

Mathematics, 2016 EC, natural science, entrance exam, round 1

Grade 12 · Mathematics · 2016 E.C.

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Time allowed: 120 minutes

Questions: 51

Total marks: 51

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1. Which one of the following is true about the Range and Interquartile Range of a given data? (1)
- A. Both are measures of the variability of each item in the data.
- B. ✓ Both are measures of variation of the data.
- C. Both are affected by extreme values in the data.
- D. Both are considering only the middle 50% of the data.

Answer: B

Both range and interquartile range are measures of dispersion (variation) of a dataset. Unlike the range, the interquartile range is not affected by extreme values because it only measures the spread of the middle 50% of the data.

2. Which one of the following numbers is the coefficient of x^6y^4 in the expansion of $(x + y)^{10}$? (1)
- A. 240
- B. 1260
- C. ✓ 210
- D. 4860

Answer: C

Using the Binomial Theorem, the coefficient of x^6y^4 in the expansion of $(x + y)^{10}$ is given by $\binom{10}{6} = \frac{10!}{6!4!} = 210$.

3. The altitude of a frustum of a regular square pyramid is 9 cm. What is the volume of the frustum if the side length of the upper base is 6 cm and the side length of the lower base is 10 cm? (1)
- A. 196 cm^3
- B. 324 cm^3
- C. ✓ 588 cm^3
- D. 108 cm^3

Answer: C

The volume of a frustum of a square pyramid is $V = \frac{1}{3}h(A_1 + A_2 + \sqrt{A_1A_2})$. Substituting $h = 9$, $A_1 = 6^2 = 36$, and $A_2 = 10^2 = 100$, we get $V = 3(36 + 100 + 60) = 588 \text{ cm}^3$.

4. Which one of the following intervals is the solution set of the inequality $|3 - \frac{1}{2}x| < 5$? (1)
- A. (-2,8)
- B. ✓ (-4,16)
- C. (-8,2)
- D. (-16,4)

Answer: B

Assuming the typo in the absolute value represents $|3 - \frac{1}{2}x| < 5$, we solve $-5 < 3 - \frac{1}{2}x < 5$ to get $-8 < -\frac{1}{2}x < 2$, which simplifies to $-4 < x < 16$, yielding the interval $(-4, 16)$.

5. A sector of a circle of diameter 8cm is formed by a central angle of 45° . What is the area of the sector? (1)
- A. $(2\pi + 8)\text{cm}^2$ B. ✓ $2\pi \text{ cm}^2$
C. πcm^2 D. $8\pi \text{ cm}^2$

Answer: B

The radius of the circle is $r = 4 \text{ cm}$. The area of the sector is given by $A = \frac{\theta}{360} \pi r^2 = \frac{45}{360} \pi (4^2) = 2\pi \text{ cm}^2$.

6. Which one of the following statements is the polynomial division theorem? (1)
- A. If f is a non-constant polynomial and c is a real number, then $x - c$ is a factor of $f(x)$ if and only if $f(c) = 0$.
B. ✓ **If $f(x)$ and $d(x)$ are polynomials such that $d(x) \neq 0$ and $\text{degree}(d(x)) \leq \text{degree}(f(x))$, then there exist unique polynomials $q(x)$ and $r(x)$ such that $f(x) = d(x)q(x) + r(x)$, where $r(x) = 0$ or $\text{degree}(r(x)) < \text{degree}(d(x))$.**
C. If f is a non-constant polynomial and c is a real number, then the remainder when $f(x)$ divided by $x - c$ is $f(c)$.
D. Let f is a non-constant polynomial with integer coefficients. If the rational number $\frac{c}{d}$ in its lowest terms is a root of f , then c is a factor of the constant term of f and d is a factor of the leading coefficient.

Answer: B

Option B is the statement of the polynomial division theorem (also known as the division algorithm for polynomials). Options A, C, and D are the Factor Theorem, Remainder Theorem, and Rational Root Theorem, respectively.

7. Let p and q be proposition with truth values true and false respectively. Which one of the following statements is NOT correct? (1)
- A. $p \vee q$ is true. B. ✓ $p \Leftrightarrow q$ is true.
C. $p \wedge q$ is false. D. $p \Rightarrow q$ is false.

