

## Mathematics, 2017 EC, natural science, entrance exam, round 1

Grade 12 · Mathematics · 2017 E.C.

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Time allowed: 120 minutes

Questions: 50

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1. Which one of the following function is NOT a power function? (1)

A.  $f(x) = x^{-\frac{3}{5}}$

B.  $f(x) = \sqrt{2}x^{\frac{3}{2}}$

C.  $f(x) = \pi x^5$

D. ✓  $f(x) = (\sqrt{3})^x$

**Answer: D**

A power function is defined as  $f(x) = kx^a$  where the variable is in the base. Since  $f(x) = (\sqrt{3})^x$  has the variable in the exponent, it is an exponential function, not a power function.

2. Let  $f(x) = (1 - 2x)^{\frac{1}{2}}$ . Then what is the values of  $f'(x)$ ? (1)

A.  $\frac{1}{\sqrt{1-2x}}$

B.  $-\frac{1}{2}\sqrt{1-2x}$

C.  $\frac{1}{2}\sqrt{1-2x}$

D. ✓  $-\frac{1}{\sqrt{1-2x}}$

**Answer: D**

Using the chain rule, the derivative of  $f(x) = (1 - 2x)^{1/2}$  is  $f'(x) = \frac{1}{2}(1 - 2x)^{-1/2} \cdot \frac{d}{dx}(1 - 2x) = \frac{1}{2}(1 - 2x)^{-1/2} \cdot (-2) = -\frac{1}{\sqrt{1-2x}}$ .

3. Which of the following statement describes the difference between scalar and vector quantities? (1)

A. Physical quantities that only have direction are scalars, while that have only magnitude are vectors.

B. **Physical quantities that only have magnitude are scalars, while that have both magnitude and direction are vectors.** ✓

C. Physical quantities that only have magnitude are vectors, while that have both magnitude and direction are scalars.

D. Physical quantities that only have direction are vectors, while that have both magnitude and direction are scalars.

**Answer: B**

By definition, scalar quantities possess only magnitude, whereas vector quantities possess both magnitude and a specific direction in space.

4. Consider the following data: 1, 3, 7, 9, 11, 13, 18, 28. Then the coefficient of mean deviation about the median is equal to: (1)

A.  $\frac{1}{4}$

B.  $\frac{8}{5}$

C. ✓  $\frac{5}{8}$

D.  $\frac{1}{2}$

**Answer: C**

The median of the ordered data set is 10. The sum of the absolute deviations about the median is  $9 + 7 + 3 + 1 + 1 + 3 + 8 + 18 = 50$ , giving a mean deviation of 6.25. Dividing this by the median yields the coefficient of mean deviation:  $6.25/10 = 0.625 = 5/8$ .

5. Which one of the following is an irrational number? (1)
- A. 3.4000  
B.  $\sqrt{0.04}$   
C. 1.16222...  
D.  $\sqrt{29}$

**Answer: D**

Terminating decimals, repeating decimals, and square roots of perfect squares are all rational numbers. Since 29 is not a perfect square, its square root is an irrational number.

6. Which one of the following statements defines favorable outcomes in a random experiment? (1)
- A.  $\checkmark$  **The outcomes that insure the occurrence of a particular result.**  
B. The outcomes containing all sample elements.  
C. The outcomes containing only one sample element.  
D. The outcomes that have equal chance of being chosen.

**Answer: A**

Favorable outcomes are those outcomes in the sample space of a random experiment that correspond to the occurrence of a specific desired event.

7. Given that  $\log 4.8 = 0.6812$ ,  $\log 6.93 = 0.8406$  and  $\log 6.84 = 0.8351$ , then what is the value of  $\sqrt{48}$ ? (1)
- A. 6.83  
B. 6.71  
C.  $\checkmark$  **6.93**  
D. 6.84

**Answer: C**

We can rewrite the desired value as  $\sqrt{48} = \sqrt{4.8 \times 10}$ , so  $\log \sqrt{48} = \frac{1}{2}(\log 4.8 + 1) = \frac{1}{2}(1.6812) = 0.8406$ . Since  $\log 6.93 = 0.8406$ , we conclude that  $\sqrt{48} = 6.93$ .

