

1. An expression that is equivalent to $\frac{x^2 + x}{x}$, $x \neq 0$, is
- A. $x + 1$, $x \neq 0$
 - B. $x^2 + 1$, $x \neq 0$
 - C. $2x$, $x \neq 0$
 - D. x^2 , $x \neq 0$

Numerical Response

2. The non-permissible value of $\frac{2x + 1}{3x - 9}$ is _____

Use the following information to answer the next question.

Sanja and David both simplified the expression $\frac{x}{x^2 + x}$. Their work is shown below.

Sanja

$$\frac{x}{x^2 + x}$$

$$\frac{x}{x(x + 1)}$$

$$\frac{1}{x + 1}$$

David

$$\frac{x}{x^2 + x}$$

$$\frac{1\cancel{x}}{x^2 + 1\cancel{x}}$$

$$\frac{1}{x + 1}$$

Sanja stated that the non-permissible values of x for the equivalent rational expressions are -1 and 0 .

David stated that the non-permissible value of x for the equivalent rational expressions is -1 .

3. Which student is correct? Justify your choice.
4. Explain why the non-permissible value for the expression $\frac{3x}{(x + 2)}$ is -2 .

5. When the rational expression $\frac{2x + 4}{x^2 - 4}$ is simplified, the equivalent expression is
- A. $\frac{2}{x - 2}, x \neq -2, 2$
- B. $\frac{2}{x + 2}, x \neq -2$
- C. $\frac{2}{x}, x \neq -2, 0, 2,$
- D. $\frac{2}{x}, x \neq 0$
6. An expression with a non-permissible value of $x = 1$ has been simplified to x . Determine an equivalent rational expression for the simplified expression.

Use the following information to answer the next question.

The expression $\frac{ab}{c}$ can be simplified to $\frac{x + 4}{x + 3}, x \neq -3, 3$. Henry knows that one expression can be selected from each of the columns below to form a correct simplification.

Possibilities for a	Code	Possibilities for b	Code	Possibilities for c	Code
$(x - 3)$	1	$(2x + 8)$	4	$(3x^2 - 27)$	7
$(2x - 6)$	2	$(x + 4)$	5	$(2x^2 - 18)$	8
$(3x - 9)$	3	$\frac{1}{2}(x + 4)$	6	$(x^2 - 9)$	9

Numerical Response

7. One possible selection to form a correct simplification is $(x - 3)$, $(x + 4)$, and $(x^2 - 9)$, so Henry records the code 159. To form another correct simplification, a code for another possibility for

a is _____ (Record in the **first** column)

b is _____ (Record in the **second** column)

c is _____ (Record in the **third** column)

8. Simplify the following. State all non-permissible values.

a. $\frac{5}{3x^2} \cdot \frac{6x}{x+2}$

b. $\frac{x}{x+2} \cdot \frac{x+2}{x-3}$

c. $\frac{x+3}{5x-1} \div \frac{2x+6}{4x}$

d. $\frac{x^2+3x}{x^2-4} \div \frac{x+3}{x+2}$

9. Simplify the following. State all non-permissible values.

a. $\frac{3}{5x} + \frac{7x}{4}$

b. $\frac{4x}{x+2} - \frac{5x+3}{x+2}$

c. $\frac{x}{3-x} - \frac{3}{x-3}$

d. $\frac{x}{x^2-4} + \frac{3x}{x^2+2x}$

e. $\frac{x^2+3x}{x^2-4} + \frac{x^2+5x}{x+2}$

10. Solve each equation.

a. $\frac{5x-1}{4x+11} = \frac{3}{4}$

b. $\frac{3}{x} + \frac{5}{3} = 10$

c. $\frac{4}{x} + \frac{6x}{x+1} = 6$

d. $\frac{2x}{x+3} + \frac{x}{x-3} = \frac{18}{x^2-9}$

Use the following information to answer the next question.

A student solved a rational equation using the steps shown below.

$$\frac{x}{x+1} - \frac{3}{x-2} = -9, x \neq -1, 2$$

Step 1 $x(x-2) - 3(x+1) = -9$

Step 2 $x^2 - 2x - 3x - 3 = -9$

Step 3 $x^2 - 5x + 6 = 0$

Step 4 $(x-3)(x-2) = 0$

Step 5 $x = 3, 2$

11. Identify the errors made in the steps shown above, and justify the corrections necessary to obtain the correct solution.

Use the following information to answer the next question.