Answer: B

Since p is true and q is false, the biconditional statement $p \Leftrightarrow q$ has a truth value of false, making option B incorrect.

8. Which one of the following is equal to the sum $\sum_{n=1}^5 2n^2$? (1)
- A. ✓ **$2+8+18+32+50$** B. $2+4+8+16+32$
C. $2+4+6+8+10$ D. $2+8+16+32+64$

Answer: A

Evaluating the terms of the sum $\sum_{n=1}^5 2n^2$ for $n = 1, 2, 3, 4, 5$ gives $2(1)^2 + 2(2)^2 + 2(3)^2 + 2(4)^2 + 2(5)^2 = 2 + 8 + 18 + 32 + 50$.

9. A company produces shirts of black and white colors from polyester and cotton. The company has 6000 units of polyester and 3000 units of cotton. To sell its store, A black shirt requires 5 units of polyester and 3 units of cotton, whereas a white shirt requires 3 units of polyester and 3 units of cotton. If the factory gets a profit of Birr 120 from each black shirt and Birr 100 from each white shirt, what is the maximum profit of the company? (1)
- A. Birr 200,000 B. ✓ **Birr 120,000**
C. Birr 144,000 D. Birr 164,000

Answer: B

The constraints are $5x + 3y \leq 6000$ and $3x + 3y \leq 3000 \Rightarrow x + y \leq 1000$. Since the line $x + y = 1000$ lies entirely within the first constraint in the first quadrant, the maximum profit of $P = 120x + 100y$ occurs at the corner point $(1000, 0)$, giving $120(1000) = 120,000$ Birr.

10. If the fifth and the tenth terms of a geometric sequence are 640 and 20 respectively, then which of the following numbers are the first term and the common ratio of the given geometric sequence respectively? (1)
- A. ✓ 10240 and $\frac{1}{2}$ B. 1024 and $\frac{1}{2}$
C. 10240 and 2 D. 1024 and 2

Answer: A

Since $a_5 = a_1 r^4 = 640$ and $a_{10} = a_1 r^9 = 20$, dividing them yields $r^5 = \frac{20}{640} = \frac{1}{32} \Rightarrow r = \frac{1}{2}$. Substituting r back gives $a_1 (\frac{1}{2})^4 = 640 \Rightarrow a_1 = 10240$.

11. Which one of the following conic section is defined by "the set of points in a plane such that the sum of the distances from two given points is constant"? (1)
- A. Circle B. Hyperbola
C. Parabola D. ✓ Ellipse

Answer: D

An ellipse is defined geometrically as the set of all points in a plane such that the sum of the distances from two fixed points (foci) is constant.

12. Let θ be an angle in standard position and $P(-3, 4)$ be a point on the terminal side of θ . Which one of the following is true about the corresponding trigonometric functions? (1)
- A. $\cos \theta = \frac{4}{5}$ B. $\sin \theta = -\frac{4}{5}$
C. $\sin \theta = \frac{3}{5}$ D. ✓ $\cos \theta = -\frac{3}{5}$

Answer: D

For the point $P(-3, 4)$, we have $x = -3$, $y = 4$, and $r = \sqrt{(-3)^2 + 4^2} = 5$. Thus, $\cos \theta = \frac{x}{r} = -\frac{3}{5}$.

13. Which one of the following is the position vector of the vector with initial point A (1, -1) and terminal point B (2, -3)? (1)
- A. ✓ $i - 2j$ B. $i - 4j$
C. $3i - 4j$ D. $3i + 4j$

Answer: A

The position vector of the vector from $A(1, -1)$ to $B(2, -3)$ is given by $\vec{AB} = (2 - 1)\mathbf{i} + (-3 - (-1))\mathbf{j} = \mathbf{i} - 2\mathbf{j}$.

14. Let A and B be two sets that contain 15 and 17 elements respectively. If $A \cap B$ contains 10 elements, what is the number of elements in $A \cup B$? (1)
- A. 32 B. 12
C. 42 D. ✓ 22

Answer: D

Using the principal of inclusion-exclusion, the number of elements in the union of sets A and B is $|A \cup B| = |A| + |B| - |A \cap B| = 15 + 17 - 10 = 22$.

