

Math Day 2026
at Murray State University
Upper Level Examination

- Do not open this exam until you are told to do so.
- Clearly fill in your NAME and STUDENT NUMBER on the bubble sheet. Your student number is located on the card your teacher gave you.
- You have 50 minutes to complete this exam.
- You may not use a calculator, phone, notes, book, or other aid. Any attempt to do so will result in disqualification.
- The exam will be scored as follows:
 - +1 point for a correct answer
 - $-\frac{1}{4}$ point for an incorrect answer
 - 0 points for a blank answer
- Clearly select one answer on the bubble sheet for each question. If more than one answer is selected, the answer will be marked as incorrect.

GOOD LUCK!

1. Suppose that Jill is x years old, and that in 8 years, Jack will be three times as old as Jill was 4 years ago. How old is Jack now in terms of x ?

(a) $3x - 4$
(b) $3x - 12$
(c) $3x - 20$
(d) $3x + 36$
(e) None of the Above

2. Let R be the region bounded by $f(t) = t^2 - 9$ in the 4th quadrant. Find the area of R .

(a) 9
(b) 72
(c) 162
(d) -18
(e) None of the Above

3. Suppose the following statement is false:

They like horses and cows, but not sheep.

Which of the following is a true statement?

(a) If they don't like horses nor cows, then they like sheep.
(b) If they like both horses and cows, then they like sheep.
(c) They don't like horses nor cows, but they like sheep.
(d) They either don't like horses or don't like cows, but they like sheep.
(e) None of the Above

4. Suppose the probability of winning game X at a carnival is 0.4 on each play. What is the probability that if you play game X 3 times, you won't win until the last game?

- (a) 0.4
- (b) 0.36
- (c) 0.144
- (d) 0.096
- (e) None of the Above

5. Suppose that

$$x = \sqrt{2 + \sqrt{3 + \sqrt{2 + \sqrt{3 + \sqrt{2 + \sqrt{\dots}}}}}}$$

Evaluate the expression $y = x^4 - 4x^2 - x$.

- (a) $y = -1$
- (b) $y = 0$
- (c) $y = 1$
- (d) $y = 2$
- (e) None of the Above

6. Suppose $f(x) = \sin\left(\frac{\pi x}{2} + \frac{\pi}{2}\right)$. If $f(x_1)$ represents the minimum value of f in the interval $[0, 2\pi]$, find the smallest positive x_2 such that $x_1 < x_2$ and $f(x_1) = f(x_2)$.

- (a) $x_2 = 4$
- (b) $x_2 = 5$
- (c) $x_2 = 6$
- (d) $x_2 = 7$
- (e) None of the Above

7. Suppose in a given classroom, 60% of students are math majors and 40% of students are statistics majors. From the math majors in the classroom, 70% like physics and from the statistics majors in the classroom, 60% like physics. What is the percentage probability that a randomly chosen student from the classroom will like physics?

- (a) 65%
- (b) 66%
- (c) 67%
- (d) 68%
- (e) None of the Above

8. Suppose the amount of a given radioactive substance $M(t)$ at time t (measured in years) satisfies the exponential model

$$M(t) = m_0 e^{kt},$$

where m_0 is the initial amount and $k < 0$ is the decay rate. Find the half-life h of $M(t)$.

- (a) $h = \frac{m_0}{2}$
- (b) $h = \frac{1}{2k}$
- (c) $h = -\ln\left(\frac{1}{2k}\right)$
- (d) $h = -\frac{\ln(2)}{k}$
- (e) None of the Above

9. Evaluate $\sin \frac{661\pi}{6} \cos \frac{200\pi}{3}$.

(a) $\frac{\sqrt{3}}{4}$

(b) $-\frac{\sqrt{3}}{4}$

(c) $\frac{1}{4}$

(d) $-\frac{\sqrt{2}}{4}$

(e) None of the Above

10. Calculate the following:

$$S = 4 \sum_{k=1}^{100} 5^{k-1}$$

(a) $S = 5^{100} - 1$

(b) $S = 4(5^{100} - 1)$

(c) $S = 4 \cdot 5^{100}$

(d) $S = 5^{100}$

(e) None of the Above

11. Evaluate $\sin^{-1} \left(\tan \left(\cos^{-1} \left(\frac{-\sqrt{2}}{2} \right) \right) \right)$.

(a) $-\frac{\pi}{2}$

(b) $-\frac{3\pi}{2}$

(c) $\frac{\pi}{2}$

(d) $\frac{3\pi}{2}$

(e) None of the Above

12. Find the root x_0 of the line that is tangent to $f(x) = \cos(\sqrt{x})$ at $x = \frac{\pi^2}{4}$.

- (a) $x_0 = -\frac{\pi^2}{4}$
- (b) $x_0 = 0$
- (c) $x_0 = \frac{\pi}{2}$
- (d) $x_0 = \frac{\pi^2}{4}$
- (e) None of the Above

13. Suppose both the following statements are true:

- I. If not for studying, Perri will not succeed.
- II. If Perri sleeps well, Perri will succeed.

Suppose that Perri succeeds. What can be concluded?

- (a) Perri studied but did not sleep well.
- (b) Perri studied and slept well.
- (c) Perri did not study and did not sleep well.
- (d) Perri did not study but slept well.
- (e) None of the Above

14. Suppose exam scores follow a normal distribution with mean 72 and standard deviation 10. What percentile would an exam score of 92 fall?

