

Mathematics, 2018 EC, entrance exam, version 4

Grade 12 · Mathematics · 2018 E.C.

MARKING KEY: CONFIDENTIAL

Time allowed: 120 minutes

Questions: 56

Total marks: 56

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1. Which one of the following statement is true about the set of integers? (1)

- A. Integers only include positive numbers and Zero.
B. ✓ **Every integer is rational number**
C. The set of integers included irrational numbers
D. Every integer is also a whole number

Answer: B

Every integer z can be expressed as a fraction $z/1$ where both the numerator and denominator are integers, which satisfies the definition of a rational number.

2. Which of the following number is an irrational number? (1)

- A. ✓ **π** B. -7
C. $0.222\ldots$ D. $\sqrt{25}$

Answer: A

The number π is a well-known transcendental, irrational number, whereas -7 , $0.222\ldots = 2/9$, and $\sqrt{25} = 5$ are all rational numbers.

3. A gardener wants to build a square flower bed with an area of 45 square feet. Between which two whole numbers on a tape measure will side length fall? (1)

- A. 8 and 9 B. 5 and 6
C. ✓ **6 and 7** D. 7 and 8

Answer: C

The side length of the square is $\sqrt{45}$. Since $6^2 = 36$ and $7^2 = 49$, the value of $\sqrt{45}$ lies between the whole numbers 6 and 7.

4. Which of the following square roots represent a rational number? (1)

- A. ✓ **$\sqrt{0.25}$** B. $\sqrt{10}$
C. $\sqrt{0.1}$ D. $\sqrt{2}$

Answer: A

$\sqrt{0.25} = 0.5 = 1/2$, which is a terminating decimal and thus a rational number, whereas $\sqrt{10}$, $\sqrt{0.1}$, and $\sqrt{2}$ are irrational.

5. A student solves a system of linear equations in two variables and finds $x = 4$. Then he concludes that the solution to the system is 4. Which evaluation is correct? (1)
- A. The conclusion is correct only if the system has no solution
B. The conclusion is correct because x is independent variable
C. The conclusion is correct if the student used substitution method.
D. ✓ **The conclusion is incorrect because the solution must be in ordered pair form.**

Answer: D

A system of linear equations in two variables (typically x and y) requires a solution in the form of an ordered pair (x, y) , rather than just a single coordinate value.

6. What is the solution set for $|x^2 - 5| = 4$? (1)
- A. ✓ **$\{-3, -1, 1, 3\}$** B. $\{-3, -2, 1, 3\}$
C. $\{-1, 1\}$ D. $\{-1, 1\}$

Answer: A

Solving $|x^2 - 5| = 4$ yields two cases: $x^2 - 5 = 4 \implies x = \pm 3$, and $x^2 - 5 = -4 \implies x = \pm 1$. Thus, the solution set is $\{-3, -1, 1, 3\}$.

7. A toy rocket is launched. The path is modeled by $h(t) = -16t^2 + 64t$. At what time does it reach maximum height? (1)
- A. ✓ **2 seconds** B. 4 seconds
C. 10 seconds D. 64 seconds

Answer: A

The maximum of a downward-opening parabola $h(t) = at^2 + bt$ occurs at the vertex $t = -b/(2a)$. Here, $t = -64/(2 \cdot -16) = 2$ seconds.

8. In survey of 100 students, 60 like mathematics, 50 like English and 30 like both. How many like neither? (1)
- A. 10 B. 30
C. ✓ **20** D. 40

Answer: C

The number of students who like at least one subject is $n(M \cup E) = n(M) + n(E) - n(M \cap E) = 60 + 50 - 30 = 80$. Thus, $100 - 80 = 20$ students like neither.

9. If set A is proper subset of set B , then their intersection is equal to: (1)
- A. $\emptyset$ B. ✓ **A**
C. U D. B

Answer: B

Since A is a proper subset of B ($A \subset B$), all elements of A are also in B , making their intersection $A \cap B$ equal to A .

10. If a relation R satisfies: whenever $(a, b) \in R$ and $(b, a) \in R$, then the relation is said to be: (1)
- A. Transitive B. ✓ **symmetric**
C. reflexive D. asymmetric

Answer: B

Despite a slight typographical omission in the question stem, the symmetric property of a relation is defined as: whenever $(a, b) \in R$, then $(b, a) \in R$.