8. Let  $f(x) = x^3 + 2x + 1$  and  $g(x) = x^2 + 1$  be given two polynomial functions. Then which of the following is true? (1)
- A.  $\frac{f(x)}{g(x)} = \frac{x^2+1}{x-1}$   
B.  $f(x) + g(x) = x^3 + x^2$   
C.  $\checkmark$   **$f(x) - g(x) = x^3 - x^2 + 2x$**   
D.  $f(x)g(x) = x^5 + x^3 + x^2 - 2x - 1$

**Answer: C**

Subtracting the two polynomials gives  $f(x) - g(x) = (x^3 + 2x + 1) - (x^2 + 1) = x^3 - x^2 + 2x$ , which matches option C.

9. Let  $A = \{x | 1 \leq x \leq 10\}$  and  $B = \{x | -1 \leq x \leq 10\}$  be two sets of real numbers. What is the relative complement of  $A$  with respect to  $B$ ? (1)
- A.  $\{x | -1 \leq x \leq 0\}$   
B.  $\emptyset$   
C.  $\{x | -1 \leq x \leq 1\}$   
D.  $\checkmark$   **$\{x | -1 \leq x < 1\}$**

**Answer: D**

The relative complement of  $A$  with respect to  $B$  is the set of elements in  $B$  that are not in  $A$  (denoted by  $B \setminus A$ ). Since  $B = [-1, 10]$  and  $A = [1, 10]$ , removing  $A$  from  $B$  leaves the interval  $[-1, 1)$ , which corresponds to  $\{x | -1 \leq x < 1\}$ .

10. Consider the function  $f(x) = x^3 - 3x^2 + 3$  on  $(-2, 3)$ . Then which of the following point is local minimum and local maximum of  $f(x)$  respectively? (1)
- A.  $(-2, -27)$  and  $(0, 3)$                       B.  $(0, 3)$  and  $(2, -1)$   
C.  $(3, 3)$  and  $(-2, -27)$                       D. ✓  $(2, -1)$  and  $(0, 3)$

**Answer: D**

The critical points are found using  $f'(x) = 3x^2 - 6x = 0$ , giving  $x = 0$  and  $x = 2$ . Evaluating these points shows that  $(2, -1)$  is a local minimum and  $(0, 3)$  is a local maximum.

11. The table below shows a grouped frequency distribution. X 0–9 10–19 20–29 30–39 40–49 f 4 3 6 5 2 What is the class midpoint of the fourth class? (1)
- A. 34                      B. ✓ 34.5  
C. 35                      D. 39

**Answer: B**

The fourth class is 30–39. The class midpoint is computed as the average of the lower and upper limits:  $(30 + 39)/2 = 34.5$ .

12. Given the data set: 29, 44, 46, 52, 35, 35, 25, 15, 10, 55, 56 What is the coefficient of quartile deviation? (1)
- A. 0.25                      B. ✓ 0.35  
C. 0.45                      D. 0.55

**Answer: B**

Sorting the 11 data points gives the quartiles  $Q_1 = 25$  and  $Q_3 = 52$ . The coefficient of quartile deviation is calculated as  $(Q_3 - Q_1)/(Q_3 + Q_1) = (52 - 25)/(52 + 25) = 27/77 \approx 0.35$ .

13. Which of the following is the simplified form of the expression  $\frac{81^{1/5}}{27^{3/5}}$ ? (1)
- A. 3                      B.  $\sqrt[5]{9}$   
C.  $\sqrt[5]{3}$                       D. ✓  $\frac{1}{3}$

**Answer: D**

Converting to base 3, we get  $81^{1/5} = (3^4)^{1/5} = 3^{4/5}$  and  $27^{3/5} = (3^3)^{3/5} = 3^{9/5}$ . Dividing them gives  $3^{4/5-9/5} = 3^{-1} = 1/3$ .