Elliott Nicholls currently holds the world record for the fastest text messaging while blindfolded. He was able to text 160 characters in a time that was 40 seconds less than the previous world record holder's time. Elliott's average rate of texting was 1.6 characters/second faster than the previous world record holder's average rate of texting. The chart below summarizes this information.

	Number of Characters	Time Taken (s)	Average Rate of Texting (characters/s)
Previous record holder	160	x	$\frac{160}{x}$
Elliott	160	$x - 40$	$\frac{160}{x - 40}$

12. The following equation models this information.

$$\frac{160}{x - 40} - \frac{160}{x} = 1.6$$

- State the non-permissible values of x for this equation.
 - Describe the values of x that must be rejected for this context.
 - The equation can be simplified to obtain $1.6x^2 - 64x - 6\,400 = 0$. Solve this equation algebraically. Express your solution to the nearest tenth of a second.
 - Do the solutions for x make sense in this context? Explain why or why not.
13. Write $4^2 = 16$ in logarithmic form.
14. Evaluate $\log_2\left(\frac{1}{16}\right)$.

15. Write each of the following logarithmic equations in exponential form.

a. $\log(100) = 2$

b. $\log_2 8 = 3$

c. $\ln(x) = 2$

d. $\log_a 5 = 2$

16. Use the laws of logarithms to determine the value of each of the following.

a. $\log_6 3 + \log_6 12$

b. $\log 520 - \log 52$

17. Describe how to estimate the value of $\log_2 15$ without using technology.

18. Express $2 \ln x - \ln y$ as a single logarithm.

19. Express $\log 6$ in a different logarithmic form.

20. Solve algebraically.

a. $3 = 9^{2x}$

b. $2^{(x-1)} = 4^{(x-2)}$

c. $10 = 3^x$

d. $2^{(x-1)} = 3$

21. Describe how to determine the solution of $2^{(x-1)} = 3^{(x-2)}$ graphically.

Use the following information to answer the next question.

Sam deposits \$100 into a savings account that pays 2.4%/a, compounded monthly. A function that models the growth of the deposit is

$$y = 100\left(1 + \frac{0.024}{12}\right)^x$$

where x = number of months and y = value of investment, in dollars.

22. a. Determine how long it will take for the investment to be worth at least \$150 at 2.4%/a, compounded monthly
- b. Modify the exponential function to reflect an interest rate of 4%/a, compounded quarterly.

Use the following information to answer the next question.

The intensity of an earthquake can be calculated using the formula

$$I = I_0(10)^M$$

where I represents the intensity of an earthquake, M is the magnitude of the earthquake on the Richter scale, and I_0 represents the intensity of an earthquake with a magnitude of 0.

23. Explain why an earthquake with a magnitude of 8.5 is almost 40 times as intense as an earthquake with a magnitude of 6.9.

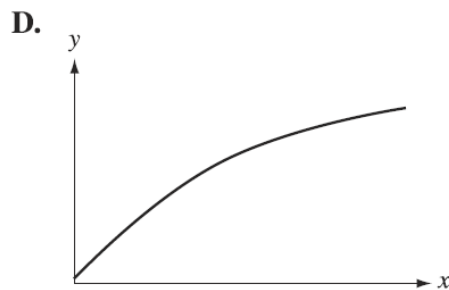
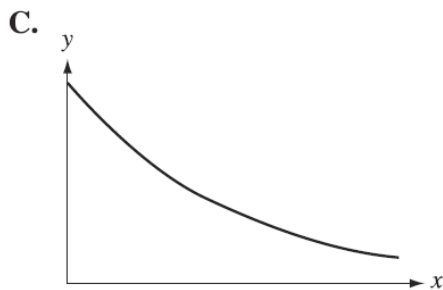
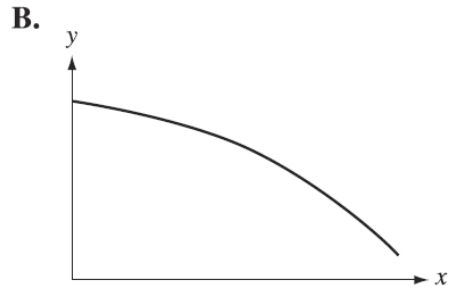
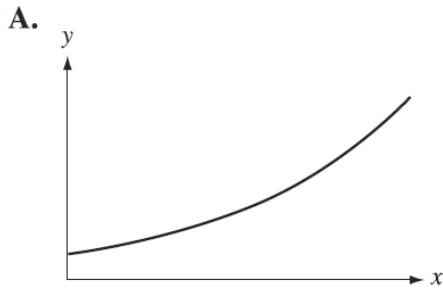
Use the following information to answer the next question.

