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Mathematics, 2018 EC, entrance exam, round 1

Grade 12 · Mathematics · 2018 E.C.

Time allowed: 120 minutes **Questions:** 58 **Total marks:** 58

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1. Consider the data: 11, 13, 15, 17, 19, 21. Which one of the following is the mean deviation from the mean? (1)

A. 4
B. 3.5
C. 4.5
D. 3

2. Consider the quadrilateral ABCD where A=(0,0), B=(-1,1)), C=(0,2) and D=(2,2). Which one of the following is true? (1)

A. CD is perpendicular to AB.
B. BC is parallel to AD.
C. CD is perpendicular to BE.
D. AB is parallel to CD.

3. Consider the greatest integer function defined by $f(x) = [x - 1]$. Which of the following sets is the domain of f? (1)

A. The set of rational numbers.
B. The set of integers.
C. The set of real numbers.
D. The set of natural numbers.

4. Which one of the following relations is a function? (1)

A. $R = \{(x, y) : x, y \in R \text{ and } y^2 = x\}$
B. $R = \{(x, y) : x, y \in R \text{ and } |y| = x\}$
C. $R = \{(x, y) : x, y \in R \text{ and } y = x^2\}$
D. $R = \{(x, y) : x, y \in R \text{ and } y^4 = x\}$

5. Which one of the following is a source of cash loan? (1)

A. Non-government organization to alleviate public problems.
B. Investors involved in home construction for a community.
C. Group of investors committed to drilling out underground water.
D. A money line group investing in health improvement sectors.

6. What is the average rate of change of $y = f(x)$ with respect to x on the interval $[a, b]$? (1)

A. $\frac{f(b)+f(a)}{2}$
B. $\frac{b-a}{f(b)-f(a)}$
C. $\frac{f(b)-f(a)}{2}$
D. $\frac{f(b)-f(a)}{b-a}$

7. Which one of the following sets is the solution of $\log_3 x + \log_3(x - 2) = 1$? (1)

A. {-1,3}
B. {3}
C. {2}
D. {0,2}

8. Given the functions $f(x) = ax^2$ and $g(x) = ax^2 + c$, for $a < 0$ and $c > 0$. Which of the following statements is true about the graph of f and g? (1)

A. The graph of f is an upward parabola, and the graph of g is obtained from that of f by shifting it downward by c units.

B. The graph of f is a downward parabola, and the graph of g is obtained from that of f by shifting it to the right by c units.

C. The graph of f is an upward parabola, and the graph of g is obtained from that of f by shifting it upward by c units.

D. The graph of f is a downward parabola, and the graph of g is obtained from that of f by shifting it upward by c units.

9. Consider the test results of 20 students in a given class. 13 14 14 15 19 18 13 15 16 16 13 14 14 15 19 18 13 15 16 16 17 18 15 13 14 16 14 18 16 16 (1)

Which one of the following numbers is the mode of the above data?

A. 16 **B.** 15

C. 14 **D.** 18

10. Consider the figure given below: (1)

Which one of the following vectors is equal to $\mathrm{AB}^{\rightarrow} + \mathrm{CD}^{\rightarrow} + \mathrm{BC}^{\rightarrow}$?

[Figure: The figure for Question 10 shows four points labeled A, B, C, and D forming a geometric arrangement with vectors. Point A is connected to point B by a line segment with an arrow pointing towards B, representing vector AB. Point C is connected to point D by a line segment with an arrow pointing towards D, representing vector CD. Point C is also connected to point A by a line segment.]

A. $\vec{CD}$ **B.** $\vec{AC}$

C. $\vec{AD}$ **D.** $\vec{BD}$

11. Which one of the following equations represents a line that passes through the points (2, -1) and (-3, 4)? (1)

A. $x + y - 1 = 0$ **B.** $x + y + 1 = 0$

C. $x - y - 1 = 0$ **D.** $x - y + 1 = 0$

12. What is the coefficient of x^3y^4 in the expansion of $(x - 2y)^7$ (1)

A. 35 **B.** 70

C. 560 **D.** -280

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

A. f(x)=x^3 **B.** f(x)=3x

C. f(x)=$4x^{-6}$ **D.** f(x)=$7x^{-1/3}$

14. Given the problem: Maximize Z=3x+y subject to: (1)

$$\begin{cases} x + y \geq 2 \\ y + 2x \leq 4 \\ y \geq 1, x \geq 0 \end{cases}$$

Which one of the following is the maximum value of Z?

