EDUCATIONAL ASSESSMENT AND EXAMINATIONS SERVICE (EAES)
ETHIOPIAN SECONDARY SCHOOL LEAVING CERTIFICATE EXAMINATION (ESSLCE)
MATHEMATICS FOR NATURAL SCIENCE
Hamlie 2015 E.C/July 2023 G.C

SUBJECT CODE: 02 **BOOKLET CODE: 339**

Number of Items: 65 **Time Allowed: 3 hours**

1. 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. 1

   B. $-\frac{3}{2}$

   C. $\frac{3}{2}$

   D. 4

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

   A. $\left(-5, \frac{3}{2}\right)$

   B. $(-\infty,-5]\cup\left[\frac{3}{2},\infty\right)$

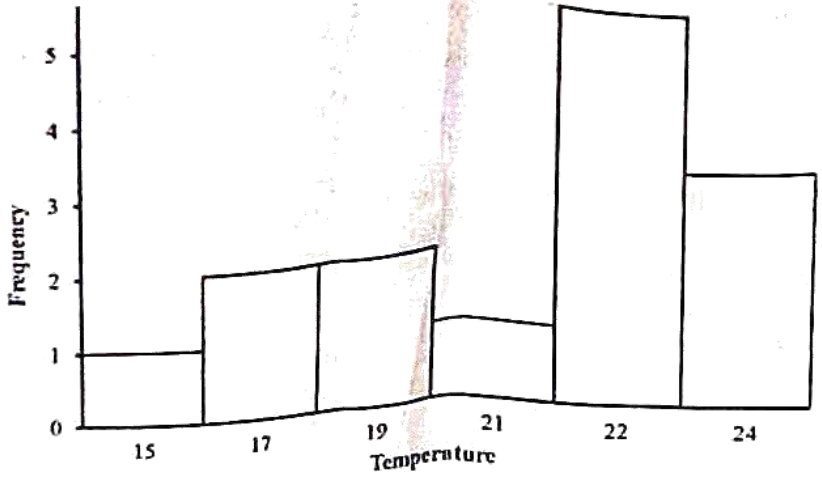
   C. $\left(-\infty,-\frac{3}{2}\right]\cup[5,\infty)$

   D. $\left[-5, \frac{3}{2}\right]$

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3. The histogram below shows the recorded temperature (in °C) of a certain town in Ethiopia for the first 15 days of March 2023.



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

A. The temperature was 24°C for two days.
B. The mode of the data is 22°C.
C. The highest frequency is 3.
D. For 45% of the days, the temperature was more than 19°C.

4. A 20m high building casts a shadow of 4m, at the same time a 35m tree casts a shadow of x m. What is the value of x?

A. 8m
B. 11m
C. 7m
D. 15m

5. A car started moving 9km to the East then moved 4 km to the North and then 12km towards West to reach its destination. How far the car it travelled from its starting point?

A. 25km
B. 12km
C. 4km
D. 5km

6. 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. -5
B. -7
C. 3
D. 6

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

A. $\{4\}$
B. $\{3\}$
C. $\{9\}$
D. $\left\{\frac{3}{2}\right\}$

8. Which of the following statement is true about $f(x) = x^2 - 6x + 10$?

A. $f(x) \geq 2$ for all x in the domain of f.
B. The line $x = 1$ is the axis of symmetry of the graph of f.
C. The graph of f opens downward.
D. The vertex of the graph of f is (3, 1).

9. What is the area of a regular hexagon inscribed in a circle of radius 6cm?

A. $48\sqrt{3}\ cm^2$
B. $54\sqrt{3}\ cm^2$
C. $48cm^2$
D. $36\sqrt{3}\ cm^2$

10. Which of the following defines a prime number?

A. It is a number that has more than two positive factors.
B. It is a number whose only factor is 1.
C. It is a number that has only two positive factors.
D. It is a number whose only factor is itself.

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11. Which of the following rational numbers is written in its standard form?

