{x-y} = \frac{3}{5y}$, which of the following proportions is equivalent?

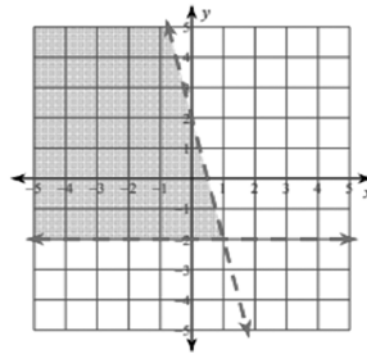
- A. $\frac{x}{y} = \frac{3}{8}$
- B. $\frac{x}{y} = \frac{8}{3}$
- C. $\frac{x}{y} = \frac{8}{15}$
- D. $\frac{x}{y} = \frac{15}{8}$

15. In 2017, the number of people who had access to the internet in a country was 3.2 million. If this number grows at a rate of 18% each year, which expression best describes the number of people y , in million, having access to the internet x years after 2017?

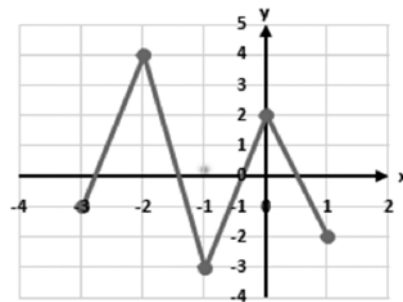
- A. $y = 0.18x + 32$
- B. $y = 1.18x + 32$
- C. $y = 3.2(0.18)^x$
- D. $y = 3.2(1.18)^x$

| | | | |
|----------|----|----|----|
| X | 2 | 5 | -3 |
| Y | -1 | -7 | ? |

16. If the values in the table above represent a linear relationship, what is the missing value?



17. In the above graph, the shaded region is the solution of the system $\begin{cases} 4x + y < 2 \\ y \geq -2 \end{cases}$. For $x=0$, what is the highest integer value of y ?



18. Based on the above graph, if the absolute maximum and minimum of the represented function $f(x)$ are (p, q) and (r, s) respectively, what is the value of $q - p + s - r$?

19. What is the value of $\frac{2^5 \times 16^4}{64^3}$?

20. If the expression $\frac{2i^2 - 3i}{1 - 2i}$ is written in the form $a + bi$ where a and b are real numbers and $i = \sqrt{-1}$, what is the value of a ?

Section II
Calculator is required
(60 minutes)

1. The secret value, k , of a 4-digit pin code **abcd** is obtained by subtracting the triple of **b** from **c**, and dividing the resulting expression by half of the sum of **a** and **d**. What is the secret value, k , in terms of **a**, **b**, **c** and **d**?

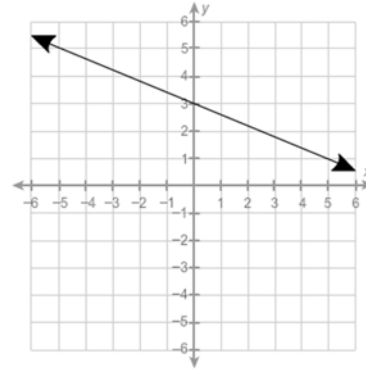
- A. $k = \frac{c-3b}{2a+2d}$
 B. $k = \frac{b-3c}{2a+2b}$
 C. $k = \frac{2c-6b}{a+d}$
 D. $k = \frac{6b-2c}{a+d}$

2. A library sells new and used books. If, out of the total of 474, there are twice as many new books as old ones. How many new books are there in the library?

- A. 316
 B. 158
 C. 352
 D. 238

3. What is the area of the sector defined by a central angle of 54° in the circle of equation $x^2 + y^2 - 8x + 12y - 12 = 0$?

- A. 15π
 B. 9.6π
 C. 5.4π
 D. 2.4π



4. The graph shown represents which of the following equations?

- A. $y = -\frac{2}{5}x - 3$
 B. $y = \frac{2}{5}x + 3$
 C. $y = -\frac{2}{5}x + 3$
 D. $y = -\frac{5}{2}x + 3$

5. If $f(x) = 5 - 2x$ and $g(x) = \frac{x^2}{4}$, Which of the following is not in the range of $f(g(x))$?

- A. -3
 B. 0
 C. 5
 D. 6

6. A line, *having* a slope of $-\frac{2}{3}$ passes through the points A $(2-k ; 5)$ and B $(-2k ; -1)$. What is the value of k ?