14. What is the total surface area (in  $\text{cm}^2$ ) of the cylinder whose radius is 2 cm and height is 7 cm? (1)
- A.  $49\pi$                       B.  $28\pi$   
C. ✓  $36\pi$                       D.  $98\pi$

**Answer: C**

The total surface area of a cylinder is  $A = 2\pi r(r + h)$ . Substituting  $r = 2$  and  $h = 7$  gives  $A = 2\pi(2)(2 + 7) = 36\pi \text{ cm}^2$ .

15. Suppose that we have 4 objects chosen 3 at a time. Then which of the following statement is true? (1)
- A. The number of combinations is 6.                      B. The number of combinations is 24.  
C. ✓ The number of permutations is 24.                      D. The number of permutations is 6.

**Answer: C**

The number of permutations of choosing 3 objects from 4 is given by  $P(4, 3) = \frac{4!}{(4-3)!} = 24$ , which is correctly stated in option C.

16. Consider the equation  $\log x + \log(x - 3) = 1$ . Then what is its solution set? (1)

- A.  $\checkmark \{5\}$  B.  $\{2, -5\}$   
C.  $\{-2, 5\}$  D.  $\{6\}$

**Answer: A**

The equation simplifies to  $\log(x(x - 3)) = 1$ , which means  $x^2 - 3x - 10 = 0$ . Solving this gives  $x = 5$  or  $x = -2$ , but only  $x = 5$  is in the domain of the logarithm ( $x > 3$ ).

17. If a fair six-sided die is tossed once, then what is the probability of getting a factor of 4? (1)

- A.  $\checkmark \frac{1}{2}$  B.  $\frac{1}{6}$   
C.  $\frac{5}{6}$  D.  $\frac{1}{3}$

**Answer: A**

The factors of 4 that can appear on a standard six-sided die are 1, 2, and 4. This gives 3 favorable outcomes out of 6, resulting in a probability of  $3/6 = 1/2$ .

18. Which of the following statement is true about a relation? (1)

- A. The domain and the range of a relation are equal sets.  
B. The range of a relation is the set of all its first coordinates.  
C. The domain of a relation is the set of all its second coordinates.  
D.  $\checkmark$  **A relation from A to B is any subset of  $A \times B$  for non-empty sets A and B.**

**Answer: D**

By definition, a relation from a non-empty set  $A$  to another non-empty set  $B$  is any subset of the Cartesian product  $A \times B$ .

19. Which one of the following expression is the correct decomposition of the rational expression  $\frac{2x-3}{x^2+x-2}$ ? (1)

- A.  $\frac{5}{3x+2} + \frac{1}{x+1}$  B.  $\checkmark \frac{1}{3-3x} + \frac{7}{3x+6}$   
C.  $\frac{1}{1-x} + \frac{5}{3x+6}$  D.  $\frac{7}{3x+2} - \frac{1}{x+1}$

**Answer: B**

Decomposing into partial fractions, we get  $\frac{2x-3}{(x+2)(x-1)} = \frac{7/3}{x+2} - \frac{1/3}{x-1} = \frac{7}{3x+6} + \frac{1}{3-3x}$ , which matches option B.

20. What is the average rate of change of  $g(x) = x^3 - 2x$  over the interval  $1 \leq x \leq 6$ ? (1)

- A.  $\frac{203}{5}$  B.  $\checkmark 41$   
C.  $\frac{37}{5}$  D. 46

**Answer: B**

The average rate of change over  $[1, 6]$  is calculated as  $\frac{g(6)-g(1)}{6-1} = \frac{204-(-1)}{5} = \frac{205}{5} = 41$ .

