$\qquad$

Work the multiple-choice questions first, choosing the single best response from the choices available. Indicate your answer here and on your answer sheet. Then attempt the tie-breaker questions at the end starting with tie breaker \#1, then \#2, and then \#3. Turn in your answer sheet, your tie-breaker pages, and your scratch work when you are finished. Figures are not necessarily drawn to scale.

1) Which expression is equivalent to $(x+2)^{2}-5(x+2)+6$ ?
A. $x(x-1)$
B. $(x-3)(x-2)$
C. $(x-4)(x+3)$
D. $(x-6)(x+1)$
E. None of the above
2) Find the missing expression to satisfy this equation:

$$
\frac{3 x}{x-5}+\frac{?}{5-x}=\frac{7 x+1}{x-5}
$$

A. $-4 x-1$
B. $10 x+1$
C. $4 x+1$
D. $-10 x-1$
E. $-10 x+1$
3) Write $\sqrt[6]{(2) 3^{5}(5)^{4}}$ in exponential form.
A. $2^{1 / 3} 3^{5 / 6} 5^{2 / 3}$
B. $2^{1 / 6} 3^{5 / 6} 5^{2 / 3}$
C. $2^{1 / 6} 3^{5 / 6} 5^{1 / 6}$
D. $2^{1 / 6} 3^{5 / 6} 5^{1 / 3}$
E. None of the above
4) Simplify the given radical expression $\sqrt{7 q^{6}} \cdot \sqrt{14 q^{5}}$ ?
A. $7 q^{6} \sqrt{q}$
B. $7 q^{5} \sqrt{2 q^{2}}$
C. $7 q^{5} \sqrt{2 q}$
D. $7 q^{5} \sqrt{q^{2}}$
E. None of the above
$\qquad$
5) What are the solutions to the equation $x^{2}+2 x+2=0$ ?
A. $x=0 ; x=-2$
B. $x=0 ; x=-2 i$
C. $x=-1+i ; x=-1-i$
D. $x=-1+2 \sqrt{2} ; x=-1-2 \sqrt{2}$
E. No value exists
6) A 400 mL solution of milk and water is inside a can. The water makes up $14 \%$ of the solution. How many mL of milk is in the solution?
A. 364
B. 86
C. 56
D. 326
E. None of the above
7) A system of linear inequalities is shown. Which graph represents the solution set?

$$
\left\{\begin{array}{c}
y \leq x+5 \\
y>-2 x-3
\end{array}\right.
$$

A.

B.

C.

D.

E. None of the above
$\qquad$
8) Solve for $x: \log _{3}\left(x^{2}+2\right)=3$
A. $x=5$
B. $x= \pm 5$
C. $x=\sqrt{998}$
D. $x= \pm \sqrt{998}$
E. Unable to determine
9) The steps used to solve an equation are shown.

| Step 1: | $\frac{2}{3} r=14 i$ |
| :---: | :---: |
| Step 2: | $\left(\frac{3}{2}\right) \frac{2}{3} r=14 i\left(\frac{3}{2}\right)$ |
| Step 3: | $\left(\frac{3}{2} \cdot \frac{2}{3}\right) r=14 i\left(\frac{3}{2}\right)$ |
| Step 4: | $1 \cdot r=21 i$ |
| Step 5: | $r=21 i$ |

What property justifies the work between Step 4 and Step 5?
A. Identity property of multiplication
B. Inverse property of multiplication
C. Commutative property of multiplication
D. Associative property of multiplication
E. This is not a property of multiplication
10) Which of these is equivalent to $i^{75}$
A. $i$
B. $-i$
C. 1
D. -1
E. None of the above
11) If no denominator equals zero, which expression is equivalent to $\frac{25-4 x^{2}}{6 x^{2}+9 x-15} \cdot \frac{6 x^{2}-2 x-4}{2 x^{2}-x-10}$
A. -2
B. 2
C. $\frac{-2(3 x+2)}{3(x+2)}$
D. $\frac{2(3 x+2)}{3(x+2)}$
E. None of the above
12) Which of the following is a solution set of the following system of equations?

$$
\left\{\begin{array}{c}
y=4 x+2 \\
y=x^{2}+x-8
\end{array}\right.
$$

A. $\{(-5,-18),(2,10)\}$
B. $\{(-1,-2),(6,26)\}$
C. $\{(-6,-22),(1,6)\}$
D. $\{(-2,-6),(5,22)\}$
E. No solution
13) The domain of the function $f(x)=\frac{x+3}{x^{2}+5 x-24}$ is all real numbers except:
A. $-8,-3,3$
B. $-8,3$
C. $-3,8$
D. 8
E. All real numbers
14) Identify the extraneous solution(s) to the following equation.