15. Which one of the following is a simple random sampling? (1)
- A. Selecting a population into groups formed by dividing the population into groups.
 - B. First divide a city into ten groups and choose the secondary school principals from the randomly selected 3 groups.
 - C. ✓ **Selecting five students from grade 12 students of the same school randomly.**
 - D. First the population is divided into homogenous groups and a sample is selected from each homogenous group.

Answer: C

Simple random sampling involves selecting individuals from the population purely by chance where each individual has an equal probability of being chosen, as described in option C.

16. Which one of the following numbers is the determinant of the matrix $M = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 10 \end{pmatrix}$? (1)
- A. 3
 - B. 6
 - C. -6
 - D. ✓ **-3**

Answer: D

The determinant of M is calculated as $1(50 - 48) - 2(40 - 42) + 3(32 - 35) = 2 + 4 - 9 = -3$.

17. Which one of the following pairs of functions is an inverse of each other in their respective domains? (1)
- A. $f(x) = \frac{x+1}{x-1}$ and $g(x) = \frac{x-1}{x+1}$
 - B. $f(x) = x^5$ and $g(x) = \frac{1}{x^5}$
 - C. ✓ **$f(x) = x^3 - 1$ and $g(x) = \sqrt[3]{x+1}$**
 - D. $f(x) = \sqrt{x+3}$ and $g(x) = x^2 - 9$

Answer: C

To find the inverse of $f(x) = x^3 - 1$, set $y = x^3 - 1 \Rightarrow x = \sqrt[3]{y+1}$. Substituting x for y gives $g(x) = \sqrt[3]{x+1}$, which shows they are inverses.

18. Which one of the following ordered pairs of numbers gives the coordinates of the point that divides a line segment with end points A(1, 1) and B(-6, 8) in the ratio of 3:4? (1)
- A. ✓ **(-2, 4)**
 - B. (-2, -4)
 - C. (2, 4)
 - D. (2, -4)

Answer: A

Using the section formula with $A(1, 1)$, $B(-6, 8)$, and ratio 3 : 4, we get $x = \frac{3(-6)+4(1)}{3+4} = -2$ and $y = \frac{3(8)+4(1)}{3+4} = 4$.

19. Which one of the following is a primary data? (1)
- A. The data obtained from a document prepared by the MOE regarding the achievements of students in a National Examination.
 - B. The data obtained by reading a journal regarding the opinion of the society about holidays.
 - C. ✓ **The data obtained by measuring the heights of students in a certain school.**
 - D. The data obtained from a chart prepared by Ministry of Health regarding the spread of HIV/AIDS.

Answer: C

Primary data is data collected firsthand by the researcher directly from the source, such as physically measuring the heights of students in a school.

20. Which one of the following is the solution set of the equation $(\sqrt{16})^{2x-1} = ({}^3\sqrt{4096})^{3x-5}$? (1)
- A. $\{\frac{11}{4}\}$ B. $\{\frac{9}{2}\}$
C. $\{\frac{11}{2}\}$ D. $\checkmark \{\frac{9}{4}\}$

Answer: D

Rewrite both sides with base 2: $(\sqrt{16})^{2x-1} = 2^{4x-2}$ and $({}^3\sqrt{4096})^{3x-5} = 16^{3x-5} = 2^{12x-20}$. Equating exponents gives $4x - 2 = 12x - 20 \Rightarrow 8x = 18 \Rightarrow x = \frac{9}{4}$.

21. If the measure of each interior angle of a regular polygon is 135° , then which one of the following is the number of lines of symmetry of the polygon? (1)
- A. $\checkmark$ 8 B. 6
C. 9 D. 7

Answer: A

The number of sides n of a regular polygon with interior angle 135° is found by solving $\frac{(n-2)180}{n} = 135 \Rightarrow n = 8$. A regular octagon has exactly 8 lines of symmetry.

22. What is the perimeter of a regular hexagon of radius 6 cm? (1)
- A. 36.3 cm B. 18 cm
C. $\checkmark$ 36 cm D. 18.3 cm

Answer: C

A regular hexagon can be divided into six equilateral triangles, so its side length is equal to its circumradius (6 cm). Thus, the perimeter is $P = 6 \times 6 = 36$ cm.