A. 2 **B.** 5.5

C. 4 **D.** 5.8

15. Let r1 and r2 be the roots of the quadratic equation $2x^2 + 3x - 4 = 0$. Which one of the following is equal to (1)

$$\frac{1}{r_1^2} + \frac{1}{r_2^2}?$$

A. 3/4
B. 25/16
C. 3/16
D. 1/4

16. Consider the matrix (1)

$$A = \begin{pmatrix} -1 & 2 & 1 \\ 3 & 4 & 2 \\ 1 & 1 & 5 \end{pmatrix}$$

Which of the following statements is true about the minor of the entries of A?

A. The cofactor of 3 is 9.
B. The cofactor of 4 is -6.
C. The minor of 4 is 6.
D. The minor of 3 is -9.

17. In the figure below, let m ($\angle \mathrm{DAC}$)=15° and m(arc BC)=70°. What is the measure of arc CD? (1)
[Figure: A circle with center O is shown. Point A lies outside the circle to the right. A secant line passes through point A, intersects the circle at point D, and continues to point B on the upper left of the circle. A tangent line starts from point A and touches the bottom of the circle at point C. Angle DAC at vertex A is marked as 15 degrees. The arc between B and C contains points D along the secant line.]

A. 42.5°
B. 55°
C. 30°
D. 40°

18. Consider the right-angled triangle $\Delta \mathrm{ABC}$ below, where $\mathrm{AC} = 5\mathrm{cm}$ and $\mathrm{BC} = 4\mathrm{cm}$. (1)
Which one of the following is the length of BD?
[Figure: A right-angled triangle labeled ΔABC with the right angle at vertex B. The vertices are labeled A at the top left, B at the bottom left, and C at the bottom right. A line segment is drawn from vertex B perpendicularly to the hypotenuse AC, meeting AC at a point labeled D. There is a right-angle symbol at vertex B and another right-angle symbol where the line segment BD meets the hypotenuse AC at point D.]

A. 5.76cm
B. 2.4cm
C. 5cm
D. 7cm

19. Which one of the following is true about definite integrals? (1)

A. $\int_a^b f(x)dx = 0, a \neq 0$
B. $\int_a^b (f(x) + g(x))dx = \int_a^b f(x)dx + \int_a^b g(x)dx$
C. $\int_a^b f(x)dx = \int_a^b g(x)dx$
D. $\int_a^b (f(x) - g(x))dx = \int_a^b (g(x) - f(x))dx$

20. Which of the following statements defines a circle? (1)

A. It is the set of points in a plane formed by the intersection of two secants in the plane.
B. It is the set of points in a space formed by the intersection of two secants in the space.
C. It is the set of points in a space each of which is equidistant from a fixed point in the space.
D. It is the set of points in a plane each of which is equidistant from a fixed point in the plane.

21. What is the transpose of the matrix (1)

$$M = \begin{pmatrix} 1 & 2 & 1 \\ 0 & -1 & 3 \\ 2 & 1 & 5 \end{pmatrix}?$$

A. $\begin{pmatrix} 1 & 0 & 2 \\ 2 & -1 & 1 \\ 1 & 3 & 5 \end{pmatrix}$

B. $\begin{pmatrix} 1 & 2 & 1 \\ 2 & -1 & 3 \\ 0 & 1 & 5 \end{pmatrix}$

C. $\begin{pmatrix} 2 & 1 & 5 \\ 0 & -1 & 3 \\ 1 & 2 & 1 \end{pmatrix}$

D. $\begin{pmatrix} 1 & 2 & 2 \\ 0 & -1 & 1 \\ 1 & 3 & 5 \end{pmatrix}$

22. Which one of the following sets is the domain of the rational function (1)

$$f(x) = \frac{x^3 + x^2}{x^4 + 2x^2 - 3}?$$

A. R\{1}

B. R\{-1,1}

C. R\{-3,1}

D. R\{-1,1,-3}

23. Which of the following statements is true in borrowing money? (1)

A. The borrower only pays back the principal amount.

B. The lender assumes no risk when giving out a loan.

C. Borrowing money involves an agreement to repay the principal amount along with accrued interestz

D. Collateral is always required for any type of financial borrowing.

24. Let f(x)=2x+1/x−1. Which of the following equations is the equation of the tangent line to the graph of f at (2,f(2))? (1)

A. 3x+y=11

B. y−3x=−1

C. x+3y=17

D. 3x−y=13

25. What is the measure of each interior angle of a regular polygon with 15 sides? (1)

A. 144°

B. 150°

C. 156°

D. 162°

26. Let $f(x) = x^3 + 4x$and $g(x) = 3x^3 - x^2$. What is the derivative of (f+g)(x)? (1)

A. $12x^2 - 2x + 4$

B. $4x^3 - x^2 + 4x$

C. $12x^2 - x + 4$

D. $9x^2 - 2x + 4$

27. Let A={$x \in \mathbb{R} : x^3 - x = 0$} and B={$x \in \mathbb{Z} : -1 \leq x < 3$}. What is the relative complement of B with respect to A (i.e., A\B)? (1)