- A. 11
 B. 4
 C. -4
 D. -11

Questions 7 and 8 refer to the following information.

The table below summarizes the results of a survey about travel destination preferences for a group of 750 university students of 4 different majors.

| | History | Math | Audit | IT | Total |
|-------|---------|------|-------|-----|-------|
| Rome | 65 | 35 | 35 | 15 | 150 |
| Paris | 75 | 65 | 10 | 25 | 175 |
| Tokyo | 40 | 115 | 50 | 20 | 225 |
| NYC | 70 | 60 | 30 | 40 | 200 |
| Total | 250 | 275 | 125 | 100 | 750 |

7. In which major can you find the highest percentage of students who prefer NYC?
- A. History
B. IT
C. Audit
D. Math
8. What fraction of people who prefer Rome or Paris come from an Audit or Math majors?
- A. $\frac{140}{325}$
B. $\frac{17}{65}$
C. $\frac{29}{65}$
D. $\frac{4}{13}$
9. The selling price of an apartment is directly proportional its area. If an apartment of 127 sqm is sold for \$168,275, what would be the price of a 156 sqm apartment?
- A. 237,900\$
B. 208,500\$
C. 136,993\$
D. 206,700\$

10. In a hospital, the medical staff is composed of 34 doctors and 68 nurses. How many additional doctors should join the hospital in order for the ratio of doctors to total number of medical staff to become 3 to 7?
- A. 21
B. 19
C. 17
D. 15

$$\sqrt{27x^3y^5 - 18x^2y^4}$$

11. Which of the following is equivalent to the above expression? (x and $y > 0$)
- A. $3xy^2(\sqrt{3xy} - \sqrt{2})$
B. $3xy^2\sqrt{3xy - 2}$
C. $9xy^2\sqrt{3xy - 2}$
D. $9xy^2(\sqrt{3xy} - \sqrt{2})$
12. If $\sin A = \cos \frac{7\pi}{3}$, what is one possible value of A in radians?
- A. $\frac{\pi}{2}$
B. $\frac{\pi}{3}$
C. $\frac{\pi}{4}$
D. $\frac{\pi}{6}$
13. Maria downloaded to her music library a total of 350 pop and rock songs. If the ratio of pop to rock song is 3 to 11. How many rock songs are there in Maria's library?
- A. 75
B. 125
C. 175
D. 275
14. If $5 - \frac{3}{2}x \geq 3$, what is the highest value of $\frac{9}{8}x + 1$?
- A. 2.5
B. 3.5
C. 4.5
D. 5.5

15. A craftsman is looking for two kinds of paint from a wholesaler. The first kind **a** is packaged in 10 kg jars, the second **b** in 25 kg jars. The 10 kg jar costs \$45 and the 25 kg one costs 120\$. The load must not exceed 250 kg and the total sum must be at least 900\$ in order to get a discount. Which system of inequalities verifies the given information?

- A. $\begin{cases} 10a + 25b \geq 250 \\ 45a + 120b \leq 900 \end{cases}$
 B. $\begin{cases} 10a + 25b \leq 250 \\ 45a + 120b \leq 900 \end{cases}$
 C. $\begin{cases} 10a + 25b \geq 250 \\ 45a + 120b \geq 900 \end{cases}$
 D. $\begin{cases} 10a + 25b \leq 250 \\ 45a + 120b \geq 900 \end{cases}$

16. Brad got an average of 76 on his last three math tests. What grade should he get on the fourth test to obtain an average of 80?

- A. 88
 B. 90
 C. 92
 D. 94

17. From 2018 to 2019, the amount in Julias's bank account increased by 22.5% to \$14325. To the nearest dollar, what was the initial amount in her bank account?

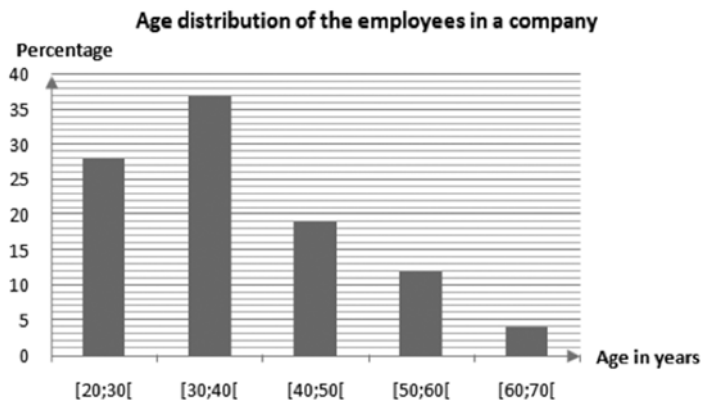
- A. 11694\$
 B. 14010\$
 C. 11102\$
 D. 12775\$

18. The ministry of finance conducted a survey to determine the average income rate in the industry of banking in a given country. So, a meeting was held in the presence of 150 bank managers to ask them about their annual income. Which conclusion can be drawn about the survey's reliability?