- (a) 95th percentile
- (b) 96th percentile
- (c) 97th percentile
- (d) 98th percentile
- (e) None of the Above

15. Simplify the following expression:

$$\frac{3x^3 - 18x^2 - 39x + 126}{x - 7}$$

- (a) $3(x - 7)(x - 6)$
- (b) $3(x - 2)(x + 3)$
- (c) $3x^2 - 18x^2 - 39x - 18$
- (d) $6x^2 - 39x + 126$
- (e) None of the Above

16. Simplify the expression $[1 + \tan^2(x)] \cos\left(x + \frac{\pi}{2}\right)$.

- (a) $\sec(x)$
- (b) $\cos(x) \cot^2(x)$
- (c) $-\tan(x) \sec(x)$
- (d) $-\cot(x) \csc(x)$
- (e) None of the Above

17. Evaluate $\lim_{x \rightarrow -\infty} \frac{4^x - 3x^9}{4 \cdot 2^{2x} + x^9}$, if the limit exists.

- (a) 0
- (b) $\frac{1}{4}$
- (c) -3
- (d) The limit does not exist.
- (e) None of the Above

18. If $\sin(\theta) = -\frac{1}{2}$ and $\sec(\theta) < 0$, then a possible value of θ (in radians) is

- (a) $\frac{5\pi}{6}$
- (b) $\frac{4\pi}{3}$
- (c) $\frac{8\pi}{3}$
- (d) $\frac{19\pi}{6}$
- (e) None of the Above

19. Suppose there are 100 people (labeled 1,2,3,4,...,99,100) in a line and each person will walk through a room with 100 light bulbs, (also labeled 1,2,3,4,...,99,100). Each light bulb starts in the off position and has a toggle which will turn it to the opposite position (from off to on or from on to off). Starting with person 1 and going in ascending order, person j will walk by and toggle every light bulb which is a multiple of j . How many light bulbs will be on after the 100th person walks through the room?

- (a) 8
- (b) 10
- (c) 12
- (d) 15
- (e) None of the Above

20. What is the value of k such that the equation

$$\frac{x^2 - 2x}{4x - 1} = \frac{k - 1}{k + 1}$$

has two real distinct roots r_1, r_2 satisfying $|r_1| = |r_2|$?

- (a) $k = \frac{1}{6}$
- (b) $k = \frac{1}{5}$
- (c) $k = \frac{1}{4}$
- (d) $k = \frac{1}{3}$
- (e) None of the Above

21. Suppose P , Q , R , and S are conditions and consider the following statement:

Either P or Q is true or R and S is true.

What does it mean for this statement to be false?

- (a) Conditions P , Q , R , and S are all false.
- (b) Conditions P and Q are both false, and at least one of conditions R or S is false.
- (c) Conditions R and S are both false, and at least one of conditions P or Q is false.
- (d) At least one of the conditions P , Q , R , or S must be true.
- (e) None of the Above

22. Define $f(x) = \begin{cases} x^2 \sin \frac{1}{x} & , \quad \text{if } x > 0 \\ 0, & \text{if } x \leq 0. \end{cases}$

Evaluate $f'(0)$, if it exists.

- (a) $f'(0) = 0$
- (b) $f'(0) = \frac{1}{2}$
- (c) $f'(0) = 1$
- (d) $f'(0)$ does not exist.
- (e) None of the Above

23. If x is such that the following data set

$7, 12, 55, 61, 78, x, 31, 33$

has a mean m satisfying $35 \leq m \leq 36$, then x must satisfy

- (a) $2 \leq x \leq 10$
- (b) $3 \leq x \leq 11$
- (c) $4 \leq x \leq 12$
- (d) $5 \leq x \leq 13$
- (e) None of the Above

24. How many solutions (in radians) exist for $\sin(4\pi x) = \frac{x}{5}$ in the interval $0 \leq x < \infty$?

- (a) 0
- (b) 2
- (c) 4
- (d) 8
- (e) None of the Above

25. Expand the expression $(2x - y)^5$.

- (a) $32x^5 - y^5$
- (b) $32x^5 - x^4y + x^3y^2 - x^2y^3 + xy^4 - y^5$
- (c) $32x^5 - 16x^4y + 8x^3y^2 - 4x^2y^3 + 2xy^4 - y^5$
- (d) $32x^5 - 80x^4y + 80x^3y^2 - 40x^2y^3 + 10xy^4 - y^5$
- (e) None of the Above

26. Suppose we have a sphere S with radius R and decide to inscribe a right circular cylinder C inside S . If h and r represent the height and radius of C , respectively, then

- (a) $h = \sqrt{R^2 - r^2}$
- (b) $h = 2\sqrt{R^2 - r^2}$
- (c) $h = \sqrt{r^2 - R^2}$
- (d) $h = 2\sqrt{r^2 - R^2}$
- (e) None of the Above

27. Find x using the following pattern:

$$1, 2, 5, 12, 27, 58, x$$

- (a) 121
- (b) 124
- (c) 127
- (d) 130
- (e) None of the Above

28. Suppose in a room, there are 100 people, labeled $0, 1, 2, 3, \dots, 98, 99$. Every person in the room is either a truth-teller (always tell the truth) or a liar (always lie). For each $k = 0, 1, 2, 3, \dots, 98, 99$, person k makes the claim that they shook hands with k truth-tellers. If x represents the number of truth-tellers in the room, then

- (a) $0 \leq x \leq 20$
- (b) $20 < x \leq 40$
- (c) $40 < x \leq 60$
- (d) $60 < x \leq 80$
- (e) $80 < x \leq 100$

29. Evaluate $\cos^{-1}(\sin(\pi)) + \cos \sin^{-1}(1)$.

- (a) 0
- (b) $\frac{\pi}{2}$
- (c) π
- (d) $\frac{\pi + 1}{2}$
- (e) None of the Above

30. Evaluate the slope of the tangent line to the graph of $y^3 + y = x$ at the point $(2, 1)$.

(a) 0

(b) -2

(c) $\frac{1}{4}$

(d) $\frac{1}{13}$

(e) None of the Above