A. 10.1×10^{-2}

B. $0.\bar{8} \times 10^{2}$

C. 0.09×10^{5}

D. 5×10^{5}

12. What is the value of x in the equation $\sqrt{125^{x}5^{2x-1}} = 25^{3x+1}$?

A. -5

B. $-\frac{5}{7}$

C. 5

D. $\frac{5}{7}$

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

A. $\left\{\frac{1}{2}, \frac{5}{4}\right\}$

B. $\left\{-1, \frac{1}{2}, \frac{5}{4}\right\}$

C. $\{\}$

D. $\left\{-1, \frac{1}{2}\right\}$

14. 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. $\{(1, 1), (2, 1), (1, 13), (2, 13)\}$

B. $\{(1, 1), (1, 2), (13, 1), (13, 2)\}$

C. $\{(1, 1), (13, 2)\}$

D. $\{(1, 2), (13, 1), (13, 2)\}$

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



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

A. 102π
B. 72π
C. 96π
D. 126π

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

A. $\mathbb{R}\backslash\{0\}$
B. $[0, \infty)$
C. $\mathbb{R}$
D. $(0, 2)$

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

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

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

A. 0.19
B. -0.81
C. 0.81
D. -0.91

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

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

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

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

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

20. If 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. $\Delta ADQ \equiv \Delta CBP$

B $\overline{AQ} \equiv \overline{PC}$

C. APCD is a trapezium.

D. APCQ is a rhombus.

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

A. 360

B. 72

C. 288

D. 720

22. 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. 3, 2

B. 2, −2

C. −1, 2

D. 0, −1

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

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

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

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

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

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

A. $(\exists x)(\exists y)(x-y=y-x)$

B. $(\forall x)(\forall y(x \neq y \Rightarrow x > y)$

C. $(\forall x)(\exists y)(x-y=5)$

D. $(\forall x)(\exists y)(xy < x)$

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

Temprature (*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 cummulative frequ. ncy of the fourth class?

A. 22

B. 27

C. 18

D. 20

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26. A fair die is going to be rolled once, and let;
E_1 be the event that an even number occurs;
E_2 be the event that a prime number occurs;
E_3 be the event that a multiple of 3 occurs;
E_4 be the event that a multiple of 5 occurs
Then which of the following pairs of events are mutually exclusive?

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

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

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

Then for data given above, what is the median weigh in kg?

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

28. A group of students, 5 from grade 10, 8 from grade 11 and 2 from grade 12 is 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 grade 12?

A. $\frac{7}{15}$
B. $\frac{5}{15}$
C. $\frac{12}{15}$
D. $\frac{1}{7}$

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29. 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. $\frac{(y+1)^2}{16}-\frac{(x-3)^2}{9}=1$

B. $\frac{(x-3)^2}{16}-\frac{(y-1)^2}{25}=1$

C. $\frac{(x-5)^2}{9}-\frac{(y-1)^2}{16}=1$

D. $\frac{(x-3)^2}{25}-\frac{(y-1)^2}{15}=1$

30. 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. $\neg p \Leftrightarrow (p \vee \neg q)$

B. $(\neg p \wedge q) \Rightarrow q$

C. $(p \wedge \neg p) \wedge q$

D. $(p \Rightarrow q) \wedge \neg p$

31. Which of the following functions is one to one?

A. $f = \{(1, 5), (2, 3), (5, 4), (6, 5)\}$

B. $f : (0, \infty) \to \mathbb{R}$, $f(x) = |x| - 1$

C. $f: \mathbb{R} \to \mathbb{R}$, $f(x) = x^2 - 1$

D. $f = \{(x, y)$: y is the mother of x$\}$

32. 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. 1, −1, 3

B. 3, −2, 6

C. 2, −2, −5

D. 2, −1, 5

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

A. The graph is symmetrical with respect to the y-axis.
B. Its y-intercept is 3.
C. Its x-intercepts are $\pm\sqrt{6}$.
D. The graph is symmetrical with respect to the origin.

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

A. $\frac{\pi}{4}$
C. $\frac{\pi}{2}$
B. $\frac{3\pi}{2}$
D. $\frac{\pi}{6}$

35. The equation of the parabola with vertex V(2, −1) and focus F(−1, −1) is

A. $(x+1)^2=-12(y+1)$
C. $(y+1)^2=12(x-2)$
B. $(y+1)^2=-12(x-2)$
D. $(x-2)^2=-12(y+1)$

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

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

37. Which one of the following is the value of α so that the function given by $f(x) = \begin{cases} \alpha x + 1 & \text{for } x \geq 1 \\ x^2 - 4 & \text{for } x < 1 \end{cases}$ is continuous at 1?