- A. The survey is reliable because it involves people from the banking industry.
 B. The survey is unreliable because the sample is too small.
 C. The survey is unreliable because the sample does not cover employees of different positions.
 D. The survey is reliable since it was made by the ministry of finance.

Questions 19 and 20 refer to the following information.

The bar graph below shows the age distribution of the employees in a multi-branched bank.



19. If 481 employees are aged between 30 and 40, what is the total number of employees in this company?

- A. 1150
 B. 1200
 C. 1550
 D. 1300

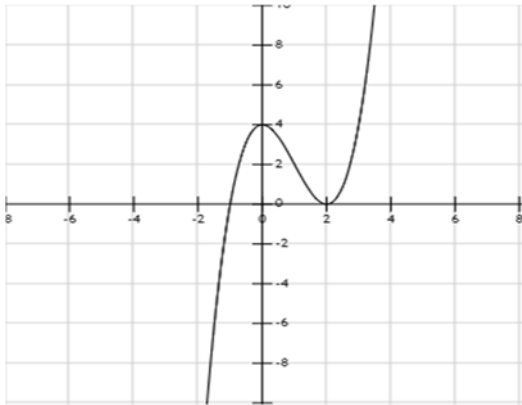
20. In which interval does the median age lie?

- A. [20;30[
- B. [30;40[
- C. [40;50[
- D. [50;60[

$$\begin{cases} \frac{2}{5}x - \frac{1}{3}y = 7 \\ -\frac{m}{10}x + \frac{5}{6}y = 3 \end{cases}$$

21. If the system of linear equations above admits no solutions, and m is an integer, what is the value of m ?

- A. -2
- B. 10
- C. 6
- D. -10

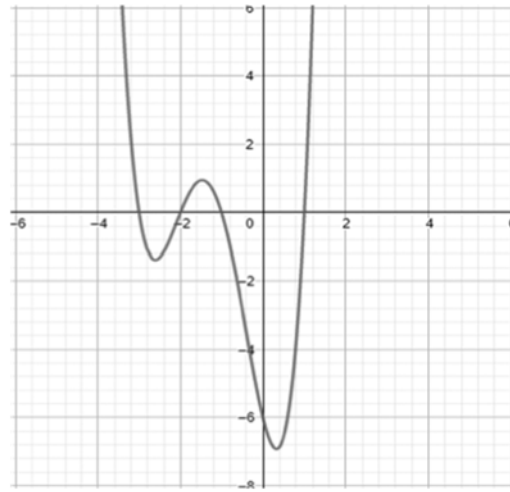


22. The graph plotted above represents which of the following functions?

- A. $f(x) = (x + 1)(x - 2)^2$
- B. $f(x) = (x - 1)(x + 2)^2$
- C. $f(x) = (x + 1)(x - 2)$
- D. $f(x) = (x - 2)(x + 1)^2$

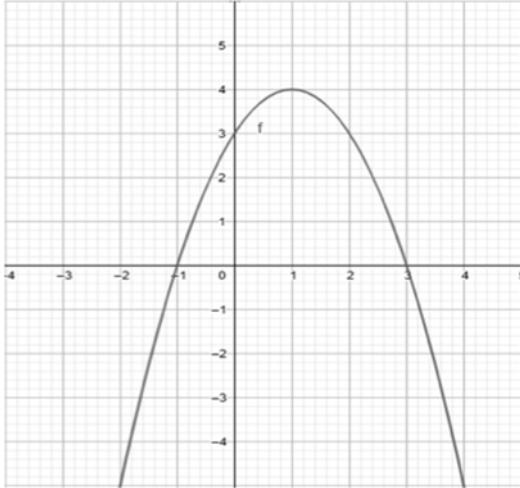
23. A secretary types on her computer keyboard at an average speed of 1.75 words per second. Her manager asked her to type a document containing 16 pages with an average of 525 words per page. How long will she be actively typing this document?

