



MONTANA COUNCIL OF TEACHERS OF MATHEMATICS
2016 MATH CONTEST
SENIOR

DIRECTIONS: DO NOT WRITE ON THIS TEST. Place the best answer for each question on the separate answer sheet.

- What is the product of the following complex numbers? $2i(3 + i)(4 - i)$
A) $14i$ B) $-2 + 26i$ C) $-52 - 4i$ D) $-2 + 22i$ E) none of these
- For the polynomial function $f(x) = ax^2 + 4x + 2$, which of the following is NOT true regarding the parameter "a"?
A) The sign of "a" determines the end behavior of the function.
B) The graph of the function will be a parabola as long as $a \neq 0$.
C) If $a = 2$, then the polynomial only has one unique real zero.
D) If $a < 0$, then the polynomial will have imaginary zeros.
E) All of these are true.
- Which of the following equations represents a parabola that opens to the right?
A) $2x^2 + 3y^2 = 12$ B) $x = 2y^2 - 3$ C) $y = (x - 4)^2$
D) $y^2 - x^2 = 49$ E) none of these
- Angie's money jar has a balance of \$1,200 at the beginning of 2016. If she spends 10% of the jar's beginning balance every month, and then adds an additional \$100 at the end of the month, how much money (to the nearest dollar) will be in the jar at the end of December?
A) \$960 B) \$981 C) \$1024 D) \$1056 E) none of these
- As $x \rightarrow \infty$, the function $f(x) = \frac{3-2x^2}{2x^3}$ approaches what?
A) -1 B) 0 C) $\frac{3}{2}$ D) ∞ E) $-\infty$
- Three zeros of a 4th degree polynomial function are 4, -2 , and $\frac{3+i}{4}$. Which one of the following statements is true?
A) There must be one additional real zero for the function.
B) One of the real zeros must be repeated.
C) There must be one additional imaginary zero for the function.
D) One of the imaginary zeros must be repeated.
E) None of these statements are true.
- An 18 foot-wide megaload truck headed for the oil fields in eastern Montana takes a wrong turn and finds itself on a one-way road in a small (and scary) North Dakota town. The driver must attempt to pass under a bridge with a semielliptical arch in order to escape. The width of the roadway is 32 feet and the height of the arch over the center of the roadway is 24 feet. Of the trucks listed below (and assuming a rectangular cross-section), which is the tallest one that can safely pass underneath and not be stuck indefinitely in our neighboring state?
A) 19 feet B) 20 feet C) 21 feet D) 22 feet E) none of these "fit"
- What is the value of the 15th term in the following sequence? $\frac{3!}{57!31!}, \frac{9!}{59!29!}, \frac{15!}{61!27!}, \dots$
A) 1247 B) 1680 C) 2537 D) 2619 E) none of these
- Find the y-intercept of the polynomial function: $g(x) = (x - 2)(x + 3)(x + 1)^2$
A) 0 B) 2 C) 3 D) -6 E) none of these
- For the greatest integer function $h(x) = 2[0.5x + 1]$, which function values are the SAME?
A) $h(3), h(4)$ B) $h(5.5), h(6.5)$ C) $h(6), h(7.5)$ D) $h(9.9), h(10.1)$ E) none of these

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11. If the two forces listed below act on an object, what is the magnitude of the resultant force?

$$\vec{F}_1 = \langle 2, -3 \rangle \quad \vec{F}_2 = \langle -4, 2 \rangle$$

- A) $\sqrt{61}$ B) 3 C) $\sqrt{5}$ D) 1 E) none of these

12. Which vector is perpendicular to the $\vec{a} = \langle 1, 2, 3 \rangle$?

- A) $\langle 3, 2, 1 \rangle$ B) $\langle 1, -2, 1 \rangle$ C) $\langle -1, -2, -3 \rangle$ D) $\langle 1, 1, 1 \rangle$ E) none of these

13. What shape is the curve whose parametric equations are $y = 2 \cos(5t)$ $x = -3 \sin(5t)$?

- A) circle B) parabola C) ellipse D) hyperbola E) line

14. A ball is kicked at an angle θ with the horizontal with an initial velocity V , the path of the ball may be described by these equations, where t is the time in seconds and x and y are in feet.

$$x = tV \cos \theta \quad y = -16t^2 + tV \sin \theta + 3$$

If the ball has an initial velocity 67 feet per second at an angle of 50° . What is the horizontal distance to the nearest foot it travels before hitting the ground?

- A) 9.7ft B) 83ft C) 134ft D) 141ft E) none of these

15. Expand $(3 + i)^3$. When plotted on the complex plane, what is the distance to the origin?

- A) 64 B) $10\sqrt{10}$ C) $\sqrt{44}$ D) $2\sqrt{277}$ E) none of these

16. Evaluate the limit: $\lim_{x \rightarrow 7^-} \frac{3x}{x^2 - 49}$

- A) 3 B) 0 C) $-\infty$ D) ∞ E) none of these

17. Evaluate the limit: $\lim_{x \rightarrow 0} \frac{\sin(x)}{3x}$

- A) 0 B) 1 C) $\frac{1}{3}$ D) ∞ E) does not exist

18. As $x \rightarrow -\infty$, the function $g(x) = -2x^5 + 4x^4 + 3x^2 + 6$ approaches what?

- A) -2 B) 0 C) $-\infty$ D) ∞ E) none of these

19. A farmer has 3000 acres to plant in wheat and canola. She plants at least 1000 acres of wheat and 400 acres of canola. Based on her calculations, she can earn \$125 per acre of wheat and \$200 per acre of canola. What is the greatest profit she can earn?

- A) 625,000 B) 525,000 C) 405,000 D) 205,000 E) none of these

20. A company is designing a cylindrical can that costs twice as much to make the top as it does the combined lateral surface and bottom. The volume is 300 cm^3 . What is the radius of the can, to the nearest 0.1 cm, that will minimize the cost of producing the can?

- A) 3.2 cm B) 2.4 cm C) 2 cm D) 3.8 cm E) none of these

21. Find the 10th term in the sequence. 0, -1, 0, 3, 8, 15

- A) 8 B) 24 C) 57 D) 63 E) none of these

SENIOR 2016 Answer Key

1. B
2. D
3. B
4. D
5. B
6. C
7. A
8. A
9. D
10. C
11. C
12. B
13. C
14. D
15. B
16. C
17. C
18. D
19. B
20. A
21. D