A. {2}

B. {0,1}

C. $\emptyset$

D. {−1,0,1}

28. Given the set B={∅,{−2,0}}, what is the power set of B? (1)

A. {∅,{−2,0}}

B. {∅,{∅},{{−2,0}},{∅,{−2,0}}}

C. {{∅},{{−2,0}}}

D. {∅,{−2},{0},{−2,0}}

29. What is the simplified form of (1)

$$\log_{16}(4) - \log_2(\sqrt{12.5}) + \log_{0.5}(2)?$$

A. $\log_2(5)$
B. 1-$\log_2(5)$
C. -$\log_2(5)$
D. 0

30. Which statement is true about the graphs of the exponential functions f(x)=a^x f and g(x)=$(1/a)^x$ where a>1? (1)

A. They are reflections of each other across the x-axis.
B. They are reflections of each other across the y-axis.
C. They never intersect each other.
D. Both functions are monotonically increasing.

31. Which of the following statements is NOT true about the mean of a given data set? (1)

A. It is highly affected by extreme values (outliers).
B. The sum of the deviations of the items from the mean is always zero.
C. It must always be one of the actual data values present in the set.
D. It uses every value in the data set for its calculation.

32. Which one of the following numbers is an irrational number? (1)

A. 3.14159 (terminating)
B. $\sqrt{16}$
C. 22/7
D. π

33. What is the area of the parallelogram spanned by the vectors $\vec{u}$=i-2j+k and $\vec{v}$=2i+2j-k (1)

A. $\sqrt{14}$
B. $3\sqrt{5}$
C. 9
D. $\sqrt{35}$

34. What is the fundamental period of the function f(x)=sin(x)? (1)

A. $\pi/2$
B. π
C. 2π
D. 4π

35. What is the simplified form of the expression $(\sqrt{45} + \frac{1}{\sqrt{5}})(\sqrt{5} - \sqrt{20}$? (1)

A. 16
B. -16
C. 8
D. -8

36. In statistical sampling, if a population is divided into homogeneous groups and a random sample is drawn from each group, this method is known as: (1)

A. Simple random sampling
B. Cluster sampling
C. Stratified sampling
D. Systematic sampling

37. A mathematics exam contains 10 multiple-choice questions and 3 short-answer questions. According to the multiplication principle, how many ways can a student select exactly one multiple-choice question and exactly one short-answer question to solve first? (1)

A. 13
B. 30
C. 10^3
D. $\binom{13}{2}$

38. A translation vector maps the origin (0,0) to the point (-2,4). Under this same translation, what is the image of the point (3,1)? (1)

A. (5,-3)
B. (1,5)
C. (-6,4)
D. (-5,3)

39. If the initial point of a vector is A(2,-1,4) and the terminal point is B(4,3,2), what is the position vector $\vec{AB}$? (1)

A. $\langle -2, -4, 2 \rangle$
B. $\langle 6, 2, 6 \rangle$
C. $\langle 2, 4, -2 \rangle$
D. $\langle 8, -3, 8 \rangle$

40. Let vector $\vec{u}$ have an initial point at (1,2)and a terminal point at (-3,6). What are the components of the vector $-1/2\vec{u}$? (1)

A. $\langle 2, -2 \rangle$
B. $\langle -2, 2 \rangle$
C. $\langle 4, -4 \rangle$
D. \langle 1,-1\rangle

41. Consider the rational function f(x)=x^2-4/x-2. The domain of f is the set of all real numbers EXCEPT: (1)

A. -2
B. 2
C. 0
D. The domain is all real numbers.

42. Which of the following properties of matrices and scalar multiplication r is TRUE for any two matrices A and B of the same dimension? (1)

A. r(AB)=(rA)(rB)
B. r(A+B)=rA+rB
C. $(A+B)^T = A^T - B^T$
D. det(A+B)=det(A)+det(B)

43. If AA is a 3×3 square matrix, which of the following is always true about its transpose AT? (1)

A. $\det(A^T) = -\det(A)$
B. $\det(A^T) = 1/\det(A)$
C. $\det(A^T) = \det(A)$
D. $A^T = A^{-1}$

44. Let AA be a 3×3 invertible matrix with determinant |A|=4. What is the determinant of $2(A^{-1})$? (1)

A. 1/2
B. 2
C. 8
D. 1/4

45. What is the solution set for the radical equation (1)

$$\sqrt{x^2 + 3x} = 2?$$

A. {1,-4}
B. {1,4}
C. {-1,4}
D. {-1,-4}

46. Given the exponential functions $f(x) = 2^x$and $g(x) = 0.5^x$, which statement describes their monotonicity? (1)

A. Both functions are increasing.
B. Both functions are decreasing.
C. f(x) is decreasing and g(x) is increasing.
D. f(x)is increasing and g(x)is decreasing.

