

**ADDIS ABABA CITY ADMINISTRATION EDUCATION BUREAU
ADDIS ABEBA
GRADE 12 MATHEMATICS MODEL EXAMINATIONS
TAHASAS 2015/JANUARY 2023**

NUMBER OF QUESTIONS: 65

TIME ALLOWED: - 3 HOURS

GENERAL DIRECTIONS

THIS BOOKLET CONTAINS **EXAMINATION FOR NATURAL SCIENCE STUDENTS ONLY**. IN THIS EXAMINATION, THERE ARE A TOTAL OF **65 MULTIPLE CHOICE QUESTIONS**. CAREFULLY SELECT THE BEST ANSWER AND **BLACKEN** ONLY THE LETTER OF YOUR CHOICE ON THE SEPARATE ANSWER SHEET PROVIDED. FOLLOW THE INSTRUCTIONS ON THE ANSWER SHEET AND THE EXAMINATION PAPER CAREFULLY. USE ONLY **PENCIL** TO MARK YOUR ANSWERS. YOUR ANSWER MARK SHOULD BE **HEAVY AND DARK**, COVERING THE ANSWER SPACE COMPLETELY. PLEASE ERASE ALL UNNECESSARY MARKS COMPLETELY FROM YOUR ANSWER SHEET.

YOU ARE ALLOWED TO WORK ON THE EXAM FOR **3 HOURS**. WHEN TIME IS CALLED, YOU MUST IMMEDIATELY STOP WORKING, PUT YOUR PENCIL DOWN, AND WAIT FOR FURTHER INSTRUCTIONS.

ANY FORM OF CHEATING OR AN ATTEMPT TO CHEAT IN THE EXAMINATION WILL RESULT IN AN AUTOMATIC DISMISSAL FROM THE EXAMINATION HALL AND CANCELLATION OF YOUR SCORE (S).

PLEASE MAKE SURE THAT YOU HAVE WRITTEN ALL THE REQUIRED INFORMATION ON THE ANSWER SHEET BEFORE YOU START TO WORK ON THE EXAMINATION.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO.

I. Choose the correct answer form the given alternatives and write your answer in the space provided.

1. If $f(x) = \frac{\sqrt{x+2}}{x+2}$ and $g(x) = \frac{1}{x} - 2$ then what is the value of $f(g(x))$ for all $x > 0$?

A. $\sqrt{x} - 2$

C. $\sqrt{x}$

B. $\sqrt{x} + 2$

D. $\frac{\sqrt{x}}{x}$

2. Which of the following is **Not** the property of $f(x) = x^{2/5}$

A. $f(xy) = f(x) \cdot f(y)$

C. decreasing on $(-\infty, 0]$

B. the range is real number
y-axis

D. the graph is symmetric with respect to the

3. Which one of the following is **not true** about signum, absolute value and greatest integer function?

A. $\text{Sgn}(x) = \pm|x|$ for all $x \in \mathbb{R}$

C. $\text{Sgn}(x) \geq |x|$ for all $x \leq 0$

B. $|x| = x \text{sgn}(x)$ for all $x \in \mathbb{R}$

D. $\text{Sgn}(x) \leq |x|$ for all $x \geq 1$

4. Which one of the following function is one to one correspondence function from

$A = [0,1]$ to $B = [2,3]$?