- A. 1 hour, 10 minutes
- B. 1 hour, 20 minutes
- C. 2 hours, 5 minutes
- D. 4 hours, 5 minutes



24. The graph above depicts a function $f(x)$. How many solutions does the equation $f(x) = 0.5$ admit?

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



25. What is the equation of the function f graphed above?

- A. $f(x) = (x+1)(x-3)$
- B. $f(x) = (x-1)(x+3)$
- C. $f(x) = -(x+1)(x-3)$
- D. $f(x) = -(x-1)(x+3)$

$$(3x - 2)^2 - (x + 3)^2 = 0$$

26. What is the absolute value of the difference between the two roots of the above equation?

- A. $\frac{11}{4}$
- B. $\frac{9}{4}$
- C. $\frac{5}{3}$
- D. $\frac{11}{2}$

27. A liquid covering 12 cm of the height of a cylindrical glass of diameter 8 cm is transferred into another glass shaped as a cone with a diameter of 12 cm. What height of the cone will the liquid cover?

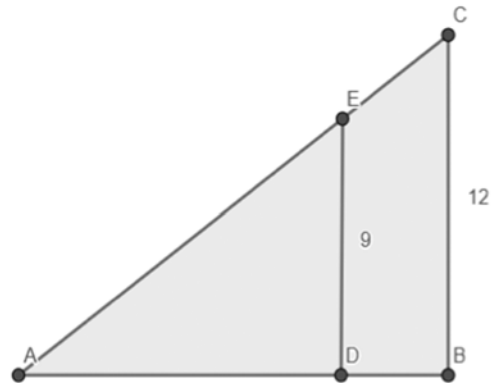
- A. 8 cm
- B. 10 cm
- C. 16 cm
- D. 14 cm

28. A gaming website charges its client by number of games downloaded g . If the total fees f of a gamer are given by the equation $f = 7g+88$, what is the best interpretation of the term 88 ?

- A. The price of one downloaded game.
- B. The subscription fees of the website
- C. The average number of games downloaded per player
- D. The fees of downloading 7 games

29. A local supermarket offered a discount of 15% on its items after the government raised all the prices by 25%. Overall, by what percentage were the original prices raised in this supermarket in particular?

- A. 8.625%
- B. 7.250%
- C. 6.250%
- D. 5.625%



30. The right triangles ADE and ABC are similar. If $AD = \frac{4}{3}ED$, how long is DB?

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

$$\frac{3y - 2(4 - 2y)}{3} = \frac{-11 + 3(2 + 3y)}{5}$$

31. What is the value of y in the equation above?

32. A multiple *choice* test contains 50 questions. A correct answer is worth 3 points and an incorrect answer is worth -2 points. If a student receives 75 on the test, how many questions did he answer correctly?

33. If $|2b - 1| \leq 3$, how many possible integer values of b are there?

34. We chose randomly a sample of 250 lawyers out of the 4900 registered in the syndicate, and we asked them about the most frequent case they defend. The results showed that 45 answered divorce, 125 answered theft and 80 answered murder. Presumably, what is the total number of lawyers registered in the syndicate who deal most frequently with murder?

35. The function g is defined by $g(x) = ax^2 - 2x - 5$ and $g(-1) = 1$. What is the value of $g(2)$?

36. What is the remainder of the division of $k(x) = 3x^3 + 8x^2 - 2x - 7$ by $x+2$?

$$x^2 - 2mx = -9$$

37. What is the minimum positive integer value of m that allows the above equation to have **two** real solutions?

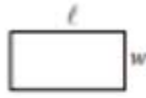
38. A right triangle has an area of 96 cm^2 . If the shorter leg is 4cm less than the longer leg, what is the length of the hypotenuse?

Reference Sheet

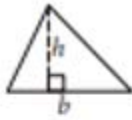


$$A = \pi r^2$$

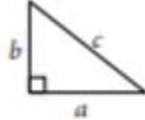
$$C = 2\pi r$$



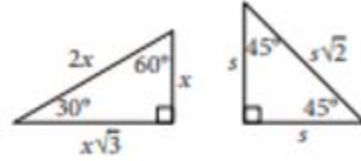
$$A = \ell w$$



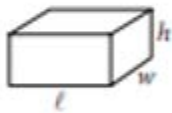
$$A = \frac{1}{2}bh$$



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



Special Right Triangles



$$V = \ell wh$$



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



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



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



$$V = \frac{1}{3}\ell wh$$

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

The number of radians of arc in a circle is 2π .

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