23. Which one of the following is a quantitative data? (1)
- A. Checking the quality of a new product.
B. Determining the tastes of foods in a restaurant.
C. Identifying the social status of individuals.
D. $\checkmark$ **Measuring the heights of each students in the given class.**

Answer: D

Quantitative data represents measurable, numerical quantities. Measuring the heights of students yields numerical data, whereas quality, taste, and social status are qualitative (categorical) attributes.

24. Which one of the following is true about the integral of a function $f(x)$ with respect to a variable x ? (1)
- A. $\int f(x) dx$ is the set of all derivatives of f .
B. $\int f'(x) dx$ is the set of all derivatives of f .
C. $\checkmark$ $\int f(x) dx$ is the set of all anti-derivatives of f .
D. $\int f'(x) dx$ is the set of all anti-derivatives of f .

Answer: C

By definition, the indefinite integral $\int f(x) dx$ represents the family of all antiderivatives of the function $f(x)$ with respect to x .

25. Which one of the following is NOT a valid reason for saving? (1)
- A. For the time of retirement B. For vacation
C. To maximize interest D. ✓ **For betting in football**

Answer: D

Saving is a disciplined financial practice for future needs such as retirement, vacations, or earning interest. Betting on football is high-risk gambling, which is not a valid reason for saving.

26. What is the maximum value of $z = 2x + 3y$ subjected to the constraints (1)

$$\begin{cases} x + y \leq 6 \\ 2x - y \leq 6 \\ x \geq 0 \\ y \geq 0 \end{cases}$$

- A. 14 B. 22
C. 12 D. ✓ **18**

Answer: D

The vertices of the feasible region defined by the constraints are $(0, 0)$, $(3, 0)$, $(4, 2)$, and $(0, 6)$. Evaluating $z = 2x + 3y$ at these vertices gives the maximum value of $z = 2(0) + 3(6) = 18$ at the vertex $(0, 6)$.

27. Which one of the following is equal to the sum $\sum_{k=1}^7 729(3^{1-k})$? (1)
- A. 1092 B. 1079
C. ✓ **1093** D. 1088

Answer: C

This is a geometric series with first term $a = 729$ and common ratio $r = 1/3$. The sum of the first 7 terms is $S_7 = 729 \frac{1-(1/3)^7}{1-1/3} = 1093$.

28. Which one of the following is an equation of the parabola with vertex $V(0, 0)$ and focus $F(2, 0)$? (1)
- A. $y^2 = \frac{1}{8}x$ B. $x^2 = \frac{1}{8}y$
C. ✓ $y^2 = 8x$ D. $x^2 = 8y$

Answer: C

Since the vertex is $(0, 0)$ and the focus is $(2, 0)$, the parabola opens to the right along the x-axis with $p = 2$. Its equation is $y^2 = 4px = 4(2)x = 8x$.

29. Which one of the following is true about the function $f(x) = \tan x$? (1)
- A. ✓ **The range of f is the set of real numbers, $\mathbb{R}$.**
B. The graph of f intersects y-axis at $(\frac{\pi}{2}, 0)$.
C. The domain of f is $\mathbb{R} \setminus \left\{-\frac{\pi}{2}, \frac{\pi}{2}\right\}$.
D. f is a periodic function with period $\frac{\pi}{2}$.

Answer: A

The range of $f(x) = \tan x$ is indeed the set of all real numbers $\mathbb{R}$. Option D is incorrect because the period of $\tan x$ is π , not $\pi/2$.

30. Which one of the following is equal to the polynomial function $f(x) = x^2 + 4x + 4$? (1)

- A. $h(x) = (x^2 + 6x + 8) - (2x - 4)$ B. $l(x) = (x^2 + 10x + 3) + (-6x + 1)$
C. $g(x) = \frac{x^4 + 4x^2 + 4}{x^2 + 2}$ D. $k(x) = (x - 2)(x + 2)$

Answer: B

By simplifying the expression in option B, we get $l(x) = x^2 + 10x + 3 - 6x + 1 = x^2 + 4x + 4$, which is exactly equal to $f(x)$.

31. Let S , R and T be any three sets. Which one of the following is NOT true about the union of the sets? (1)

- A. $\checkmark S \cup T = T$ B. $S \cup S = S$
C. $S \cup R = R \cup S$ D. $(S \cup R) \cup T = T \cup (R \cup S)$

Answer: A

The statement $S \cup T = T$ is only true if S is a subset of T , so it is not a general property of set union for any sets S and T .