A. $f(x) = x$

C. $f(x) = 2x + 2$

B. $\frac{1}{3}x^3 + 1$

D. $f(x) = x^2 + 2$

5. What is the partial fraction decomposition of $\frac{5x^2-8x+5}{(x-2)(x^2-x+1)}$?

A. $\frac{3}{(x-2)} + \frac{2x-1}{(x^2-x+1)}$

C. $\frac{2}{(x+2)} + \frac{3x+1}{(x^2-x+1)}$

B. $\frac{3}{(x+2)} + \frac{2x+1}{(x^2-x+1)}$

D. $\frac{3}{(x-2)} + \frac{2x-1}{(x^2-x+1)}$

6. Suppose $f(x) = \frac{Q(x)}{x(x^2-1)}$ where $Q(x)$ is a quadratic function. Which one of the following is necessarily true about the graph f ?
- A. $x = 0, x = 1$ and $x = -1$ are vertical asymptote of the graph f .
 - B. The graph of f does not intersect with its horizontal asymptote.
 - C. The vertical asymptote of the graph of f is only $x = -1$, if $Q(x) = x^2 - x$
 - D. The vertical asymptote of the graph of f is only $x = 1$, if $Q(x) = 2x^2$
7. What is the solution set of $\frac{2}{x} - \frac{x-2}{x^2-2x} = 1 - \frac{2x-2}{3x-2}$?
- A. $\{-2, 1\}$
 - B. $\{1, 2\}$
 - C. $\{-1\}$
 - D. $\{1\}$
8. Given line $4y = 3x + 24$ and another line ℓ parallel to this line at a distance of 4 units from it. A possible equation for ℓ is
- A. $y = \frac{3}{4}x$
 - B. $y = \frac{3}{4}x + 1$
 - C. $y = \frac{3}{4}x + 2$
 - D. $y = \frac{3}{4}x + 10$
9. Suppose an eccentricity of the hyperbola $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ is reciprocal to that of the eccentricity of the ellipse $x^2 + 4y^2 = 4$ if the hyperbola passes through a focus of the ellipse, what is the equation of the hyperbola?
- A. $x^2 - 2y^2 = 2$
 - B. $x^2 - 3y^2 = 3$
 - C. $\frac{x^2}{3} - \frac{y^2}{2} = 1$
 - D. $\frac{x^2}{2} - \frac{y^2}{3} = 1$
10. Which one of the following is the equation of a circle whose center is on x- axis and radius is 3?
- A. $x^2 + y^2 + 6y = 0$
 - B. $x^2 + (y - 2)^2 = 3$
 - C. $(x - 2)^2 + y^2 = 0$
 - D. $x^2 - 2x + y^2 = 8$

11. Which of the following is **NOT** true about a parabola $y^2 + 2x - 4y + 6 = 0$
- A. It opens to the left
B. Its vertex is $(-1, 2)$
C. Its focus is $\left(\frac{3}{2}, 2\right)$
D. Its directrix is the line $x = -\frac{1}{2}$
12. The distance from the point $p(3,4)$ to the line L with equation: $3x + 4y = 5$ is
- A. 6 units
B. 7units
C. 4 units
D. 5units
13. What is the locus all points in the plane in which the difference of the distances from two fixed points is constant?
- A. Ellipse
B. Circle
C. Hyperbola
D. Parabola
14. Let p and q be propositions. Which of the following compound statement is a tautology?
- A. $(p \wedge q) \Leftrightarrow p$
B. $(p \Rightarrow q) \Leftrightarrow (\neg p \vee q)$
C. $(p \vee q) \Leftrightarrow p$
D. $(p \Rightarrow q) \Leftrightarrow q$
15. If $p \Rightarrow q$ is **false**, then which of the following compound statement is **true**?
- A. $p \wedge q$
B. $p \Leftrightarrow q$
C. $p \vee q$
D. $(p \vee q) \Rightarrow q$
16. Which of the following arguments is **invalid** logical argument?
- A. $p \wedge \neg q, p, r \Rightarrow q \vdash \neg r$
B. $p \Rightarrow q, \neg r \Rightarrow \neg q, \vdash \neg p \vee r$
C. $p \vee r, p \wedge q \vdash p \Rightarrow r$
D. $\neg p \vee q, \neg q \vdash \neg q$
17. Which of the following is the inverse of; “If wages increase, then inflation decreases”?
- A. If inflation decreases, then wage increase.
B. If wages decreases, then inflation increases.
C. If wages decreases, then inflation decreases.
D. If wages increase, then inflation increases.

