

EDUCATIONAL ASSESSMENT AND EXAMINATIONS SERVICE
ETHIOPIAN SECONDARY SCHOOL LEAVING CERTIFICATE
EXAMINATION (ESSLCE)

MATHEMATICS FOR NATURAL SCIENCE

Hamle 2015 E.C/ July 2023 G.C

SUBJECT CODE: 02

BOOKLET CODE: 340

Number of Items: 65

Time Allowed: 3 hours

1. Given $A = \{x \in \mathbb{N} : x < 3\}$ and B is the set of all possible factors of 13.

Then, which one of the following is equal to $B \times A$?

- A. $\{(1, 1), (1, 2), (13, 1), (13, 2)\}$
 - B. $\{(1, 1), (2, 1), (1, 13), (2, 13)\}$
 - C. $\{(1, 2), (13, 1), (13, 2)\}$
 - D. $\{(1, 1), (13, 2)\}$
2. Which of the following statements is true about $f(x) = x^2 - 6x + 10$?
- A. The line $x = 1$ is the axis of symmetry of graph of f .
 - B. $f(x) \geq 2$ for all x in the domain of f .
 - C. The vertex of the graph of f is $(3, 1)$.
 - D. The graph of f opens downward.
3. What is the area of a regular hexagon inscribed in a circle of radius 6 cm?
- A. $54\sqrt{3} \text{ cm}^2$
 - B. $48\sqrt{3} \text{ cm}^2$
 - C. $36\sqrt{3} \text{ cm}^2$
 - D. 48 cm^2
4. Which of the following defines a prime number?
- A. It is a number whose only factor is 1.
 - B. It is a number that has more than two positive factors.
 - C. It is a number whose only factor is itself.
 - D. It is a number that has only two positive factor.
5. Which one of the following rational numbers is written in its standard form?
- A. $0.\bar{8} \times 10^2$
 - B. 10.1×10^{-2}
 - C. 5×10^5
 - D. 0.09×10^5
6. What is the value of x in the equation $\sqrt{125 \times 5^{2x-1}} = 25^{3x+1}$?
- A. $-\frac{5}{7}$
 - C. $\frac{5}{7}$

B. -5

D. 5

7. The solution set of the equation $3|2x - 4| = 6 - 2|1 - 5x|$ is

A. $\{-1, 1/2, 5/4\}$

C. $\{-1, 1/2\}$

B. $\{1/2, 5/4\}$

D. $\{ \}$

8. A regular pyramid has a hexagonal base whose side length is 12 cm. What is the lateral surface area of the pyramid in square centimeters if the length of each lateral edge is 10 cm?

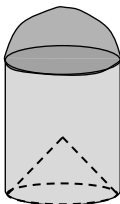
A. 72

C. 720

B. 360

D. 288

9. The object shown in the figure below is made of wood. Its top cover is solid hemisphere and its bottom is a cylinder of base diameter 6 cm and height of 12 cm. From the bottom of the cylindrical part a right circular cone of height 8 cm is cut off.



Thus, what is the volume of the solid in cubic centimeters?

A. 72π

C. 126π

B. 102π

D. 96π

10. The domain of the function $f(x) = 2x^{\frac{2}{3}}$ is:

A. $[0, \infty)$

C. $(0, 2)$

B. $\mathbb{R} \setminus \{0\}$

D. \mathbb{R}

11. The slope of a line that makes an angle of 135° with the positive x-axis is equal to:

A. -1

C. 3

B. 2

D. 1

12. If $\tan 31^\circ = 0.81$, then what is the value of $\tan 509^\circ$

A. -0.81

C. -0.91

B. 0.19

D. 0.81

13. If $\sin \theta = -\frac{3}{5}$ and θ is 4th quadrant angle, then what is the value of $\sec \theta$?

A. $\frac{5}{4}$

C. $-\frac{5}{4}$

B. $-\frac{5}{3}$

D. $\frac{5}{3}$

14. Suppose ABCD is a parallelogram with P a mid-point of \overline{AB} and Q a mid-point of \overline{CD} . Then which of the following is **NOT** necessarily true?