$$
\frac{x}{x+6}=\frac{72}{x^{2}-36}+4
$$

A. $x=6$
B. $x=-6$
C. $x= \pm 6$
D. $x=4$
E. None of the above
15) A person's batting average is determined by dividing the number of hits by the number of at bats. William has 11 hits in 53 at bats and has a batting average of 0.208 . He wants to have a batting average of at least 0.300. Which equation could be used to determine $x$, the number of hits in a row William needs to get in order to have a batting average of at least 0.300 ?
A. $\quad 0.300 \geq \frac{11 x}{53 x}$
B. $0.300 \leq \frac{11}{53}$
C. $0.300 \geq \frac{11+x}{53}$
D. $0.300 \leq \frac{11+x}{53+x}$
E. $\quad 0.300 \geq \frac{11+x}{53+x}$
16) The function $f(x)$ is given by the equation $f(x)=3\left(x^{2}+2\right)$. The values for the quadratic function $h(x)$ are shown in the table. Which statement about the y -intercept of $f(x)$ is true?

| $x$ | -2 | -1 | 0 | 1 | 2 |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $h(x)$ | 6 | -3 | -6 | -3 | 6 |

A. It is 12 units above the $y$-intercept of $h(x)$.
B. It is 8 units below the $y$-intercept of $h(x)$.
C. It is 6 units above the $y$-intercept of $h(x)$.
D. It is 6 units below the $y$-intercept of $h(x)$.
E. It is 4 units above the $y$-intercept of $h(x)$.
17) Calvin purchases a piece of heavy machinery for $\$ 32,300$. The value of the machine depreciates at an annual rate of $8.3 \%$. Which function represents the value of the machine with an approximate equivalent monthly depreciation rate?
A. $f(t)=32,300\left(0.917^{1 / 12}\right)^{t}$
B. $f(t)=32,000\left(1.083^{1 / 12}\right)^{t}$
C. $f(t)=32,300\left(0.917^{1 / 12}\right)^{12 t}$
D. $f(t)=32,300\left(1.083^{1 / 12}\right)^{12 t}$
E. Not enough information given
18) Which expression is the correct factorization of $x^{6}-y^{6}$ ?
A. $(x+y)^{3}(x-y)^{3}$
B. $\left(x^{2}-y^{2}\right)\left(x^{4}+2 x y+y^{4}\right)$
C. $(x-y)(x+y)\left(x^{2}+x y+y^{2}\right)\left(x^{2}-x y+y^{2}\right)$
D. $(x-y)\left(x^{2}+2 x y+y^{2}\right)(x+y)\left(x^{2}-2 x y+y^{2}\right)$
E. None of the above
19) If $P=\left[\begin{array}{cc}-1 & 4 \\ 6 & 3\end{array}\right]$ and $Q=\left[\begin{array}{cc}0 & 5 \\ 5 & -2\end{array}\right]$ then $P \times Q$ is:
A. $\left[\begin{array}{cc}0 & 20 \\ 30 & -6\end{array}\right]$
B. $\left[\begin{array}{cc}-1 & 9 \\ 11 & 1\end{array}\right]$
C. $\left[\begin{array}{cc}20 & -13 \\ 15 & 24\end{array}\right]$
D. $\left[\begin{array}{cc}30 & 15 \\ -17 & 14\end{array}\right]$
E. none of the above
$\qquad$
20) What is the matrix form of the following equations?