11. A taxi service charges a flat fee of Birr 25 and Birr 20 per kilometer. How much does a 10 km ride cost? (1)
- A. 45 birr
B. 270 birr
C. 55 birr
D. ✓ 225 birr

Answer: D

The cost of the taxi ride is modeled by $C(x) = 25 + 20x$. For a distance of 10 km, the cost is $25 + 20(10) = 225$ Birr.

12. Based on a graph of a linear function, what does the y-intercept represent? (1)
- A. The value of x when $y=0$
B. ✓ The point where the line crosses the vertical axis ($x=0$)
C. The steepness of the line
D. The total length of the line segment

Answer: B

The y -intercept of a function is the point where its graph intersects the vertical axis, which corresponds to the value of y when $x = 0$.

13. If a relation $R = \{(x,y): y \leq x \text{ and } x \leq 4\}$, then which is true? (1)
- A. Domain = $\{x: x < 4\}$
B. ✓ Range = $\{y: y \leq 4\}$
C. Range = $\{y: y \geq 4\}$
D. Domain = $\{x: x \geq 4\}$

Answer: B

Since $x \leq 4$ and $y \leq x$, we have $y \leq 4$, so the range of the relation is $\{y : y \leq 4\}$.

14. Which of the following sets of ordered pairs is a function? (1)
- A. $\{(1,2),(3,4),(3,-1),(-1,2)\}$
B. $\{(0,2),(6,3),(7,1),(0,-2)\}$
C. ✓ $\{(1,3),(4,6),(2,3),(-2,6)\}$
D. $\{(1,3),(2,6),(2,7),(-2,3)\}$

Answer: C

A set of ordered pairs represents a function if and only if each domain element maps to exactly one range element. Option C contains unique domain elements $\{1, 4, 2, -2\}$.

15. If the expression $(x^2 - 5x + 6)$ represents the area of a rectangle, what is the perimeter when $x=6$? (1)
- A. 12
B. 16
C. 18
D. ✓ 14

Answer: D

The area can be factored as $x^2 - 5x + 6 = (x - 2)(x - 3)$, representing sides of length $(x - 2)$ and $(x - 3)$. At $x = 6$, the dimensions are 4 and 3, yielding a perimeter of $2(4 + 3) = 14$.

16. Which of the following is the vertex of $y = x^2 + 4x + 11$? (1)
- A. ✓ $(-2,7)$
B. $(-3,4)$
C. $(3,-4)$
D. $(2,-7)$

Answer: A

The vertex of $y = ax^2 + bx + c$ has $x = -b/(2a) = -4/2 = -2$. Substituting $x = -2$ into the equation gives $y = (-2)^2 + 4(-2) + 11 = 7$, so the vertex is $(-2, 7)$.

17. If $f(x)=x^3+2x^2+x-5$ and $g(x)=-2x^2+5x-3$, then degree and constant term of $f(x) \cdot g(x)$ respectively? (1)
- A. 6 and -15
B. ✓ 5 and 15
C. 2 and -8
D. 3 and 9

Answer: B

The degree of the product of two polynomials is the sum of their degrees ($3 + 2 = 5$), and the constant term of the product is the product of their constant terms ($-5 \cdot -3 = 15$).

18. If $f(x)=x^{16}+8x^3+77x+99$ and $d(x)=x+1$, remainder when $f(x)$ divided by $d(x)$ is: (1)
- A. 31
B. 99
C. ✓ 15
D. 108

Answer: C

According to the Remainder Theorem, the remainder when $f(x)$ is divided by $x + 1$ is $f(-1) = (-1)^{16} + 8(-1)^3 + 77(-1) + 99 = 1 - 8 - 77 + 99 = 15$.

19. Which of the following is a factor of $f(x)=x^3+4x^2+x-6$? (1)
- A. $x-2$
B. $x-3$
C. $x+1$
D. ✓ $x+2$

Answer: D

By the Factor Theorem, $x - c$ is a factor if $f(c) = 0$. Testing the root $x = -2$ from option D gives $f(-2) = (-2)^3 + 4(-2)^2 + (-2) - 6 = -8 + 16 - 2 - 6 = 0$.

20. Which graph of polynomial function represents negative leading coefficient and odd degree? (1)
- A. It falls to left and right
B. It rises to left and right
C. ✓ It rises to left and falls to right
D. It falls to left and rises to right

Answer: C

A polynomial function with an odd degree and a negative leading coefficient behaves like $-x^3$, which rises towards positive infinity to the left and falls towards negative infinity to the right.