18. What is the odd in favor of getting exactly two heads when three coins are tossed?

A. $\frac{3}{8}$
B. $\frac{5}{3}$

C. $\frac{5}{8}$
D. $\frac{3}{5}$

19. If a family has 4 children, then what is the probability that they have at least 2 girls?

A. $\frac{1}{5}$
B. $\frac{3}{5}$

C. 1
D. $\frac{1}{2}$

20. From a box containing 2 white and 6 green balls, a ball is drawn at random. The probability of not a green ball is :

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

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

21. The expenditure of 50 families is given below.

expenditure	0 - 9	10 - 19	20 - 29	30 - 39	40 - 49
Number of families	6	10	F_1	4	F_2

If the mode of the data is 23.5 what are the value of F_1 and F_2 ?

A. $F_1 = 17$ and $F_2 = 13$
B. $F_1 = 8$ and $F_2 = 22$

B. $F_1 = 24$ and $F_2 = 6$
D. $F_1 = 22$ and $F_2 = 8$

22. How many three digit number can be formed from the digits 2,5,6,7 and 9 less than 600, if digits is used once only.

A. 24

C. 125

B. 40

D. 50

23. In a random arrangement of the word “SOCIETY “what is the total number of words in which all the three vowels come together?

A. 120

C. 420

B. 720

D. 840

24. Which of the following is the constant term of $\left(x^2 - \frac{1}{2x^6}\right)^8$

A. 28

C. -7

B. 7

D. -28

Instruction: For questions (25 – 26) the distribution of marks obtained in mathematics exam (out of 40) is given below

Mark	10 - 14	15 - 19	20 - 29	30 - 39
Number of students	15	23	46	16

25. From the above data, if student in the top 8% are to be awarded a certificate. What is the minimum mark for a certificate:

A. 34.5

C. 32

B. 30.5

D. 33

26. A group 100 items have a mean of 62. If the mean of 40 of these items is 55, what is the mean of the remaining items?

A. 66.67

C. 65.00

B. 69.00

D. 64.55

27. Which of the following is **not true** about non- singular square matrices A and B having the same order?

A. $\det(A) = \frac{1}{\det(A^{-1})}$
 $B^{-1}A^{-1}$

C. $(AB)^{-1} =$

B. $\det(AB) = \det(A) \cdot \det(B)$
 $A^T B^T$

D. $(AB)^T =$

28. For what values of a and b does the system of equation

$$\begin{cases} 3x - 2y + z = b \\ 5x - 8y + 9z = 3 \\ 2x + y + az = -1 \end{cases} \text{ has no solution?}$$

A. $a = -3, b \in R$

B. $a = -3, b = -1/3$

C. $a = -3, b \neq 1/3$

D. $a = 3, b \in R$

29. If $\begin{pmatrix} 1-x & 0 \\ 1 & 2y \end{pmatrix} + \begin{pmatrix} y-1 & 4 \\ 2 & 1-3x \end{pmatrix} = \begin{pmatrix} 0 & 4 \\ 3 & 5 \end{pmatrix}$, then the values of x and y respectively are:

A. -2 and 2

B. 1 and -1

C. 0 and 0

D. -4 and -4

30. Suppose $A = \begin{pmatrix} 4 & 0 \\ 1 & 1 \end{pmatrix}$ and $B = \begin{pmatrix} 4 & 4 \\ 12 & -8 \end{pmatrix}$. If X is a 2×2 matrix such that $X + \frac{1}{2}B^T = AB$, then X is equal to:

