

Name: _____

Date: _____

1. A shipping company transports fragile artifacts exclusively in small crates weighing 40 pounds each and large crates weighing 75 pounds each. For a specific transport van, safety regulations require that the van must carry at least 16 crates, and the combined weight of the crates cannot exceed 950 pounds. What is the maximum number of large crates the van can carry on a single trip?

A. 7
B. 8
C. 9
D. 10

2. An environmental researcher observes a culture of bacteria. The population P decreases exponentially such that for every increase of 3 hours in time t , the population is reduced to one-third of its value at the beginning of that period. When $t = 0$, the population is 5,400. Which equation correctly models the population P after t hours?

A. $P = 5,400 \left(\frac{1}{3}\right)^{3t}$
B. $P = 5,400 \left(\frac{1}{3}\right)^{\frac{t}{3}}$
C. $P = 5,400(3)^{-\frac{t}{3}}$
D. $P = 1,800 \left(\frac{1}{3}\right)^t$

3. In the xy -plane, the equation below defines a circle:

$$x^2 + y^2 - 12x + 6y - 5k = 0$$

where k is a constant. The radius of this circle is $3\sqrt{7}$. What is the value of k ?

- A. 3.6
- B. 4.2
- C. 7
- D. 18

4. Circle M in the xy -plane is defined by the equation $(x - 3)^2 + (y + 4)^2 = 18$. Circle N has the same center as Circle M , but Circle N has an area that is 3 times the area of Circle M . If the equation of Circle N is written in the form $(x - 3)^2 + (y + 4)^2 = c$, where c is a constant, what is the value of c ?

5. In the xy -plane, a circle centered at the origin passes through point $P(k, 4\sqrt{5})$, where $k > 0$. An angle θ in standard position has its terminal ray passing through point P . If $\cos(\theta) = \frac{2}{3}$, what is the value of constant k ?

- A. 6
- B. 8
- C. 12
- D. 18

6. In the xy -plane, Circle A is defined by the equation $x^2 + y^2 + 14x - 8y + 40 = 0$. Circle B is obtained by translating Circle A to the right by 15 units and down by b units, where $b > 0$. If Circle B is tangent to the x -axis, what is the value of b ?
7. A scientific expedition carries two types of emergency battery packs: Type X, which weighs 14 ounces and provides 60 watt-hours of energy, and Type Y, which weighs 22 ounces and provides 110 watt-hours of energy. The team must pack at least 25 battery packs in total, but the combined weight cannot exceed 430 ounces. What is the maximum number of Type Y battery packs the team can include?
- A. 9
B. 10
C. 11
D. 12

8. In the xy -plane, a circle is defined by:

$$x^2 + y^2 + 16x - 12y + c = 0$$

where c is a constant. If the radius of this circle is 13, what is the value of c ?

9. In the xy -plane, the unit circle is centered at the origin. An angle α in standard position has its terminal ray intersect the circle at point $P\left(-\frac{7}{25}, y\right)$, where $y > 0$. An angle β in standard position has its terminal ray perpendicular to the terminal ray of α such that $\beta = \alpha + \frac{\pi}{2}$. What is the value of $\cos(\beta)$?
- A. $-\frac{24}{25}$
B. $-\frac{7}{25}$
C. $\frac{7}{25}$
D. $\frac{24}{25}$
10. In the xy -plane, Circle A is given by $(x - 5)^2 + (y + 1)^2 = 16$. Circle B has radius $R_B = 3 \cdot R_A$ and its center is translated 8 units left and 10 units up from Circle A . If the equation of Circle B is $(x + h)^2 + (y - k)^2 = m$, what is the value of $h + k + m$?
11. A sample of a radioactive isotope decays according to the equation $M(t) = 450\left(\frac{1}{2}\right)^{\frac{t}{18}}$, where $M(t)$ is the remaining mass in grams after t hours. The equation can be rewritten in the equivalent form $M(t) = 450(b)^t$. What is the value of b ?
- A. $\left(\frac{1}{2}\right)^{18}$
B. $\sqrt[18]{\frac{1}{2}}$
C. $\frac{1}{36}$
D. 2^{-18}

12. For an acute angle x , the expression $\sin(x)$ is equal to $\frac{2\sqrt{m}}{7}$. If $\cos\left(\frac{\pi}{2} - x\right) = \frac{6}{7}$, what is the value of the constant m ?
13. A circle in the xy -plane has its center at $(d, -4)$, where $d > 0$. The circle passes through the origin $(0, 0)$ and point $(0, -8)$. If the radius of the circle is $4\sqrt{5}$, what is the value of d ?
- A. 4
B. 6
C. 8
D. 16
14. A chemist mixes Solution A, which contains 15% acid by volume, with Solution B, which contains 40% acid by volume, to create a 60-liter mixture. If the final mixture must contain between 22% and 30% acid by volume (inclusive), what is the minimum volume, in liters, of Solution B required?
- A. 16.8
B. 20.0
C. 24.0
D. 36.0

15. The equation of a circle is $(x - 4)^2 + (y + 2)^2 = 25$. The vertical line $x = k$ is tangent to the circle. Which of the following could be the value of k ?

A. -3
B. -1
C. 7
D. 10

16. In right triangle DEF , angle E measures 90° . If $\tan(D) = \frac{\sqrt{7}}{3}$, what is the value of $\cos(F)$?

A. $\frac{3}{4}$
B. $\frac{\sqrt{7}}{4}$
C. $\frac{3}{\sqrt{7}}$
D. $\frac{4}{3}$

17. The equation $x^2 + y^2 - ax + 10y + 9 = 0$ defines a circle in the xy -plane with center $(3, -5)$ and radius r . What is the value of $a + r^2$?

18. An online artisan sells hand-carved bowls. The production cost consists of a fixed setup fee of \$180 plus \$12 per bowl. The artisan sells each bowl for \$28. If all produced bowls are sold, what is the minimum number of bowls the artisan must sell to earn a net profit of at least \$700?
- A. 54
B. 55
C. 56
D. 58
19. In the xy -plane, line segment AB is a diameter of a circle, with endpoints $A(-3, 8)$ and $B(7, -6)$. The equation of the circle can be expressed as $(x - h)^2 + (y - k)^2 = c$, where h , k , and c are constants. What is the value of c ?
20. A circle with radius $r = 6$ has a central angle measuring θ radians. The area of the sector formed by θ is equal to $k\pi$. If $\sin\left(\frac{\theta}{2}\right) = \frac{1}{2}$ and $0 < \theta < \pi$, what is the value of k ?
- A. 3
B. 6
C. 9
D. 12