21. What is the simplest form of $\log 24 - 2 \log 6 + \log 15$? (1)
- A. ✓ 1
B. 2
C. 3
D. 4

Answer: A

Using logarithm laws, $\log 24 - 2 \log 6 + \log 15 = \log 24 - \log 36 + \log 15 = \log\left(\frac{24 \times 15}{36}\right) = \log 10 = 1$.

22. Which one of the following is not true? (1)
- A. $\sqrt{3\sqrt{64}} = 2$
B. $(3\sqrt{2})^{\sqrt{2}} = 9$
C. $(2/3)^{-2} = 9/4$
D. ✓ $(1/2)^{-3} = 1/8$

Answer: D

The expression $(1/2)^{-3} = 2^3 = 8$. Thus, option D stating $(1/2)^{-3} = 1/8$ is false.

23. Which one of the following is false about $f(x)=3^x$?

(1)

- A. Domain is the set of real numbers
- B. Range is the set of positive real numbers
- C. has no x-intercept
- D. ✓ it is decreasing function

Answer: D

For $f(x) = 3^x$, the base $3 > 1$ means the function is strictly increasing, making the statement that it is a decreasing function false.

24. What is the value of $\ln(e^x/e^y)$?

(1)

- A. ✓ $x-y$
- B. $x+y$
- C. xy
- D. x/y

Answer: A

Using properties of exponents and logarithms, $\ln(e^x/e^y) = \ln(e^{x-y}) = x - y$.

25. The solution set of $\log_x(5x-6)=2$ is:

(1)

- A. ✓ $\{2,3\}$
- B. $\{3\}$
- C. $\{2\}$
- D. $\{1,4\}$

Answer: A

From $\log_x(5x - 6) = 2$, we get $x^2 = 5x - 6 \implies x^2 - 5x + 6 = 0$, which solves to $x = 2$ and $x = 3$. Both satisfy the constraints $x > 0$, $x \neq 1$, and $5x - 6 > 0$.

26. Which of the following function is not a power function?

(1)

- A. $f(x)=3x^2$
- B. ✓ $f(x)=2^{-x}$
- C. $f(x)=x^{4/3}$
- D. $f(x)=-4x^{-3}$

Answer: B

A power function is of the form $f(x) = kx^p$ where k and p are constants. Option B represents an exponential function, $f(x) = 2^{-x} = (1/2)^x$, and is therefore not a power function.

27. Given $R=\{(x,y): y=x^2-2, x \in \{0,1,2,3\}\}$, then range of R is:

(1)

- A. $\{0,1,2,-7\}$
- B. ✓ $\{-2,-1,2,7\}$
- C. $\{0,1,2,3\}$
- D. $\{0,1,2,4\}$

Answer: B

By substituting each element of the domain $\{0, 1, 2, 3\}$ into the formula $y = x^2 - 2$, we obtain the set of outputs: $-2, -1, 2$, and 7 , which form the range.

28. If $x < 0$, then what is the value of $(4x - |x|)/x$?

(1)

- A. 3
- B. ✓ 5
- C. 4
- D. 6

Answer: B

For $x < 0$, the absolute value is $|x| = -x$. Substituting this gives $(4x - (-x))/x = (4x + x)/x = 5x/x = 5$.

29. Which one is the inverse of $f(x) = -3x + 2$? (1)

- A. $f^{-1}(x) = (x+2)/3$ B. $f^{-1}(x) = -(x+2)/3$
C. $f^{-1}(x) = (x-2)/3$ D. ✓ $f^{-1}(x) = (2-x)/3$

Answer: D

To find the inverse of $f(x) = -3x + 2$, we solve $y = -3x + 2$ for x , which yields $x = (2 - y)/3$, hence $f^{-1}(x) = (2 - x)/3$.

30. What is the range of $f(x) = 3 - \operatorname{sgn} x$? (1)

- A. ✓ **{2,3,4}** B. {2,7,8}
C. {-2,6,7} D. {-1,0,1}

Answer: A

The signum function $\operatorname{sgn} x$ outputs values in $\{-1, 0, 1\}$. Consequently, $f(x) = 3 - \operatorname{sgn} x$ outputs values in $\{3 - (-1), 3 - 0, 3 - 1\} = \{4, 3, 2\}$.

31. The simplest form of $((2x^2 + 10x + 12)/(x^2 - 9)) \div ((x+2)/(x-3))$, $x \neq \pm 3$ is: (1)

- A. 1 B. ✓ **2**
C. 3 D. 4

Answer: B

Factoring the numerator and denominator of the first term gives $2(x+2)(x+3)/((x-3)(x+3)) = 2(x+2)/(x-3)$. Dividing this by $(x+2)/(x-3)$ results in 2.