A researcher discovered mould growing in a Petri dish in her laboratory. When first observed, the mould covered only 3% of the dish's surface. Every 24 hours, the surface area of the mould doubles in size, as shown in the table below.

Time (h)	Area covered (%)
0	3
24	6
48	
72	

24. a. Complete the table above and then write an exponential function to model the growth of the mould over time.
- b. Use your function from part (a) to determine the approximate length of time, to the nearest tenth of an hour, it will take for the Petri dish to be completely covered with mould.

25. A painting was purchased in 2012 for \$10 000. If the painting appreciates in value at 5%/a, then which of the following graphs best models the appreciated value of this painting for the next 40 years?



Use the following information to answer the next question.

The pH of a solution can be determined using the formula

$$\text{pH} = -\log_{10}(C)$$

where C is the concentration of hydrogen ions in the solution. The pH of a particular solution is 6.6.

Numerical Response

26. To the nearest tenth, if the concentration of hydrogen ions in the solution is doubled, the new pH of the solution will be _____.

Use the following information to answer the next question.

Corlene invested money in a GIC that pays interest compounded annually, as shown in the table below.

Year	Value of Investment
0	\$1 000.00
1	\$1 020.00
2	\$1 040.40
3	\$1 061.21

27. a. To model the investment's growth and predict its future value, Corlene has chosen to use an exponential model. Discuss the effectiveness of her model.
- b. Write an exponential function that Corlene could use to predict the future value of her investment. Explain what the numerical values in your function represent in the context of this problem.
- c. If Corlene invested in a GIC that paid 1.40%/a compounded annually, how would this affect the value of the investment over time?
- d. If Corlene invested in a GIC that paid 1.40%/a compounded annually, how would this affect the function found in Part b?

Use the following information to answer the next question.

When objects of different mass are compared without a scale, to be perceived the difference in mass must be large enough. For example, when held in a person's hands, masses within 5 g of 100 g will seem to be the same. The 5 g difference is known as the Minimum Perceivable Difference.

For heavier objects, the Minimum Perceivable Difference increases. The Minimum Perceivable Difference for various masses is shown in the table below.

Mass (g)	Minimum Perceivable Difference (g)
100	5
200	10
400	15
800	20

These data can be modelled by a logarithmic regression function of the form

$$y = a + b \ln(x)$$

where x is the mass of the object, in grams, and y is the Minimum Perceivable Difference in mass, in grams.

28. a. Determine a logarithmic regression function of the form $y = a + b \ln(x)$, to model these data. Round values of a and b to the nearest tenth.
- b. Based on the regression equation, determine the Minimum Perceivable Difference for a 2100 g object, to the nearest whole gram.
29. Describe the graph of $f(x) = -(x + 1)(x - 2)^2$. Include the intercepts, minimum, maximum, domain, and range in your description.

Use the following information to answer the next two questions.

A 15-gallon tank is being filled with water and has a pump that will cause it to drain when the amount of water inside the tank hits a certain volume. The volume of water in the tank over a 3-hour period can be modelled by the function

$$y = -2t^2 + 5t + 6$$

where y represents the volume of water in the tank in gallons and t represents the time in hours after noon on a particular day.

30. To determine the volume of water in the tank at noon, the characteristic of the function that should be analyzed is the
- A. y -intercept
 - B. positive t -intercept
 - C. t -coordinate of the vertex
 - D. y -coordinate of the vertex

Numerical Response

31. The maximum volume of liquid in the tank, to the nearest tenth of a gallon, is _____ gallons.

Use the following information to answer the next question.

The rate at which snow fell on a driveway on a particular day can be modelled by

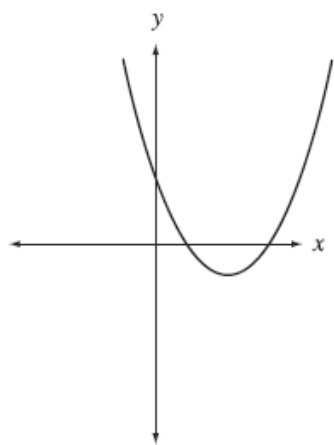
$$y = -3x^2 + 6x$$

where y represents the rate of snowfall in ft^3/hr , and x represents the time in hours after midnight.

