



MONTANA COUNCIL OF TEACHERS OF MATHEMATICS  
2015 MATH CONTEST  
**SENIOR**

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

- Solve the equation.  $4x^2 + 9 = 0$ .  
A)  $\frac{-3}{4}$     B)  $\pm\frac{3i}{2}$     C)  $\frac{-3i}{2}$     D)  $\pm\frac{3}{2}$     E) none of these
- Find the product of the complex numbers  $(5a-3i)$  and  $(a+2i)$ .  
A)  $4a - i$     B)  $5a^2 - 6i^2$     C)  $6 + 5a^2 + 7ai$     D)  $5a + 7ai - 6i$     E) none of these
- What is the radius of the circle  $y^2 + x^2 - 10x + 16 = 0$ ?  
A) 3    B) 9    C) 16    D) 4    E) none of these
- Write the equation of an ellipse that meets the set of conditions. The endpoints of the major axis are at  $(-10,3)$  and  $(8,3)$  and the end points of the minor axis are at  $(-1,7)$  and  $(-1,-1)$ .  
A)  $\frac{(x+1)^2}{81} + \frac{(y-3)^2}{16} = 1$     B)  $\frac{(x+1)^2}{9} + \frac{(y-3)^2}{4} = 1$     C)  $\frac{(x-3)^2}{16} + \frac{(y+1)^2}{81} = 1$   
D)  $(x-3)^2 + (y+1)^2 = 36$     E) none of these
- Write the equation in slope-intercept form of a line whose parametric equations are  $x = -3 + 2t$  and  $y = 4 - 5t$ .  
A)  $y = 3x + 1$     B)  $y = -.4x + 4$     C)  $y = -2.5x - 3.5$     D)  $y = -2.5x + 2.5$   
E) none of these
- If a football is thrown at an angle  $\theta$  with the horizontal with an initial velocity  $\mathcal{V}$ , the path of the football may be described by these equations, where  $t$  is time in seconds and  $x$  and  $y$  are in feet.  
 $x = t\mathcal{V}\cos\theta$      $y = t\mathcal{V}\sin\theta - 16t^2 + 5$   
If a football is thrown at an initial velocity of 55 feet per second at an angle of  $32^\circ$  what is the horizontal distance to the nearest foot it travels before hitting the ground?  
A) 66ft    B) 84ft    C) 87ft    D) 92ft    E) 124ft
- Write  $y$  in terms of  $x$  if  $y = 3\sin\theta$  and  $x = 3\cos\theta$ .  
A)  $y = x + 3$     B)  $y^2 = x^2 + 3$     C)  $y = \tan(x)$     D)  $y^2 + x^2 = 9$   
E) none of these
- The sequence below has a first term of 2. What would be the 9<sup>th</sup> term?  
 $2, i, 2i, -2, -4i, 8i, \dots$   
A)  $16i$     B) 256    C) -256    D)  $8192i$     E) none of these
- The numbers 1,5,12,22, and 35 are referred to as the first five "pentagonal" numbers. What is the 10<sup>th</sup> pentagonal number?  
A) 63    B) 100    C) 145    D) 176    E) none of these
- Identify all of the irrational zeros of the polynomial:  $h(x) = x^3 + 2x^2 - 5x - 10$   
A)  $\pm\sqrt{5}$     B)  $\pm 2$     C)  $\pm\sqrt{5}, 2$     D)  $\pm\sqrt{10}$     E) none of these

11. If  $f(x) = \llbracket x \rrbracket$  is defined as the greatest integer function, then determine the range for  $g(x) = \llbracket x - \frac{1}{2} \rrbracket$ .
- A) All reals                      B) All integers                      C)  $\frac{1}{2}$   
 D)  $\left\{y: y = \frac{1}{2} + k, \text{ where } k \text{ is an integer}\right\}$                       E) none of these
12. As  $x \rightarrow -\infty$ , the function  $p(x) = x^5 + 24x^4 + 192x^3 + 656x^2 + 1008x + 576$  approaches what?
- A) -2                      B) 576                      C)  $+\infty$                       D)  $-\infty$                       E) none of these
13. If the three forces listed below act on an object, what is the magnitude of the resultant force?
- $\vec{F}_1 = \langle 1, 5 \rangle$                        $\vec{F}_2 = \langle -2, 6 \rangle$                        $\vec{F}_3 = \langle -3, -4 \rangle$
- A)  $\sqrt{65}$                       B)  $\sqrt{33}$                       C) 28                      D) 3                      E) none of these
14. A traffic light is supported equally by two cables. The cables form a  $130^\circ$  with each other. If the weight of the traffic light exerts a 750 N force downward, what is the force exerted (to the nearest Newton) by each of the cables?
- A) 887 N                      B) 583 N                      C) 414 N                      D) 375 N                      E) none of these
15. Which vector is orthogonal to (perpendicular to the plane containing) the given vectors?
- $\vec{v} = \langle 1, 3, 1 \rangle$                        $\vec{w} = \langle 0, 1, 2 \rangle$
- A)  $\langle 1, 4, 3 \rangle$                       B)  $\langle 5, 2, 1 \rangle$                       C)  $\langle 5, -2, -2 \rangle$   
 D)  $\langle 5, -2, 1 \rangle$                       E) none of these
16. As  $x \rightarrow \infty$ , what value does the function  $y = \frac{75x}{x^2-1}$  approach?
- A) 0                      B) 1                      C) 75                      D) -75                      E) none of these
17. Evaluate the limit:  $\lim_{x \rightarrow 4} 8$
- A) 32                      B) 8                      C) 4                      D) 0                      E) none of these
18. Evaluate the limit:  $\lim_{x \rightarrow 2} \frac{x-3}{x^2-5x+6}$
- A) 3                      B) 2                      C) 1                      D) 0                      E) none of these
19. A company produces two types of bookcases, a small and a large size. The company can make a total of 60 bookcases per day, and it has 120 labor-hours available each day. It takes 1 labor-hour to make a small bookcase and 4 labor-hours to make a large bookcase. The profit is \$40 per small bookcase and \$60 per large bookcase. How many of each type of bookcase should the company make to maximize its daily profit?
- A) 60 small bookcases                      B) 60 large bookcases                      C) 30 of each  
 D) 40 small bookcases, 20 large bookcases                      E) none of these
20. A plumber charges \$90 per hour or fraction of an hour plus \$50 per service call. Determine the total charge if she works 3 hours and 40 minutes in response to a service call.
- A) \$356                      B) \$410                      C) \$380                      D) \$273                      E) none of these

**SENIOR 2015 Answer Key**

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