21. Which of the following matrix is the inverse of the matrix  $\begin{pmatrix} 1 & -1 & 2 \\ 1 & 0 & 1 \\ 3 & 1 & 3 \end{pmatrix}$ ? (1)

A.  $\begin{pmatrix} 1 & 5 & -1 \\ -3 & 0 & 1 \\ -4 & -1 & 1 \end{pmatrix}$

B.  $\begin{pmatrix} -1 & 0 & 1 \\ 5 & -3 & -4 \\ -1 & 1 & 1 \end{pmatrix}$

C.  $\begin{pmatrix} -1 & 0 & 1 \\ 5 & 3 & 4 \\ 1 & -1 & 1 \end{pmatrix}$

D. ✓  $\begin{pmatrix} -1 & 5 & -1 \\ 0 & -3 & 1 \\ 1 & -4 & 1 \end{pmatrix}$

**Answer: D**

The inverse of a matrix can be found using the formula  $M^{-1} = \frac{1}{\det(M)} \text{adj}(M)$ . Since  $\det(M) = 1$ ,  $M^{-1}$  is simply the transpose of the cofactor matrix, which yields option D.

22. When the number  $43 \times 10^8 \times 10^{-5}$  is written in standard form, it equals (1)

A. ✓  $4.3 \times 10^4$

B.  $43 \times 10^3$

C.  $4.3 \times 10^3$

D.  $0.43 \times 10^5$

**Answer: A**

Simplifying the expression gives  $43 \times 10^3$ . In scientific standard form, the coefficient must be between 1 and 10, so we rewrite it as  $4.3 \times 10^4$ .

23. If a square pyramid has a base side of 6 cm long and its lateral faces are equilateral triangles, then what is its volume (in  $\text{cm}^3$ )? (1)

A. 72

B.  $3\sqrt{2}$

C. 48

D. ✓  $36\sqrt{2}$

**Answer: D**

The distance from the center of the square base to a corner is  $3\sqrt{2}$  cm. The height of the pyramid is  $h = \sqrt{6^2 - (3\sqrt{2})^2} = 3\sqrt{2}$  cm, leading to a volume of  $V = \frac{1}{3} \times 6^2 \times 3\sqrt{2} = 36\sqrt{2} \text{ cm}^3$ .

24. A television company assembles flat screen and curved screen televisions. The company has to invest Birr 15,000 to assemble one flat screen and Birr 20,000 to assemble one curved screen television. The company allocates a maximum of Birr 900,000 in a week for assembling. The company gets Birr 1800 profit from a sale of one flat screen television and Birr 2000 profit from a sale of one curved screen television. Moreover, the company has a store of maximum capacity of storing 50 televisions. Let  $x$  be the number of flat screens and  $y$  be the number of curved screens. Then which one of the following inequalities should model the profit for the objective function  $Z=1800x+2000y$ ? (1)

A.  $\begin{cases} 20,000x + 15,000y \leq 360,000 \\ x + y \leq 50 \\ x, y \geq 0 \end{cases}$

B. ✓  $\begin{cases} 15,000x + 20,000y \leq 900,000 \\ x + y \leq 50 \\ x, y \geq 0 \end{cases}$

C.  $\begin{cases} 15,000x + 20,000y \leq 360,000 \\ x + y \leq 50 \\ x, y \geq 0 \end{cases}$

D.  $\begin{cases} 20,000x + 15,000y \leq 900,000 \\ x + y \leq 50 \\ x, y \geq 0 \end{cases}$

**Answer: B**

The total cost constraint is  $15,000x + 20,000y \leq 900,000$  and the capacity constraint is  $x + y \leq 50$ . Together with the non-negativity constraints, this system perfectly matches option B.

25. Which one of the following distribution is multimodal? (1)
- A. 18, 14, 15, 10, 11, 3, 18, 12      B. 6, 10, 9, 6, 10, 4
- C. ✓ 8, 7, 11, 13, 17, 9, 8, 7, 6, 11      D. 12, 13, 26, 15, 25, 38, 28, 27, 32

**Answer: C**

In set C, the numbers 7, 8, and 11 each appear twice, while all other numbers appear once. Thus, there are three modes, making it multimodal.