47. In an arithmetic progression, the first term is 11 and the common difference is –13. What is the sum of the first 7 terms? (1)

A. -28
B. -196
C. -67
D. 196

48. In a geometric sequence, the first term is $g_1 = 2$ and the fifth term is $g_5 = 8$ (assume the common ratio is positive). What is the value of the 13th term (g_{13})? (1)

A. 32
B. 64
C. 128
D. 256

49. The infinite repeating decimal 0.373737... can be expressed as which rational fraction in lowest terms? (1)

A. 37/100
B. 37/99
C. 37/90
D. 1/3

50. According to the properties of integration, which of the following is equivalent to $\int (3f(x) - g(x))dx$? (1)

A. $3\int f(x)dx \cdot \int g(x)dx$
B. $\int 3f(x)dx - \int g(x)dx$
C. $3(\int f(x)dx - \int g(x)dx)$
D. $\int f(x)dx - 3\int g(x)dx$

51. Three vertices of a parallelogram ABCD are A(0,0), B(5,0), and C(7,4). If AD is parallel to BC, what are the coordinates of vertex D? (1)

A. (2,4)
B. (-2,4)
C. (12,4)
D. (2,-4)

52. If α and β are complementary angles ($\alpha + \beta = 90^\circ$), which of the following trigonometric relations is always true? (1)

A. $\sin(\alpha) = \sin(\beta)$
B. $\tan(\alpha) = \tan(\beta)$
C. $\sin(\alpha) = \cos(\beta)$
D. $\sec(\alpha) = \cos(\beta)$

53. In descriptive statistics, the third decile (D_3) corresponds to which percentile? (1)

A. 3rd percentile
B. 30th percentile
C. 33rd percentile
D. 70th percentile

54. Which one of the following statements defines a matrix? (1)

A. A matrix is a rectangular array of numbers.
B. A matrix is a vertical array of letters.
C. A matrix is a horizontal array of letters.
D. A matrix is a circular array of numbers.

55. Which one of the following is the decomposition of the rational expression $3x^2 + 5x - 1/(x+2)(x+1)^2$ as a sum of partial fractions? (1)

A. $\frac{2}{x+2} + \frac{3}{x+1} + \frac{1}{(x+1)^2}$
B. $\frac{3}{x+2} - \frac{3}{(x+1)^2}$
C. $\frac{1}{x+2} + \frac{2}{x+1} - \frac{3}{(x+1)^2}$
D. $\frac{5}{x+2} + \frac{4}{(x+1)^2}$

56. A farmer having a total capital of Birr 400,000 bought oxen and sheep. An ox costs Birr 60,000 and a sheep Birr 5,000. He sold each ox at Birr 65,000 and each sheep at Birr 6,000. Which one of the following is a representation of the problem in order to maximize his profit, assuming uniform prices where x is the number of oxen and y is the number of sheep? (1)

A. Z(x,y)=6000x+5000y subject to $x + y \leq 35, 12x + y \leq 80, x \geq 0, y \geq 0$
B. Z(x,y)=60000x+5000y subject to $x + y \leq 35, 12x + y \leq 80, x \geq 0, y \geq 0$
C. Z(x,y)=5000x+1000ysubject to $x + y \leq 35, 12x + y \leq 800, x \geq 0, y \geq 0$
D. Z(x,y)=5000x+1000ysubject to $x + y \leq 35, 12x + y \leq 80, x \geq 0, y \geq 0$

57. Which one of the following statements is true about the given numbers and points on the number line? (1)

A. There is a one-to-one correspondence between the set of natural numbers and points on the number line.

B. There is a one-to-one correspondence between the set of rational numbers and points on the number line.

C. There is a one-to-one correspondence between the set of irrational numbers and points on the number line.

D. There is a one-to-one correspondence between the set of real numbers and points on the number line.

58. A spherical ball has diameter 30cm. What is its surface area (in cm^2)? (1)

A. 3600π

B. 1000π

C. 900π

D. 600π

END OF THE EXAMINATION

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