A. 4
B. −4
C. −1
D. 1

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

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

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

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

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

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

41. Which one of the following numbers is the upper bounds of the sequence $\left\{\frac{2n+1}{n+1}\right\}_{n=1}^{\infty}$

A. $\frac{3}{2}$ C. 1

B. 0 D. 4

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

A 1 C. 3

B. 4 D. $\frac{1}{3}$

43. Which of the following argument is valid?

A. $p \vee q, p \Rightarrow q \vdash \neg q$ C. $p \Rightarrow q, q, r \Rightarrow p \vdash r$

B. $p, p \Rightarrow q, r \vee \neg q \vdash p \wedge \neg r$ D. $p \Rightarrow q, \neg r \wedge q \vdash p \vee r$

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

A. $1+2+2^2+\ldots+2^n = 2^{n+1}-1$ for $n \geq 0$

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

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

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

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

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

B. $\sin 3x + c$

C. $\sin x + c$

D. $-\sin x + c$

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

A. 16

B. 32

C. $\frac{16}{3}$

D. $\frac{32}{3}$

47. 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. −22

B. 11

C. 0

D. 22

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

A. {(x, y, z) | x, y, z ∈ ℝ and x=z=0}

B. {(x, y, z) | x, y, z ∈ ℝ and y=0}

C. {(x, y, z) | x, y, z ∈ ℝ and x=0}

D. {(x, y, z) | x, y, z ∈ ℝ and z=0}

49. What is the coordinates of the midpoint of the line segment joining (−1, -3, 3) and (1, 5, −7) in space?

A. $(-1, 3, \frac{9}{2})$

B. (1, 4, 3)

C. (−1, 1, -2)

D. (−1, 3, 5)

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

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

B. The graph lies below the x-axis on $(\frac{\pi}{4}, \frac{\pi}{2})$.

C. The graph completes one cycle on the interval $[0, \frac{\pi}{4}]$.

D. The graph rises up on $[0, \frac{\pi}{4}]$.

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

A. $f(x) = 3\sin(3x + \frac{\pi}{6})$

B. $f(x) = 3\sin(\frac{4}{3}x + \frac{\pi}{2})$

C. $f(x) = 2\sin(\frac{2}{3}x + \frac{\pi}{6})$

D. $f(x) = 2\sin(2x + \frac{\pi}{6})$

52. 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 $\det(C)$ respectively?

A. 20 and 10

B. 20 and 0

C. 10 and 20

D. 10 and 10

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

A. $\{(-4-2k, k, 2-k): k \in \mathbb{R}\}$
B. $\{(k+1, 2k, k-1): k \in \mathbb{R}\}$
C. $\{(2-2k, 3-k, k): k \in \mathbb{R}\}$
D. $\{(k, k+1, k-1): k \in \mathbb{R}\}$

54 Let z_1, z_2, and z_3 be complex numbers. Then which 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. $(z_1 z_2) z_3=(z_2 z_1) z_3$
D. $(z_1 z_2) z_3=z_1(z_2 z_3)$

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

A. $-3+i$
B. $3+i$
C. $-1-3i$
D. $-3-i$

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

A. $(x-3)^2+(y-3)^2=4$
B. $(x-2)^2+(y+3)^2=4$
C. $(x-5)^2+(y+1)^2=4$
D. $(x+3)^2+(y+3)^2=4$

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

A. $(-10, 12)$
B. $(-10, 11)$
C. $(-4, 24)$
D. $(-15, 18)$

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58. Water is running into a canonical tank which is pointed down at a constant rate of 6π cm^3/sec. The cone has height of 10 cm and a base radius 5cm, then how fast is the water level rising when the water reaches 2 cm deep?

A. $\frac{4}{\pi}$ cm/sec

B. 6cm/sec

C. 4cm/sec

D. $\frac{6}{\pi}$ cm/sec

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

A. $\frac{d}{dx}\int F(x)dx = F(x)$

B. $F'(x) = f(x)$

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

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

60. 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. $\frac{\sqrt{3}}{2}$

B. 1

C. 4

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

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

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

C. $\frac{5}{6}$

D. 1

62. Let $f(x) = 5x^3 + 2x - \sin x + e^x$. What is the value of $f'(0)$?

A. 2
B. 1
C. −1
D. 4

63. 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. 2
B. 1
C. 6
D. 4

64. Which of the following describes the mechanical meaning of derivative?

A. Gradient of graphs of functions
B. Area under the curve
C. Instantaneous rate of change
D. Slope of tangent line

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

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