32. Solution set of $(2x^2 - x - 21)/(2x-7) = 0$, $x \neq 7/2$ is: (1)

- A. ✓ **{-3}** B. {3}
C. {-4} D. {2}

Answer: A

Factoring the numerator gives $(2x-7)(x+3) = 0$. Since x cannot be $7/2$ to avoid division by zero, the only solution is $x = -3$.

33. Which one of the following is not a rational function? (1)

- A. ✓ **$f(x) = (3x+2)/\sqrt{x^2}$** B. $g(x) = 2x^2 + 6x - 7$
C. $n(x) = x^3/(2x+1)$ D. $k(x) = (x^4+1)/(x+3)$

Answer: A

A rational function is a ratio of two polynomial functions. In Option A, the denominator contains the term $\sqrt{x^2} = |x|$, which is not a polynomial, making it not a rational function.

34. Which is true about $f(x) = (3x^2+1)/(x^2+4x+4)$? (1)

- A. $x=2$ is vertical asymptote B. $f(x)$ has a hole at $x=-2$
C. $y=0$ is horizontal asymptote D. ✓ **The line $y=3$ is horizontal asymptote**

Answer: D

Since the degrees of the numerator and the denominator are equal (both are 2), the horizontal asymptote is the ratio of their leading coefficients, which is $y = 3/1 = 3$.

35. The perimeter of a triangle is 30 cm. The shortest side is 4 cm shorter than the longest side. The longest side is 6 cm less than the sum of the other two. Find the sides. (1)
- A. 6,7,8
B. 10,11,12
C. ✓ 8,10,12
D. 9,13,14

Answer: C

Letting the sides be a , b , and c with $a \leq b \leq c$, we set up the system: $a + b + c = 30$, $a = c - 4$, and $c = a + b - 6$. Solving this system yields the side lengths 8, 10, and 12.

36. What is the area of the triangle with vertices A(1,1), B(1,3), C(4,5)? (1)
- A. 4
B. ✓ 3
C. 2
D. 6

Answer: B

Using the area formula for a triangle with vertices (x_1, y_1) , (x_2, y_2) , and (x_3, y_3) , we compute $\text{Area} = 0.5 * |1(3-5) + 1(5-1) + 4(1-3)| = 0.5 * |-6| = 3$.

- 37.** Let A and B be 3×3 matrices with $\det(A)=2$, $\det(B)=3$. Then $\det(3AB^T)$ is:
- A. 160 B. 48
C. 54 D. ✓ **162**

Answer: D

For 3x3 matrices, $\det(3AB^T) = 3^3 \cdot \det(A) \cdot \det(B^T)$. Since $\det(B^T) = \det(B) = 3$, this equals $27 \cdot 2 \cdot 3 = 162$.

- 38.** Let A and B be 2×2 matrices with $\det(A)=2$, $\det(B)=16$. Then $\det(2A^{-1}B)$ is:
- A. ✓ **32** B. 64
C. 128 D. 108

Answer: A

For 2×2 matrices, $\det(2A^{-1}B) = 2^2 * \det(A^{-1}) * \det(B) = 4 * (1/\det(A)) * \det(B) = 4 * (1/2) * 16 = 32$.

- 39.** An amphitheater has 30 seats in first row, 35 in second, 40 in third, etc. If there are 30 rows, how many seats in 30th row? (1)
- A. 1775 B. 3075
- C. ✓ **175** D. 275

Answer: C

This is an arithmetic progression with first term $a_1 = 30$ and common difference $d = 5$. The 30th term is $a_{30} = a_1 + 29d = 30 + 29(5) = 175$.

- 40.** If sum of first three consecutive terms of an AP (all positive) is 15 and sum of their squares is 83, then sum of first five terms?
- A. ✓ **35**
- B. 45
- C. 47
- D. 53

Answer: A

Let the first three terms be $a-d$, a , $a+d$. Their sum is $3a = 15$, so $a = 5$. Their sum of squares is $(5-d)^2 + 25 + (5+d)^2 = 75 + 2d^2 = 83$, which gives $d = 2$. The first 5 terms are 3, 5, 7, 9, 11, whose sum is 35.