32. Let r_1 and r_2 be the roots of a quadratic equation $ax^2 + bx + c = 0$, such that $r_1 + r_2 = -2.5$ and $r_1 r_2 = 1.5$. Which one of the following can be the values of a , b and c respectively? (1)

- A. $\checkmark$ 2, 5, and 3 B. 2, 3, and 5
C. 1, 5, and 6 D. 1, 6, and 5

Answer: A

From the relations of roots, $r_1 + r_2 = -b/a = -2.5$ and $r_1 r_2 = c/a = 1.5$. If we let $a = 2$, we get $b = 5$ and $c = 3$ respectively.

33. The following data gives the scores of 10 students in a Mathematics examination: 6, 10, 8, 5, 9, 8, 5, 10, 10, 9. Which one of the following is the standard deviation of the given data? (1)

- A. $\sqrt{5.8}$ B. $\checkmark \sqrt{3.6}$
C. 5.8 D. 3.6

Answer: B

The mean of the data is $\mu = 8$. The population variance is $\sigma^2 = \frac{1}{10} \sum (x_i - \mu)^2 = 3.6$, which yields a standard deviation of $\sigma = \sqrt{3.6}$.

34. Which of the following pairs of lines with the given equations are parallel? (1)

- A. $\ell_1 : x - 2y + 1 = 0$ and $\ell_2 : x + 2y - 1 = 0$ B. $\ell_1 : 4x - y = 2$ and $\ell_2 : -x + 4y - 3 = 0$
C. $\ell_1 : 2x + 3y = 5$ and $\ell_2 : 3x + 2y = 4$ D. $\checkmark \ell_1 : x - y + 3 = 0$ and $\ell_2 : -x + y - 9 = 0$

Answer: D

Two lines are parallel if they have equal slopes. Calculating the slopes of the lines in option D shows both have a slope of 1 ($m_1 = m_2 = 1$), meaning they are parallel.

35. Let $z = -a + 2i$ and $w = 5 - bi$ be two complex numbers, where a and b are real numbers. If $z = w$, then which one of the following pairs of numbers are equal to a and b respectively? (1)

- A. -5 and 2 B. $\checkmark$ -5 and -2
C. 5 and 2 D. 5 and -2

Answer: B

For two complex numbers to be equal, their real parts must be equal ($-a = 5 \implies a = -5$) and their imaginary parts must be equal ($2 = -b \implies b = -2$).

36. The following table presents the number of traffic accidents in a certain city per year for five consecutive years (1)
 from 2019 to 2023. Year 2019 2020 2021 2022 2023 Number of Accidents 3500 2750 2850 3500 3750 What
 is the average number of accidents per year for the given five years?

- A. 3210 B. ✓ 3270
 C. 3200 D. 3250

Answer: B

The average is computed by dividing the total sum of accidents by the number of years: $\frac{3500+2750+2850+3500+3750}{5} = \frac{16350}{5} = 3270$.

37. Consider that a data set given below: 10, 8, 10, 2, 12, 6, 12, 18, 3, 7, 10, 8, 8 Which one of the following is the (1)
 coefficient of range of the data?

- A. ✓ 4/5 B. 20
 C. 16 D. 5/4

Answer: A

The maximum value is $L = 18$ and the minimum value is $S = 2$. The coefficient of range is given by $\frac{L-S}{L+S} = \frac{18-2}{18+2} = \frac{16}{20} = \frac{4}{5}$.

38. Let M be a matrix such that $M = \begin{pmatrix} 9 & 24 & 6 \\ -12 & 18 & 15 \\ 0 & 27 & 3 \end{pmatrix}$. Which one of the following matrices is equal to $\frac{2}{3}M$? (1)

- A. $\begin{pmatrix} 6 & 8 & 4 \\ -8 & 6 & 10 \\ 0 & 9 & 2 \end{pmatrix}$ B. ✓ $\begin{pmatrix} 6 & 16 & 4 \\ -8 & 12 & 10 \\ 0 & 18 & 2 \end{pmatrix}$
 C. $\begin{pmatrix} 3 & 8 & 2 \\ -4 & 6 & 5 \\ 0 & 9 & 1 \end{pmatrix}$ D. $\begin{pmatrix} 6 & 16 & 2 \\ -8 & 12 & 10 \\ 0 & 18 & 2 \end{pmatrix}$

Answer: B

Multiplying each element of M by $\frac{2}{3}$ gives the resulting matrix in option B, for instance $\frac{2}{3} \times 24 = 16$ and $\frac{2}{3} \times 18 = 12$.