26. What is the equation of a line that passes through  $(-2, 5)$  and has a slope  $\frac{1}{2}$ ? (1)
- A. ✓  $2y - x - 12 = 0$       B.  $y = 2x + 12$
- C.  $2y + x = 5$       D.  $y = \frac{1}{2}x + 5$

**Answer: A**

Using the point-slope formula  $y - y_1 = m(x - x_1)$  with  $(-2, 5)$  and  $m = 1/2$  gives  $y - 5 = \frac{1}{2}(x + 2)$ , which simplifies to  $2y - x - 12 = 0$ .

27. What is the minimum value of the function defined by  $f(x) = -3 + 4x + x^2$ ? (1)
- A. ✓  $-7$       B. 1
- C. 0      D.  $-2$

**Answer: A**

The quadratic function  $f(x) = x^2 + 4x - 3$  has its minimum at the vertex  $x = -b/(2a) = -2$ , giving a minimum value of  $f(-2) = (-2)^2 + 4(-2) - 3 = -7$ .

28. Which of the following statement is true about the given system of linear equations? (1)
- A.  $\begin{cases} x + 3y = 6 \\ 2x - 5y = 2 \end{cases}$  is a homogeneous system.      B.  $\begin{cases} 2x + y = 0 \\ x - 4y = 0 \end{cases}$  is a non-homogeneous system.
- C. ✓  $\begin{cases} x + 3y = 2 \\ 2x - 5y = 1 \end{cases}$  is a non-homogeneous system.      D.  $\begin{cases} 3x - y = 1 \\ x + 3y = 0 \end{cases}$  is a homogeneous system.

**Answer: C**

A system of linear equations is non-homogeneous if at least one constant term on the right-hand side is non-zero, which is true for option C where the constants are 2 and 1.

29. Suppose  $f(x) = 3\sqrt{x}$  and  $g(x) = \frac{1}{3}x^4 + 2x$  be given two functions. Then which of the following is equal to  $(f + g)'(x)$ ? (1)
- A.  $3x^{-\frac{1}{2}} + 4x^3 + 2$       B.  $\frac{2}{3}x^{-\frac{1}{3}} + 4x^3 + 2x$
- C.  $\frac{2}{3}x^{-\frac{1}{3}} + 4x^3 + 2$       D. ✓  $\frac{3}{2}x^{-\frac{1}{2}} + \frac{4}{3}x^3 + 2$

**Answer: D**

Using the sum and power rules of differentiation,  $(f + g)'(x) = f'(x) + g'(x) = \frac{3}{2}x^{-1/2} + \frac{4}{3}x^3 + 2$ .

30. The table given below shows the ages distribution of children in a small village in years. Age interval Frequency (1)  
(f) 2-4 4 5-7 1 8-10 2 11-13 3 Then what is the mean age of the children's (in years)?
- A. 6.9      B. 6.6
- C. 7.5      D. ✓ 7.2

**Answer: D**

The midpoints of the intervals are 3, 6, 9, and 12. The mean is calculated as  $\frac{(4 \times 3) + (1 \times 6) + (2 \times 9) + (3 \times 12)}{4 + 1 + 2 + 3} = \frac{72}{10} = 7.2$ .

31. A worker of a company borrowed Birr 100,000 from the company's credit and saving association. She agreed to pay 10% of the loan during the agreement and on the remaining amount to pay Birr 3000 (monthly plus interest) in 36 monthly installments. What is the total amount of money she paid to the credit and saving association? (1)
- A. Birr 106,000  
B. ✓ Birr 118,000  
C. Birr 108,000  
D. Birr 116,000

**Answer: B**

The worker paid 10% of 100,000 upfront, which is 10,000 Birr, and then paid 36 monthly installments of 3000 Birr, totaling  $10,000 + (36 \times 3000) = 118,000$  Birr.