A. $\begin{pmatrix} 14 & 5 \\ 5 & -8 \end{pmatrix}$

B. $\begin{pmatrix} 10 & -6 \\ 10 & 0 \end{pmatrix}$

C. $\begin{pmatrix} 10 & -6 \\ 10 & -4 \end{pmatrix}$

D. $\begin{pmatrix} 14 & 10 \\ 14 & 0 \end{pmatrix}$

31. If A is a square matrix of order 3 and $\det(A) = 5$, then what is the value of $\det(A \cdot \text{adj}(A))$?

A. 125

B. 5

C. 25

D. 3

32. For any $n \times n$ square matrix A , which of the following is true?
- $\det(A) = -\det(A^T)$ where A^T is transpose of A
 - If k is scalar, then $\det(kA) = k^n \det(A)$
 - If B is a matrix obtained from A by interchanging of two rows of A , then $\det(A) = \det(B)$
 - If A is invertible, then $\det(A) = \det(A^{-1})$
33. For what value of x , $\left(\frac{1+i}{1-i}\right)^x = 1$,
- $x = 2n + 1$, Where $n \in \mathbb{N}$
 - $x = 4n$, Where $n \in \mathbb{N}$ where $n \in \mathbb{N}$
 - $x = 2n$, where
 - $x = 4n + 1$,
34. If the real part of $\frac{\bar{z}+2}{\bar{z}-1}$ is 4, then the locus of the point representing z in the complex plane is:-
- Circle
 - a straight line
 - a parabola
 - Hyperbola
35. If $z = \frac{(2-2\sqrt{3}i)}{(1+i)}$, then which one of the following is the polar representation of z ?
- $z = 2\sqrt{2}(\cos(-105^\circ) + i\sin(-105^\circ))$
 - $z = 4(\cos(-105^\circ) + i\sin(-105^\circ))$
 - $z = 2\sqrt{2}(\cos(15^\circ) + i\sin(15^\circ))$
 - $z = 4(\cos(75^\circ) + i\sin(75^\circ))$
36. If $z_1 = \frac{2-i}{1+i}$ and $z_2 = \frac{1+i}{1-i}$, then what is the value of $z_1 - 2z_2$?
- $1 - 7i$
 - $\frac{1+7i}{2}$
 - $\frac{1-7i}{2}$
 - $1 - 7i$

- mathematics for natural

49. If $f(x) = x^2 + 2 \ln x^2$, then $\lim_{h \rightarrow 0} \left(\frac{f(1+h) - f(1)}{h} \right)$ is equal to:

- A. 2 B. 6 C. 5 D. ∞

50. Let $f(x) = e^{3x-1}$ and $g(x) = \tan x$. If $F(x) = xf(x) + f(g(x))$, which of the following is equal to $F'(0)$?

- A. $3e^{-1}$ B. e^{-1} C. $\frac{1}{e} \left(1 + \frac{1}{e} \right)$ D. $\frac{1}{e} \left(1 + \frac{3}{e} \right)$

51. If $f(x) = \pi^3$, then $f'(2)$ is equal to: _____

- A. $3\pi^2$ B. 0 C. 12 D. 1

52. If $y = e^{2x} + x - 3 \cos x$, then what is $\frac{d^2y}{dx^2}$?

- A. $4e^{2x} + 3 \cos x$ C. $4e^{2x} - 3 \cos x$
B. $e^{2x} + 1 + 3 \sin x$ D. $e^{2x} + 1 - 3 \sin x$

53. Which of the following function has NO vertical asymptote?

- A. $f(x) = \ln(x + 1)$ C. $f(x) = \frac{x^2 - 9}{x - 3}$
B. $f(x) = \frac{x^2 + 1}{x^3 + 8}$ D. $f(x) = \frac{x - 1}{x^2 - x}$

54. Which of the following is the equation of the line tangent to the graph of $f(x) = \frac{1}{x+1} + e^{2x} \cos x$ at $x = 0$?