39. Which one of the following is an onto function from $\mathbb{R}$ onto $\mathbb{R}$? (1)

- A. $f(x) = \sqrt{x^2 + 1}$ B. ✓ $f(x) = 5x^3 + 1$
 C. $f(x) = |x - 1|$ D. $f(x) = 2x - 3x^2$

Answer: B

The cubic function $f(x) = 5x^3 + 1$ has a range of $\mathbb{R}$ because it is continuous and goes from $-\infty$ to ∞ , making it an onto function from $\mathbb{R}$ to $\mathbb{R}$.

40. If the length of the sides of a triangle are 8cm, 6cm and 4 cm, then which one of the following is the area of the (1)
 triangle?

- A. 12 cm² B. $1.5\sqrt{15} \text{ cm}^2$
 C. 24 cm² D. ✓ $3\sqrt{15} \text{ cm}^2$

Answer: D

Using Heron's formula with semiperimeter $s = \frac{8+6+4}{2} = 9$, the area is $A = \sqrt{9(9-8)(9-6)(9-4)} = \sqrt{9 \times 1 \times 3 \times 5} = 3\sqrt{15} \text{ cm}^2$.

41. Which one of the following is equal to the expression

(1)

$$\frac{(125)^{\frac{2}{3}}(81)^{-\frac{3}{4}}}{(27)^{-\frac{2}{3}}(625)^{\frac{3}{4}}}$$

- A. $\frac{5}{3}$
C. $\frac{3}{5}$

- B. 15
D. $\checkmark \frac{1}{15}$

Answer: D

Simplifying each term gives $\frac{(5^3)^{2/3}(3^4)^{-3/4}}{(3^3)^{-2/3}(5^4)^{3/4}} = \frac{5^2 \times 3^{-3}}{3^{-2} \times 5^3} = \frac{1}{5 \times 3} = \frac{1}{15}$.

42. Which one of the following numbers is a common multiple of 324 and 1152?

(1)

- A. 7776
C. 5184

- B. $\checkmark$ 20736
D. 13824

Answer: B

The least common multiple (LCM) of 324 and 1152 is 10368. Among the choices, 20736 is a multiple of 10368 ($10368 \times 2 = 20736$), making it a common multiple.

43. Which one of the following is the solution of the equation $(243)^{2x-3} = \frac{(81)^{-3x+2}}{3}$ in the set of real numbers?

(1)

- A. $\checkmark$ 1
C. -1

- B. -2
D. 2

Answer: A

By expressing both sides of the equation with base 3, we get $3^{10x-15} = 3^{-12x+7}$. Equating the exponents yields $10x - 15 = -12x + 7$, which simplifies to $22x = 22$, giving the solution $x = 1$.

44. What is the total surface area of a regular square pyramid with slant height 8cm and base area 25 cm²?

(1)

- A. 90 cm²
C. $\checkmark$ 105 cm²

- B. 65 cm²
D. 80 cm²

Answer: C

Since the base is a square of area 25 cm², its side length is 5 cm and perimeter is 20 cm. The total surface area is the sum of the base area and the lateral area, calculated as $25 + \frac{1}{2}(20)(8) = 105$ cm².

45. The following table presents the scores of Grade 11 students of a certain school in a Mathematics Examination.

(1)

Score 31-40 41-50 51-60 61-70 71-80 81-90 91-100 Number of Students 10 9 15 12 10 4 2 What is the median of the data given in the above table?

- A. 55.5
C. 50.5

- B. 60.5
D. $\checkmark$ 58.5

Answer: D

With a total of $N = 62$ students, the median lies at the 31st position, which falls in the class interval 51–60. Applying the median formula, we get $\text{Median} = 50.5 + \left(\frac{31-19}{15}\right) \times 10 = 58.5$.