32. Given the system of linear equations  $\begin{cases} a_1x + b_1y = c_1 \\ a_2x + b_2y = c_2 \end{cases}$ , where  $a_1, a_2, b_1, b_2, c_1, c_2 \in \mathbb{R}$  and  $a_2, b_2, c_2 \neq 0$ , (1)
- then which of the following is true?
- A. ✓ If  $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$ , then the system has one solution.  
B. If  $\frac{a_1}{a_2} = \frac{c_1}{c_2}$ , then the system has no solution.  
C. If  $\frac{b_1}{b_2} = \frac{c_1}{c_2}$ , then the system has unique solution.  
D. If  $\frac{a_1}{a_2} \neq \frac{c_1}{c_2}$ , then the system has infinitely many solutions.

**Answer: A**

If the ratio of the coefficients of  $x$  and  $y$  is unequal ( $a_1/a_2 \neq b_1/b_2$ ), then the two lines have different slopes and must intersect at exactly one point, yielding a unique solution.

33. Which of the following is true about the cosecant value of the given angles? (1)
- A.  $\csc 135^\circ = -\frac{1}{\sqrt{2}}$   
B.  $\csc 135^\circ = -\sqrt{2}$   
C.  $\csc 45^\circ = \frac{1}{\sqrt{2}}$   
D. ✓  $\csc 45^\circ = \sqrt{2}$

**Answer: D**

Since  $\sin 45^\circ = 1/\sqrt{2}$ , its reciprocal is  $\csc 45^\circ = \sqrt{2}$ , which makes option D correct.

34. Which of the following statement defines geometric progression? (1)
- A. ✓ It is a sequence in which the ratio between consecutive terms is a non-zero constant.  
B. It is a sequence in which the difference between consecutive terms is a positive constant.  
C. It is a sequence in which the difference between consecutive terms is a non-zero constant.  
D. It is a sequence in which the ratio between consecutive terms is a positive constant.

**Answer: A**

A geometric progression is defined as a sequence of numbers where each term after the first is found by multiplying the previous term by a fixed, non-zero number called the common ratio.

35. Consider the line segment  $PQ$  with  $P = (1, -1)$  and  $Q = (4, 2)$ . Then which of the following point divides  $PQ$  internally in the ratio of 2:1? (1)
- A. ✓ (3, 1)  
B. (2, 0)  
C. (2, 1)  
D. (3, 0)

**Answer: A**

Using the section formula for internal division with ratio 2:1, the coordinates are  $(\frac{2(4)+1(1)}{2+1}, \frac{2(2)+1(-1)}{2+1}) = (3, 1)$ .

36. What is the determinant of the matrix  $\begin{pmatrix} \frac{1}{2} & 1 & \frac{3}{2} \\ 2 & \frac{5}{2} & 3 \\ \frac{7}{2} & 4 & \frac{9}{2} \end{pmatrix}$ ?

A. ✓ 0

B.  $\frac{1}{2}$

C.  $\frac{1}{2}$

D. 1

**Answer: A**

Multiplying the matrix by 2 gives rows (1, 2, 3), (4, 5, 6), and (7, 8, 9), which are in arithmetic progression and thus linearly dependent, resulting in a determinant of 0.

37. Given the objective function  $Z = -x + 2y$  that is subjected to the constraints  $\begin{cases} x \geq 3 \\ x + y \geq 5 \\ x + 2y \leq 6 \\ y \geq 0 \end{cases}$ , what are the maximum and minimum values of Z respectively?

A. ✓ -2 and -6  
B. -2 and 1  
C. 1 and -2  
D. -6 and -2

**Answer: A**

The feasible region is bounded by the vertices  $(4, 1)$ ,  $(5, 0)$ , and  $(6, 0)$ . Evaluating  $Z = -x + 2y$  at these points gives a maximum value of  $-2$  at  $(4, 1)$  and a minimum value of  $-6$  at  $(6, 0)$ .