$$
\begin{gathered}
-3 x+y=11 \\
5 x-2 y=-16
\end{gathered}
$$

A. $\left[\begin{array}{cc}11 & 1 \\ -16 & -2\end{array}\right]\left[\begin{array}{l}x \\ y\end{array}\right]=\left[\begin{array}{c}-3 \\ 5\end{array}\right]$
B. $\left[\begin{array}{cc}-3 & 5 \\ 1 & -2\end{array}\right]\left[\begin{array}{l}x \\ y\end{array}\right]=\left[\begin{array}{c}11 \\ -16\end{array}\right]$
C. $\left[\begin{array}{cc}-3 & 1 \\ 5 & -2\end{array}\right]\left[\begin{array}{l}x \\ y\end{array}\right]=\left[\begin{array}{c}11 \\ -16\end{array}\right]$
D. $\left[\begin{array}{cc}-3 & 11 \\ 5 & -16\end{array}\right]\left[\begin{array}{l}x \\ y\end{array}\right]=\left[\begin{array}{c}1 \\ -2\end{array}\right]$
E. Not enough information given
21) Find the equation of a line written in Standard Form that is perpendicular to the line $x-2 y=5$ and passes through the point $(-2,2)$.
A. $2 x+y=2$
B. $x+2 y=2$
C. $x-2 y=-6$
D. $2 x-y=-6$
E. None of the above
22) Simplify: $\ln (A+B)-\ln \left(A^{-1}+B^{-1}\right)$
A. $\ln \left(A^{2}+B^{2}\right)$
B. $\ln \left(\frac{1}{A}+\frac{1}{B}\right)$
C. $\ln (A B)$
D. $\ln (0)$
E. $\frac{1}{A}+\frac{1}{B}$
23) Create a recursive formula for the sequence $64,48,36, \ldots$
A. $a_{n}=64(0.75)^{n-1}$
B. $a_{1}=64$ and $a_{n}=a_{n-1}-16$
C. $a_{n}=64+(n-1)(-16)$
D. $a_{1}=64$ and $a_{n}=0.75 a_{n-1}$
E. No solution
$\qquad$
24) A cyclist pedals a bike at a rate of 60 revolutions per minute.

The height, $h$, of a pedal at time $t$, in seconds, is plotted below.
The graph can be modeled by the function $h(t)=5 \sin (k t)$, where $k$ is equal to
A. 1
B. $2 \pi$
C. 60
D. $\frac{\pi}{30}$
E. Unable to determine

25) Find the remainder when $5 x^{3}-6 x^{2}+3 x+11$ is divided by $x-2$.
A. $5 x^{2}+4 x+11$
B. $5 x+11$
C. 33
D. -59
E. No remainder exists

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School

## Tie Breaker \#1

Find a polynomial of degree 4 with integer coefficients which has $\sqrt{2}+\sqrt{5}$ as a zero.

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## School

$\qquad$

Tie Breaker \#2

The points $(1,2),(5, A)$, and $(A, 7)$ lie on a straight line. Find all possible values for $A$.

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## School

$\qquad$

## Tie Breaker \#3

For the given polynomial $p(x)=x^{3}+18 x^{2}-5 x+1$, find the sum of $p(x)$ 's zeros.

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## ANSWER KEY

| 1) A | 11) C | 21) E |
| :--- | :--- | :--- |
| 2) A | 12) D | 22) C |
| 3) B | 13) B | 23) D |
| 4) C | 14) B | 24) B |
| 5) C | 15) D | 25 ( C |
| 6) E | 16) A |  |
| 7) C | 17) A |  |
| 8) B | 18) C |  |
| 9) A | 19) C |  |
| 10) B | 20) C |  |

Tie Breaker Answer 1

| 41.1 * ${ }^{\text {doc } \nabla}$ | RAD |
| :---: | :---: |
| $x=\sqrt{2}+\sqrt{5}$ | $x=\sqrt{5}+\sqrt{2}$ 슴 |
| © $(x=\sqrt{5}+\sqrt{2})^{2}$ | $x^{2}=2 \cdot \sqrt{10}+7$ |
| $\left(x^{2}=2 \cdot \sqrt{10}+7\right)-7$ | $x^{2}-7=2 \cdot \sqrt{10}$ |
| © $\left(x^{2}-7=2 \cdot \sqrt{10}\right)^{2}$ | $\left(x^{2}-7\right)^{2}=40$ |
| $\left(\left(x^{2}-7\right)^{2}=40\right)-40$ | $x^{4}-14 \cdot x^{2}+9=0$ |

One polynomial is $f(x)=x^{4}-14 x^{2}+9$.
Other answers are possible.
$\qquad$
Tie Breaker Answer 2


Several approaches are possible to this problem. This approach calculates the slopes between each pair of coordinates. It then sets the slopes equal to each other and solves for a.

There are two values for $a$ possible: $a=-3$ or $a=6$. We can verify with a scatter plots.



## Tie Breaker Answer 3

For the given polynomial $p(x)=x^{3}+18 x^{2}-5 x+1$, find the sum of $p(x)$ 's zeroes.

Consider this polynomial $f(x)$ and expand it.

$$
\begin{aligned}
f(x) & =(x-a)(x-b)(x-c) \\
& =x^{3}-(a+b+c) x^{2}+(a b+a c+b c) x-a b c
\end{aligned}
$$

We can match coefficients, in particular the $x^{2}$ coefficient.

$$
\begin{aligned}
& -(a+b+c)=18 \\
& (a+b+c)=-18
\end{aligned}
$$

The sum of the zeroes is -18