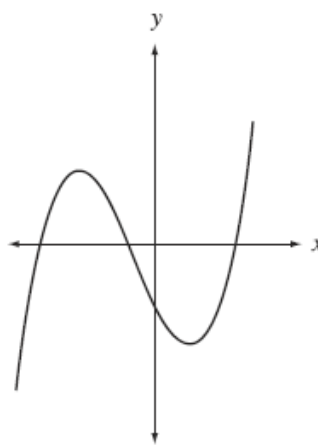
32. To estimate the length of time that snow fell on this particular day, a student should determine the
- A. y -intercept
 - B. x -coordinate of the vertex
 - C. y -coordinate of the vertex
 - D. difference between the x -intercepts

33. Which of the following graphs would most likely represent the graph of a cubic function?

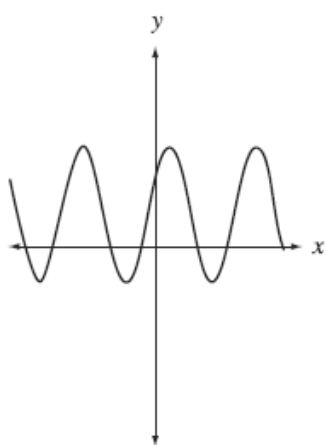
A.



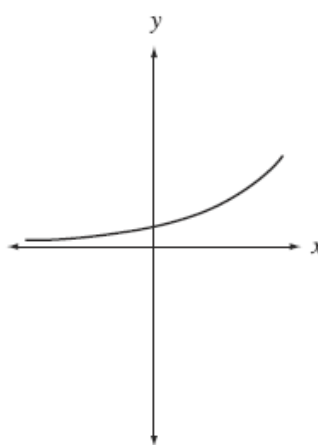
B.



C.



D.



Use the following information to answer the next question.

A hockey arena seats 1 600 people. The cost of a ticket is \$10. At this price, every ticket is sold. To obtain more revenue, the arena management plans to increase the ticket price. A survey was conducted to estimate the potential revenue for different ticket prices, as shown below.

Ticket price (\$)	Potential Revenue (\$)
10	16 000
15	19 500
20	20 300
25	14 750
30	5 500

The data above can be modelled by a quadratic regression function of the form

$$y = ax^2 + bx + c$$

where x is the ticket price, in dollars, and y is the potential revenue, in dollars.

34. Determine the ticket price that would maximize the revenue.

Use the following information to answer the next question.

A juice box measures 5.0 cm \times 4.0 cm \times 12.0 cm and contains 240 mL of juice. The manufacturer wants to design a larger box by increasing each dimension of the juice box by the same amount.

The volume of the larger box can be modelled by the function

$$V = (5 + x)(4 + x)(12 + x)$$

where V represents the volume, in mL, and x represents the increase in the length of each dimension, in cm.

Note: 1 cm³ = 1 mL

Numerical Response

35. If the larger box must hold a maximum of 1 000 mL of juice, the amount, x , by which each dimension of the juice box must be increased, to the nearest tenth of a centimetre, is _____ cm.

Use the following information to answer the next question.

The height of a pendulum, h , in inches, above a table top t seconds after the pendulum is released can be modelled by the sinusoidal regression function

$$h = 2 \sin(3.14t - 1) + 5$$

Numerical Response

36. To the nearest tenth of an inch, the height of the pendulum at the moment of release is _____ in.

Use the following information to answer the next two questions.

The height of a rider on a Ferris wheel can be modelled by the sinusoidal regression function

$$h = 6 \sin(1.05t - 1.57) + 8$$

where h is the height of the rider above the ground, in metres, and t is the time in minutes after the ride starts.

37. According to the sinusoidal regression function, the maximum height of the rider above the ground is
- A. 2 m
 - B. 6 m
 - C. 8 m
 - D. 14 m