**38.** Let  $a, b \in \mathbb{R}$  such that  $a < b$  and  $f$  be a polynomial function. Then which one of the following statement states the location theorem? (1)

**A. ✓ If  $f(a)$  and  $f(b)$  have opposite signs, then there is at least one zero of  $f$  between  $a$  and  $b$ .**

B. If  $f(a)$  and  $f(b)$  have the same signs, then there is at least one zero of  $f$  between  $a$  and  $b$ .

C. If  $f(a)$  and  $f(b)$  have the same signs, then there exist a unique zeros of  $f$  between  $a$  and  $b$ .

D. If  $f(a)$  and  $f(b)$  have opposite signs, then there is a unique zeros of  $f$  between  $a$  and  $b$ .

**Answer: A**

The location theorem (a case of the Intermediate Value Theorem) states that if a continuous function (such as a polynomial) has values of opposite signs at the endpoints of an interval  $[a, b]$ , then it must cross the x-axis, meaning there is at least one zero of the function in  $(a, b)$ .

39. Suppose two triangles are similar by SSS similarity theorem. If the side lengths of one triangle are 2 cm, 4 cm and 6 cm, and the shorter side of the other triangle is 9 cm long, then what are the lengths (in cm) of the other two sides of the triangle?

A. 9 and 21  
B. ✓ 18 and 27  
C. 9 and 27  
D. 18 and 21

**Answer: B**

The ratio of the shortest sides is  $9/2 = 4.5$ . Multiplying the remaining sides by this scale factor yields  $4 \times 4.5 = 18$  cm and  $6 \times 4.5 = 27$  cm.

40. Let  $a, b \in \mathbb{R}$  such that  $a < b$  and  $f$  be a polynomial function. Then which one of the following statement states the location theorem? (1)

- A. ✓ **If  $f(a)$  and  $f(b)$  have opposite signs, then there is at least one zero of  $f$  between  $a$  and  $b$ .**
- B. If  $f(a)$  and  $f(b)$  have the same signs, then there is at least one zero of  $f$  between  $a$  and  $b$ .
- C. If  $f(a)$  and  $f(b)$  have the same signs, then there exist a unique zeros of  $f$  between  $a$  and  $b$ .
- D. If  $f(a)$  and  $f(b)$  have opposite signs, then there is a unique zeros of  $f$  between  $a$  and  $b$ .

**Answer: A**

The location theorem states that if  $f(a)$  and  $f(b)$  have opposite signs for a continuous (polynomial) function, there must be at least one zero between  $a$  and  $b$ , because the function's graph must cross the x-axis to go from positive to negative (or vice versa).

41. If  $\begin{pmatrix} x+y & 2 \\ 5 & 3 \end{pmatrix} = \begin{pmatrix} 7 & 2 \\ 5 & x-y \end{pmatrix}$ , then what is the value of  $x$ ? (1)

- A. -2
- B. -5
- C. ✓ **5**
- D. 2

**Answer: C**

Equating the corresponding elements from the matrices yields  $x + y = 7$  and  $x - y = 3$ . Adding these two linear equations gives  $2x = 10$ , which simplifies to  $x = 5$ .

42. Consider the following data: 13, 16, 19, 19, 19, 19, 24, 27 What is the mean deviation about the mode? (1)

- A. 4
- B. ✓ **2.75**
- C. 3.75
- D. 3

**Answer: B**

The mode of the dataset is 19. The mean deviation about the mode is the average of the absolute deviations from 19, which is  $\frac{|13-19|+|16-19|+4|19-19|+|24-19|+|27-19|}{8} = \frac{22}{8} = 2.75$ .

43. Which of the following statement is true about types of data: (1)

- A. ✓ **The age of students in a class is a quantitative data.**
- B. The height of students in a class is a qualitative data.
- C. The weight of students in class is a qualitative data.
- D. The gender of students in a class is a quantitative data.

**Answer: A**

Age is measured numerically and can be subjected to arithmetic operations, which makes it quantitative data, while height and weight are also quantitative, and gender is qualitative.