A. $\overline{AQ} \equiv \overline{PC}$

C. APCQ is a rhombus

B. $\triangle ADQ \equiv \triangle CBP$

D. APCD is a trapezium

15. The solution set of the equation $5\log_9 x - 2\log_9(x^2) - \log_4 8 = -1$ is

A. $\{3\}$

C. $\{3/2\}$

B. $\{4\}$

D. $\{9\}$

16. What is the value of x that satisfies the equation $5\left(\frac{125}{8}\right)^{\frac{1}{3}x^2 - \frac{2}{3}x} = 2$?

A. $-3/2$

C. 4

B. 1

D. $3/2$

17. The solution set of the inequality $(2x-3)(x+5) \leq 0$ is

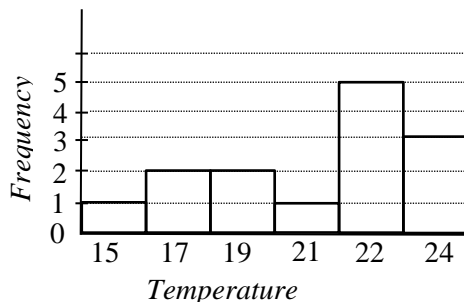
A. $(-\infty, -5] \cup [3/2, \infty)$

C. $[-5, 3/2]$

B. $(-5, 3/2)$

D. $(-\infty, -3/2] \cup [5, \infty)$

18. The histogram below shows the recorded temperature (in $^{\circ}\text{C}$) of certain town in Ethiopia for the first 15 days of March 2023.



Then which one of the following statements is true about the data represented by the histogram?

A. The mode of the data is 22°C .

B. The temperature was 24°C for two days.

C. For 45% of the days, the temperature was more than 19°C .

D. The highest frequency is 3.

19. A 20 m high building casts a shadow of 4 m, at the same time a 35 m tree casts a shadow of x m. What is the value of x ?
- A. 11 m
B. 8 m
C. 15 m
D. 7 m
20. A car started moving 9 km to the East then moved 4 km to the North and then 12 km towards West to reach its destination. How far the care travelled from its starting point?
- A. 12 km
B. 25 km
C. 5 km
D. 4 km
21. When the polynomial $p(x) = 3x^6 + 5x^4 - 7x^3 + 2kx^2 + 3$ is divided by $x+1$, the remainder is 4. What is the value of k ?
- A. -7
B. -5
C. 6
D. 3
22. The equation of a parabola with vertex $V(2, -1)$ and focus $F(-1, -1)$ is
- A. $(y + 1)^2 = -12(x-2)$
B. $(x + 1)^2 = -12(y+2)$
C. $(x - 2)^2 = -12(y+2)$
D. $(y + 1)^2 = 12(x-2)$
23. What is the equation of the hyperbola with foci $F_1 = (-2, 1)$, $F_2 = (8, 1)$ and the length of the conjugate axis is 8 units?
- A. $\frac{(x-3)^2}{16} - \frac{(y-1)^2}{25} = 1$
B. $\frac{(y+1)^2}{16} - \frac{(x-3)^2}{9} = 1$
C. $\frac{(x-3)^2}{25} - \frac{(y-1)^2}{15} = 1$
D. $\frac{(x-5)^2}{9} - \frac{(y-1)^2}{16} = 1$
24. If the truth value of p is T, then which of the following compound propositions has a truth value T for any proposition q ?
- A. $(\neg p \wedge q) \Rightarrow q$
B. $\neg p \Leftrightarrow (p \vee \neg q)$
C. $(p \Rightarrow q) \wedge \neg p$
D. $(p \wedge \neg p) \wedge q$
25. Which of the following functions is one to one?
- A. $f: (0, \infty) \rightarrow \mathbb{R}, f(x) = |x| - 1$
B. $f = \{(1, 5), (2, 3), (5, 4), (6, 5)\}$
C. $f = \{(x, y): y \text{ is the mother of } x\}$
D. $f: \mathbb{R} \rightarrow \mathbb{R}, f(x) = x^2 - 1$
26. If $\frac{x^2+14}{(x+2)(x-1)^2} = \frac{A}{x+2} + \frac{B}{x-1} + \frac{C}{(x-1)^2}$, then what are the values of A, B and C respectively?
- A. 3, -2, 6
C. 2, -1, 5