47. Find derivative of $f(x)=5x^3-2x+7$

(1)

A. $5x^2-2$

B. ✓ $15x^2-2$

C. $15x^2-2x$

D. $15x^3-2$

Answer: B

Using the power rule for differentiation, the derivative of $5x^3$ is $15x^2$, the derivative of $-2x$ is -2 , and the derivative of the constant 7 is 0. Therefore, $f'(x) = 15x^2 - 2$.

48. Find equation of normal line to $f(x)=x^2$ at (1,1).

(1)

A. $y-1 = -2(x-1)$

B. ✓ $y-1 = -\frac{1}{2}(x-1)$

C. $y=x$

D. $y-1 = -2(x-1)$

Answer: B

The derivative of $f(x) = x^2$ is $f'(x) = 2x$, so the slope of the tangent line at $x = 1$ is $f'(1) = 2$. The slope of the normal line is the negative reciprocal of the tangent slope, which is $-1/2$, yielding the equation $y - 1 = -\frac{1}{2}(x - 1)$.

49. If graph of $f'(x)$ is a horizontal line above x-axis, what about $f(x)$?

(1)

A. Constant function

B. Increasing at increasing rate

C. Parabola opening upwards

D. ✓ **Linear function with positive slope**

Answer: D

If $f'(x)$ is a horizontal line above the x-axis, then $f'(x) = c$ for some positive constant $c > 0$. Integrating this derivative gives $f(x) = cx + d$, which represents a linear function with a positive slope.

50. Slope of tangent to $f(x)=x^2-5x+6$ at $x=3$?

(1)

A. 4

B. -2

C. ✓ 1

D. 6

Answer: C

The slope of the tangent line is given by the derivative $f'(x) = 2x - 5$. Evaluating this at $x = 3$ gives $f'(3) = 2(3) - 5 = 1$.

51. Find area bounded by $f(x)=x^2$, x-axis, $x=0$ and $x=3$.

(1)

A. 6

B. ✓ 9

C. 3

D. 27

Answer: B

The area under the curve is given by the definite integral $\int_0^3 x^2 dx = [\frac{x^3}{3}]_0^3 = \frac{27}{3} - 0 = 9$.

52. A company's marginal revenue $MR(x)=-2x+100$. Change in total revenue when production increases from 10 to 20 units?

(1)

A. 1000

B. ✓ 700

C. 800

D. 600

Answer: B

The change in total revenue is found by integrating the marginal revenue function from $x = 10$ to $x = 20$: $\int_{10}^{20} (-2x + 100) dx = [-x^2 + 100x]_{10}^{20} = (-400 + 2000) - (-100 + 1000) = 1600 - 900 = 700$.

53. Find the range of the grouped data: x:10-14,15-19,20-24,25-29,30-34; f:2,5,8,4,1 (1)

- A. 20
B. 24
C. ✓ 25
D. 15

Answer: C

In grouped data, the range is calculated as the difference between the upper boundary of the highest class and the lower boundary of the lowest class. Here, the highest class boundary is 34.5 and the lowest is 9.5, giving a range of $34.5 - 9.5 = 25$.

54. Find the mode of the grouped data (to two decimal places). (1)

- A. 23.66
B. 20.91
C. ✓ 21.64
D. 24.34

Answer: C

The modal class is 20-24 because it has the highest frequency of 8. Using the mode formula $\text{Mode} = L + \left(\frac{\Delta_1}{\Delta_1 + \Delta_2}\right) \cdot w$
 $w = 19.5 + \left(\frac{3}{3+4}\right) \cdot 5 = 19.5 + 2.14 = 21.64$.

55. Find the median of the grouped data. (1)

- A. 18.685
B. 19.875
C. 20.865
D. ✓ 21.375

Answer: D

The median class is 20-24 since the cumulative frequency reaches $N/2 = 10$ in this interval. Applying the median formula yields $\text{Median} = L + \left(\frac{N/2 - CF}{f}\right) \cdot w = 19.5 + \left(\frac{10-7}{8}\right) \cdot 5 = 19.5 + 1.875 = 21.375$.

56. Find the mean of the grouped data. (1)

- A. ✓ 21.25
B. 19.45
C. 18.15
D. 16.95

Answer: A

The mean of grouped data is calculated as $\frac{\sum f_i x_i}{N}$. Summing the products of the class marks ($x_i = 12, 17, 22, 27, 32$) and their frequencies ($f_i = 2, 5, 8, 4, 1$) gives $24 + 85 + 176 + 108 + 32 = 425$, and dividing by $N = 20$ yields 21.25.

END OF THE MARKING KEY

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