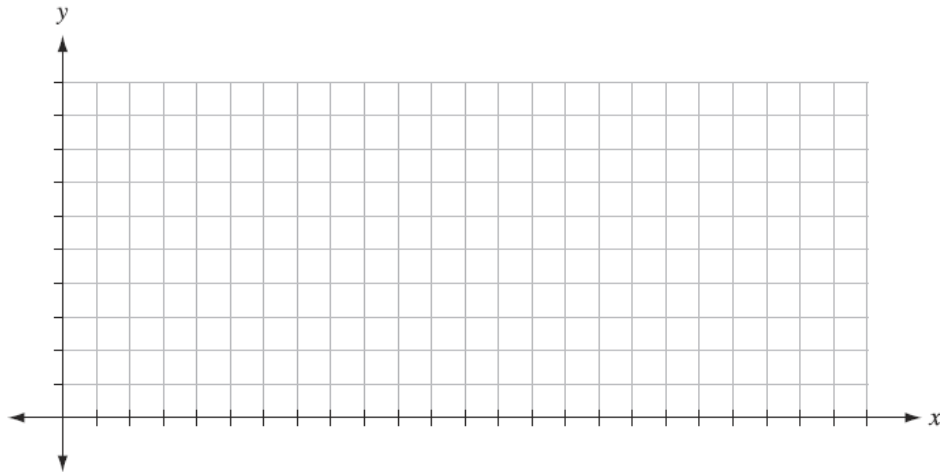
Numerical Response

38. When the rider is at least 11.5 m above the ground, she can see the rodeo grounds. During each rotation of the Ferris wheel, the length of time that the rider can see the rodeo grounds, to the nearest tenth of a minute, is _____ min.

Use the following information to answer the next question.

A Ferris wheel has a radius of 8 m and its centre is 10 m above the ground. A rider gets on a chair of the Ferris wheel at its lowest point and completes one full revolution in 48 seconds.

39. a. Sketch a graph of the rider's height above the ground over the first 48 seconds on the grid below and label key points on the graph.



- b. State the amplitude, period, and equation of the midline for the function sketched in part a, above.
- c. Determine a function of the form $h = a \sin(bt - 1.57) + d$, where h represents the height of a rider above the ground and t represents the time after the ride has started that could be used to model the height of a rider on the Ferris wheel described above.

Use the following information to answer the next question.

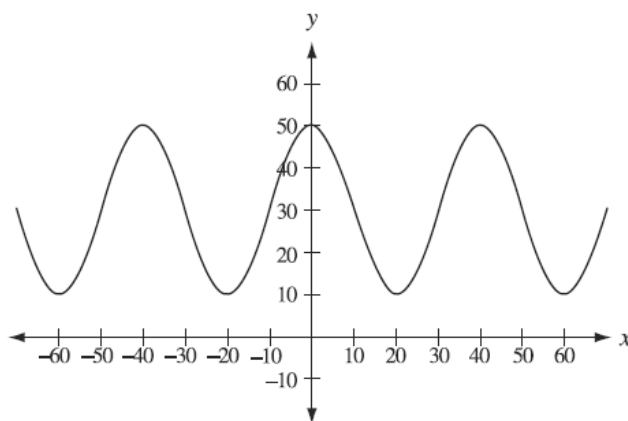
The average daily high temperature of Montreal, in °F, for each of the months of the year is shown in the table below. January is month 1, February is month 2, etc..

Month	Average Daily High Temperature in °F	Month	Average Daily High Temperature in °F
1	22	7	80
2	25	8	77
3	36	9	67
4	52	10	51
5	66	11	41
6	75	12	28

40. Write a sinusoidal regression function of the form $y = a \cdot \sin(bx + c) + d$, where x is the month number and y is the average daily high temperature, that could be used to model these data. Round the values of a , b , c , and d to the nearest hundredth.

Use the following information to answer the next question.

The graph of a sinusoidal function is shown below.



41. The amplitude of the sinusoidal function is *i* units and the midline is $y =$ *ii* units.

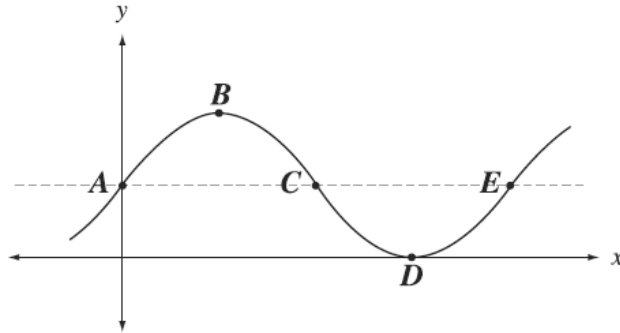
Pick one of the following choices to fill in each blank in the statement above:

Choices for amplitude in blank *i* are: 10, 20, 30, 40, or 50

Choices for midline in blank *ii* are: 10, 20, 30, 40, or 50

Use the following information to answer the next question.

The graph of a sinusoidal function is shown below. The points A , B , C , D , and E are labelled.



42. a. Mary says that in order to find the period of the function, she would need to know the coordinates of points A and E . Bill says that he could find the period using the coordinates of B and D . Both Mary and Bill are correct. Explain why.
- b. Select all the points that represent the x -intercepts of the function.
- c. Select all the points that represent the minimum value of the function.
- d. Select two points that could be used to determine the amplitude of the function. Explain a process that could be used to determine the amplitude using the two selected points.