B. 1, -1, 3

D. 2, -2, -5

27. Which of the following is true about the intercept and symmetry of the graph of $f(x) = \frac{x^3 - 3x}{x^2 - 6}$?

A. Its y-intercept is 3.

B. The graph is symmetrical with respect to the y-axis.

C. The graph is symmetrical with respect to the origin.

D. Its x-intercepts are $\pm\sqrt{6}$.

28. Consider the lines $\ell_1: y = 2x + 3$ and $\ell_2: y = 1 - 3x$. Then the angle between ℓ_1 and ℓ_2 is

A. $3\pi/2$

C. $\pi/6$

B. $\pi/4$

D. $\pi/2$

29. Let $\mathbf{u} = (-1, 6)$ and $\mathbf{v} = (2, 4)$ be position vectors. Then the value of $4\mathbf{u} - 3\mathbf{v}$ is

A. $(-10, 11)$

C. $(-15, 18)$

B. $(-10, 12)$

D. $(-4, 24)$

30. Which of the following is true about the graph of $y = 3\sin(4x)$?

A. The graph lies below x-axis on $(\pi/4, \pi/2)$.

B. The graph completes one cycle on the interval $[0, \pi]$.

C. The graph rises up on $[0, \pi/4]$.

D. The graph completes one cycle on the interval $[0, \pi/4]$.

31. If a translation T takes a point $(-1, 1)$ to point $(3, 2)$, then the image of the circle $x^2 + y^2 - 2x + 4y + 1 = 0$ under T is

A. $(x - 2)^2 + (y + 3)^2 = 4$

C. $(x + 3)^2 + (y + 3)^2 = 4$

B. $(x - 3)^2 + (y - 3)^2 = 4$

D. $(x - 5)^2 + (y + 1)^2 = 4$

32. Let A be a square matrix of order n and let B be a matrix obtained by multiplying one row of A by 2 and C be a matrix found by adding one row of A to another row of A. If $\det(A) = 10$, what are $\det(B)$ and $\det(C)$?

A. 20 and 0

C. 10 and 10

B. 20 and 10

D. 10 and 20

33. The solution set of the system
$$\begin{cases} 2x - y + 3z = 1 \\ x + y + 3z = 5 \\ x - y + z = -1 \end{cases}$$
 is

A. $\{(k+1, 2k, k-1): k \in \mathbb{R}\}$

B. $\{(-4-2k, k, 2-k): k \in \mathbb{R}\}$

C. $\{(k, k+1, k-1): k \in \mathbb{R}\}$

D. $\{(2-2k, 3-k, k): k \in \mathbb{R}\}$

34. Let z_1 , z_2 , and z_3 be complex numbers. Then which one of the following is **NOT** necessarily true?

A. $z_1 - (z_2 - z_3) = (z_1 - z_2) - z_3$

B. $z_1 - (z_2 + z_3) = (z_1 - z_2) - z_3$

C. $(z_1 z_2) z_3 = z_1 (z_2 z_3)$

D. $(z_1 z_2) z_3 = (z_2 z_1) z_3$

35. Which one of the following complex numbers corresponds to the point $(-3, -1)$ in the Argand plane?

A. $2+i$

C. $-3-i$

B. $-3+i$

D. $-1-3i$

36. A group of students, 5 from grade 10, 8 from grade 11 and 2 from grade 12 to be formed. If a student is chosen randomly from this group, what is the probability that the chosen student is either from grade 10 or from grade 12?

A. $5/15$

C. $1/7$

B. $7/15$

D. $12/15$

37. If $\begin{pmatrix} 2 & -1 \\ a & 4 \end{pmatrix} \begin{pmatrix} 1 & b \\ -1 & 3 \end{pmatrix} = \begin{pmatrix} 3 & 1 \\ -1 & 18 \end{pmatrix}$, then what are the values of a and b respectively?