46. What is the area of the region bounded by the graph of $f(x) = x^3$ and the x-axis on the interval $[-4, 2]$? (1)
- A. ✓ 68 Square units B. 136 Square units
C. 60 Square units D. 120 Square units

Answer: A

The bounded area is found by integrating the absolute value of $f(x) = x^3$ over $[-4, 2]$. This gives $\int_{-4}^0 -x^3 dx + \int_0^2 x^3 dx = \left[-\frac{x^4}{4}\right]_{-4}^0 + \left[\frac{x^4}{4}\right]_0^2 = 64 + 4 = 68$ square units.

47. Let $f(x) = \frac{x+1}{x-1}$ and $g(x) = \sqrt{x+2}$ be two functions. Which one of the following is true about the combination values of f and g at $x = 2$? (1)
- A. $(f - g)(2) = -1$ B. $\left(\frac{f}{g}\right)(2) = \frac{2}{3}$
C. $(f + g)(2) = 3$ D. ✓ $(f \cdot g)(2) = 6$

Answer: D

Evaluating the functions at $x = 2$ gives $f(2) = \frac{2+1}{2-1} = 3$ and $g(2) = \sqrt{2+2} = 2$. Thus, the combination $(f \cdot g)(2) = 3 \cdot 2 = 6$ is correct, while the others are false.

48. Which one of the following defines an exponential function? (1)
- A. $f : (0, \infty) \rightarrow \mathbb{R}$ defined by $f(x) = x^b$, where $b > 0$ and $b \neq 1$. B. $f : \mathbb{R} \rightarrow (0, \infty)$ defined by $f(x) = x^b$, where $b > 0$ and $b \neq 1$.
C. $f : (0, \infty) \rightarrow \mathbb{R}$ defined by $f(x) = b^x$, where $b > 0$ and $b \neq 1$. D. $f : \mathbb{R} \rightarrow (0, \infty)$ defined by $f(x) = b^x$, where ✓ $b > 0$ and $b \neq 1$.

Answer: D

An exponential function is defined as a function $f : \mathbb{R} \rightarrow (0, \infty)$ of the form $f(x) = b^x$, where the base b is a positive constant other than 1 ($b > 0$ and $b \neq 1$).

49. In the following figure, O is the center of the circle and the line segments $\overline{AB}$ and $\overline{AC}$ are intersecting the circle at D and E respectively. If $m(\angle ACD) = 30^\circ$ and $m(\angle BEC) = 50^\circ$, then which one of the following is equal to $m(\angle BAC)$? (1)
- A. 30° B. 80°
C. ✓ 20° D. 70°

Answer: C

The inscribed angles $\angle BDC$ and $\angle BEC$ both subtend the same arc BC , so $m(\angle BDC) = 50^\circ$. This makes $m(\angle ADC) = 180^\circ - 50^\circ = 130^\circ$, and from triangle ADC , we find $m(\angle BAC) = 180^\circ - (130^\circ + 30^\circ) = 20^\circ$.

50. Let f be a differentiable function at a number 'a' for $a \in \text{Domain } f$. In the expression $\frac{f(a+h)-f(a)}{h}$ for $h \neq 0$, as h gets closer and closer to zero from both directions, the expression becomes closer to $f'(a)$, which is equal to (1)
- A. ✓ The gradient of the tangent line to the graph of f at a point $(a, f(a))$.
B. The gradient of the vertical line to the graph of f at a point $(a, f(a))$.
C. The gradient of the secant line to the graph of f at a point $(a, f(a))$.
D. The gradient of the normal line to the graph of f at a point $(a, f(a))$.

Answer: A

The limit of the difference quotient as h approaches zero is the definition of the derivative $f'(a)$, which geometrically represents the slope (gradient) of the tangent line to the curve at $(a, f(a))$.

51. If 180 individuals can complete a job in 15 days by working 10 hours a day, how many individuals are needed to complete the job in 10 days if they work 12 hours a day? (1)
- A. 220
B. 144
C. ✓ 225
D. 200

Answer: C

The total work required is $180 \times 15 \times 10 = 27,000$ man-hours. To complete this work in 10 days working 12 hours a day, the number of individuals needed is $27,000 / (10 \times 12) = 225$.

END OF THE MARKING KEY

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