- A. $x + y = 2$ C. $x - y = 2$
B. $x - y = -2$ D. $x + 4y = 2$

55. What is the n^{th} derivative of the function $f(x) = e^{3x+1}$?

- A. $3^{n-1} e^{3x+1}$ C. $3^n e^{3x+1}$
B. $3^{n+1} e^{3x+1}$ D. $n 3^n e^{3x+1}$

56. Which of the following is the solution set of the equation $\sin 2x - \sin x = 0$ in the interval of $[0, 2\pi]$?

- A. $\left\{0, \frac{\pi}{3}, \frac{5\pi}{3}\right\}$ C. $\left\{0, \frac{\pi}{6}, \frac{11\pi}{6}\right\}$
 B. $\left\{0, \frac{\pi}{6}, \frac{11\pi}{6}, 2\pi\right\}$ D. $\left\{0, \frac{\pi}{3}, \frac{5\pi}{3}, \pi\right\}$

57. If $\sin(\alpha + \theta) = \frac{12}{13}$ and $\sin\theta = \frac{4}{5}$, then $\sin\alpha$ is : _____

- A. $\frac{16}{65}$ C. $\frac{56}{45}$
 B. $\frac{1}{5}$ D. $\frac{16}{45}$

58. Which of the following is **true** about $f(x) = -3 \cos\left(\frac{1}{2}x\right)$?

- A. The amplitude of f is -3 C. 5π is a zero of the function
 B. The range of f is $[-1, 1]$ D. $f(-x) = -f(x)$, $\forall x \in \mathbb{R}$

59. Your football has landed at the edge of the roof of your school building. When you are 25 meters away from the base of the building, the angle of elevation to your football is 45° . How high off the ground is your football?

- A. 25 meters C. 50meters
 B. $\frac{50}{\sqrt{2}}$ meters D. $\frac{25}{\sqrt{2}}$ meters

60. Which one of the following is NOT a correct identity?

- A. $\sin x \cos^2 x - \sin x = -\sin^3 x$ C. $\sin^4 x - \cos^4 x = \sin^2 x - \cos^2 x$
 B. $\frac{\cos x \tan x - \sin x}{\cot x} = 0$ D. $\frac{\sin x}{1 + \cos x} = \sec x - \tan x$

61. Which of the following is the image of the point $(1, 3)$ when reflected along the line $x - 2y - 5 = 0$?

- A. $\left(\frac{4}{3}, \frac{-11}{3}\right)$ C. $\left(-6, \frac{-1}{2}\right)$
 B. $(3, -1)$ D. $(5, -5)$

62. If $\vec{u} = -\vec{i} + 2\vec{j}$, $\vec{v} = -3\vec{i} + \vec{j}$ and $\vec{w} = -3\vec{j}$ are vector in $\mathbb{R}^2$, what is the cosine of angle between $\vec{u} + \vec{w}$ and $\vec{v}$?

A. $\frac{1}{\sqrt{5}}$
D. 0

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

C. $\frac{4}{\sqrt{20}}$

63. Let $\vec{a} = \vec{i} - \vec{j}$ and $\vec{b} = 2\vec{i} - 3\vec{j}$. What is a unit vector in the direction of $\vec{a} - \vec{b}$?

A. $\frac{1}{5}\vec{i} - \frac{2}{5}\vec{j}$

C. $\frac{1}{\sqrt{5}}\vec{i} - \frac{2}{\sqrt{5}}\vec{j}$

B. $-\frac{1}{\sqrt{5}}\vec{i} + \frac{2}{\sqrt{5}}\vec{j}$

D. $-\frac{1}{5}\vec{i} - \frac{2}{5}\vec{j}$

64. Which of the following is the vector equation of the line tangent to the circle $x^2 + y^2 + 2x - 7 = 0$ at $(1, 2)$?

A. $(x, y) = (0, 3) + \lambda(-1, 2)$

C. $(x, y) = (0, 3) + \lambda(1, -1)$

B. $(x, y) = (1, 2) + \lambda(2, -1)$

D. $(x, y) = (1, 2) + \lambda(-1, 2)$

65. Let two vectors $\vec{a} = -2\vec{i} + 2\vec{j} + m\vec{j}$ and $\vec{b} = 3\vec{i} + 6\vec{j}$ for what value of m they are perpendicular?

A. 1

B. 2

C. 0

D. -1