A. $2, -2$

C. $0, -1$

B. $3, 2$

D. $-1, 2$

38. Let $A = \begin{pmatrix} 1 & -1 \\ 0 & 2 \\ -3 & 6 \end{pmatrix}$. Then, A^T is

A. $\begin{pmatrix} 1 & -1 \\ -1 & 2 \\ -3 & 6 \end{pmatrix}$

C. $\begin{pmatrix} -1 & 1 \\ 2 & 0 \\ 6 & -3 \end{pmatrix}$

B. $\begin{pmatrix} 1 & 0 & -3 \\ -1 & 2 & 6 \end{pmatrix}$

D. $\begin{pmatrix} -1 & 2 & 6 \\ 1 & 0 & -3 \end{pmatrix}$

39. In a certain month of a year, the temperature of a city was recorded and presented as follows.

Temperature (in °C)	10-14	15-19	20-24	25-29	30-34
Frequency (Number of days)	2	9	11	5	3

Which one of the following is the cumulative frequency of the fourth class?

- A. 27 B. 22 C. 20 D. 18

40. On set of Natural numbers \mathbb{N} , which one of the following propositions has a truth value True?

- A. $(\forall_x)(\forall_y)(x \neq y \Rightarrow x > y)$ C. $(\forall_x)(\exists_y)(xy < x)$
 B. $(\exists_x)(\exists_y)(x - y = y - x)$ D. $(\forall_x)(\exists_y)(x - y = 5)$

41. The following is distribution of the weight of 40 students in a certain class.

Weight (in Kg)	40-48	49-57	58-66	67-75	76-84
Frequency, f	8	18	7	5	2

Then, for the data given above, what is the median weight in Kg?

- A. 55 C. 53.8
 B. 54.5 D. 53

42. A fair die is going to be rolled once, and let events be given as;

- E_1 = an even number occurs;
 E_2 = a prime number occurs;
 E_3 = a multiple of 3 occurs;
 E_4 = a multiple of 5 occurs.

Then, which one of the following pairs of events is mutually exclusive?

- A. E_3 and E_4 C. E_2 and E_4
 B. E_1 and E_3 D. E_1 and E_2

43. Which of the following is true about zero(s) of a function $f(x)$?

- A. If $f(a) = 0$, then $y = a$ is the y-intercept.
 B. If $f(a) = 0$, then $x - a$ is a factor of $f(x)$.
 C. If $f(a) = 0$, then a is not necessarily in the domain of f .
 D. If $f(a) = 0$, then $(x-a)^2$ is a factor of $f(x)$

44. What is the value of a number in the interval $(0, 1)$ that satisfies the Mean Value Theorem for the function $f(x) = 3x^2 - 5x + 1$?
- A. $3/5$ B. $1/2$ C. 1 D. $5/6$
45. Water is running into a canonical tank which is pointed down at a constant rate of $6\pi \text{ cm}^3/\text{sec}$. The cone has a height of 10 cm and base radius 5 cm. How fast is the water level rising when the water reaches 2 cm deep?
- A. 6 cm/sec C. $\frac{6}{\pi} \text{ cm/sec}$
B. $\frac{4}{\pi} \text{ cm/sec}$ D. 4 cm/sec
46. Let $f(x) = \frac{1}{\sqrt{x}}$ and $g(x) = 2 - \frac{1}{6}x^3$ be two functions. For what values of x do the graphs of f and g have tangent lines of the same slope?
- A. 1 C. $1/4$
B. $\sqrt{3}/2$ D. 4
47. Which of the following describes the mechanical meaning of derivative?
- A. Area under curve
B. Gradient of graph of functions
C. Slope of tangent line
D. Instantaneous rate of change
48. Let $f(x) = 5x^3 + 2x - \sin x + e^x$. What is the value of $f'(x)$?
- A. 1 C. 4
B. 2 D. -1
49. Let f and g be differentiable functions and $h(x) = g(f(3x+1))$. If $f'(1) = f(1) = 2$ and $g'(2) = 1$, then what is the value of $h'(0)$?
- A. 1 C. 4
B. 2 D. 6
50. Which of the following argument is valid?
- A. $p, p \Rightarrow q, r \vee \neg q \vdash p \wedge \neg r$ C. $p \Rightarrow q, \neg r \wedge q \vdash p \vee r$
B. $p \vee q, p \Rightarrow q \vdash \neg q$ D. $p \Rightarrow q, q, r \Rightarrow p \vdash r$
51. What is the coordinate of the mid-point of the line segment joining $(-1, -3, 3)$ and $(-1, 5, -7)$ in space?
- A. $(1, 4, 3)$ C. $(-1, 3, 5)$