44. A company offers a discount of 25% on one of its product for promotion. What is a regular price of the product if it is purchased for Birr 99? (1)

- A. 110
- B. 198
- C. ✓ **132**
- D. 125

**Answer: C**

A discount of 25% means the purchase price is 75% of the regular price. Therefore, the regular price  $P$  is calculated as  $99/0.75 = 132$  Birr.

45. What is the total surface area (in  $\text{cm}^2$ ) of the cylinder whose radius is 2cm and height is 7cm? (1)
- A.  $49\pi$  B.  $28\pi$   
 C. ✓  $36\pi$  D.  $98\pi$

**Answer: C**

The total surface area of a cylinder is  $2\pi r(h + r)$ . Substituting  $r = 2$  and  $h = 7$  gives  $2\pi(2)(7 + 2) = 36\pi \text{ cm}^2$ .

46. Which of the following statement is true about the given infinite series? (1)
- A.  $\sum_{n=1}^{\infty} (-1)^n 2^n$  is convergent. B.  $\sum_{n=1}^{\infty} \left(\frac{4}{3}\right)^n$  is convergent.  
 C. ✓  $\sum_{n=1}^{\infty} 2^n$  is divergent. D.  $\sum_{n=1}^{\infty} (-1)^n \left(\frac{2}{5}\right)^n$  is divergent.

**Answer: C**

The infinite geometric series  $\sum_{n=1}^{\infty} 2^n$  has a common ratio  $r = 2 \geq 1$ , meaning it is a divergent series.

47. Let  $\theta$  be an angle in standard position and  $(x, y)$  be a point on the terminal side of  $\theta$ , which is different from the origin. Let  $r$  be the distance from  $(x, y)$  to the origin. Then which of the following defines  $\cos \theta$ ? (1)
- A.  $\frac{r}{y}$  B.  $\frac{y}{r}$   
 C.  $\frac{r}{x}$  D. ✓  $\frac{x}{r}$

**Answer: D**

In trigonometry on the Cartesian plane, the cosine of an angle  $\theta$  in standard position is defined as the ratio of the x-coordinate of a point on its terminal side to its distance  $r$  from the origin, i.e.,  $\cos \theta = x/r$ .

48. Which one of the following is the solution set of  $5^x = 11.2$ ? [Use  $\log 5 = 0.6990$  and  $\log 1.12 = 0.0485$ ] (1)
- A. 1.12 B. ✓ 1.5  
 C. 1.2 D. 1.69

**Answer: B**

By taking the base-10 logarithm on both sides of  $5^x = 11.2$ , we get  $x \log 5 = \log(11.2)$ . Since  $\log(11.2) = \log(10 \times 1.12) = 1 + \log(1.12) = 1.0485$ , the solution is  $x = 1.0485/0.6990 = 1.5$ .

49. A boy and girl are both standing on a sun light. The boy's height is 1.6m and casts a shadow of 2m. If the girl's height casts a shadow of 1.8m, then what is the height (in meter) of the girl? (1)
- A. 1.5 B. 1.54  
 C. 1.68 D. ✓ 1.44

**Answer: D**

Using the similarity of triangles formed by the objects and their shadows, the ratio of height to shadow length is constant:  $1.6/2 = h_g/1.8$ . Solving for the girl's height gives  $h_g = 0.8 \times 1.8 = 1.44$  meters.

50. If two vectors  $\vec{V} = \vec{AB}$ , and  $\vec{U} = \vec{BC}$  are given as shown in the figure below. Then what is the vector  $\vec{V} + \vec{U}$ ? (1)
- A. ✓  $\vec{AC}$  B.  $\vec{BA}$   
 C.  $\vec{CA}$  D.  $\vec{CB}$

**Answer: A**

According to the triangle law of vector addition, when we add the vector  $\vec{AB}$  and the vector  $\vec{BC}$  (where the terminal point of the first is the initial point of the second), the resulting sum vector is  $\vec{AC}$ .

END OF THE MARKING KEY

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