B. $(-1, 3, 7/2)$

D. $(-1, 1, -2)$

52. Which of the following assertions is true applying the Principle of Mathematical Induction?

A. $n! \geq 2^n$ for $n \geq 0$

B. $1 + 2 + 2^2 + \cdots + 2^n = 2^{n+1} - 1$ for $n \geq 0$

C. $3 + 5 + 7 + \cdots + (2n + 1) = n^2$ for $n \geq 1$

D. $2 + 3 + 4 + \cdots + n = \frac{n(n+1)}{2} + 1$ for $n \geq 2$

53. Let F be the anti-derivative of f . Then which of the following is **NOT** true about F and f ?

A. $F' = f(x)$

C. $\int \frac{d}{dx} f(x) dx = f(x) + c$

B. $\frac{d}{dx} \int F(x) dx = F(x) + c$

D. $\int F(x) dx = f(x) + c$

54. Which of the following is equal to $\int 3 \cos 3x dx$?

A. $\sin 3x + c$

C. $-\sin x + c$

B. $\frac{1}{3} \sin 3x + c$

D. $\sin x + c$

55. What is the area of the region bounded by the graph of $f(x) = x^2 - 4$ and x -axis in square units?

A. 32

C. $32/3$

B. 16

D. $16/3$

56. Let f be a continuous function on $[0, 1]$ and let F be an anti-derivative of f with $F(1) = -11$ and $F(0) = 11$. Then $\int_0^1 f(x) dx$ is equal to

A. 11

C. 22

B. -22

D. 0

57. Which of the following set of equations define the xz -plane?

A. $\{(x, y, z) \mid x, y, z \in \mathbb{R} \text{ and } y = 0\}$

B. $\{(x, y, z) \mid x, y, z \in \mathbb{R} \text{ and } x = z = 0\}$

C. $\{(x, y, z) \mid x, y, z \in \mathbb{R} \text{ and } z = 0\}$

D. $\{(x, y, z) \mid x, y, z \in \mathbb{R} \text{ and } x = 0\}$

58. Let the sequence $\{a_n\}$ converges to 3 while $\{b_n\}$ converges to -1. Then the sequence $\{a_n - b_n\}$ converges to

A. 4

C. $1/3$

B. 1

D. 3

59. What is the value of $\lim_{x \rightarrow 1} \frac{x^2-1}{x^2+1}$?

- A. 1
B. 3
C. 0
D. 2

60. Which of the following is the value of α so that the function given by

$$f(x) = \begin{cases} \alpha x + 1, & x \geq 1 \\ x^2 - 4, & x < 1 \end{cases} \text{ is continuous at } 1?$$

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

61. Which of the following functions has a graph that completes one full cycle on $[-\frac{\pi}{4}, \frac{11\pi}{4}]$?

- A. $f(x) = 3\sin(\frac{4}{3}x + \frac{\pi}{2})$
B. $f(x) = 3\sin(3x + \frac{\pi}{6})$
C. $f(x) = 2\sin(2x + \frac{\pi}{6})$
D. $f(x) = 2\sin(\frac{2}{3}x + \frac{\pi}{6})$

62. Let $f(x) = -\frac{1}{3}\cos(\frac{3}{2}x - \frac{\pi}{3})$. Then what is the period and Phase shift of the graph of f respectively?

- A. $\frac{2\pi}{3}$ and $\frac{2\pi}{9}$
B. $\frac{4\pi}{3}$ and $\frac{2\pi}{9}$
C. $\frac{\pi}{9}$ and $\frac{4\pi}{9}$
D. $\frac{3\pi}{2}$ and $\frac{4\pi}{9}$

63. What is the fifth term of the sequence $\{2^n + 4n - 5\}_{n=0}^\infty$?

- A. 17
B. 27
C. 15
D. 47

64. Which one of the following numbers is the upper bound of the sequence

$$\left\{\frac{2n+1}{n+1}\right\}_{n=1}^\infty?$$

- A. 0
B. $3/2$
C. 4
D. 1

65. If the 6th and the 11th terms of an arithmetic sequence are 35 and 75 respectively, then what is the sum of the first 31 terms of the sequence?

- A. 724
B. 2145
C. 846
D. 2635