Date: _____

CHAPTER 7

Exponents

Get Set

Answer these questions to check your understanding of the Prerequisite Skills concepts on pages 354–355 of the *Foundations for College Mathematics 11* textbook.

Powers

1. Write each product as a power.

a) $5 \times 5 \times 5$

b) $(-2)(-2)(-2)(-2)(-2)$

c) $(-3)(-3)(-3)(-3)(-3)(-3)$

d) $\left(\frac{1}{4}\right)\left(\frac{1}{4}\right)\left(\frac{1}{4}\right)\left(\frac{1}{4}\right)\left(\frac{1}{4}\right)$

2. Evaluate each power.

a) 6^2 **b)** $(-3)^4$ **c)** -2^7 **d)** $(-2)^3$ **e)** -4^5

Linear Relations

3. Identify the slope and the y-intercept of each linear relation.

a) $y = 2x + 1$ **b)** $y = \frac{1}{2}x - 5$ **c)** $y = -3x$

4. John is paid \$100 per day plus \$2 per phone call as a marketing representative. Write the amount John earns in a day as a linear relation.

Evaluate Formulas

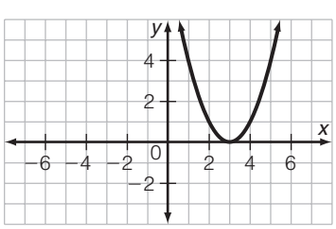
5. Evaluate each formula by substituting the values for the indicated variables.

a) $P = 1500(1 + i)^n$ $i = 0.05$, $n = 10$ **b)** $V = \pi r^2 h$ $r = 2$ m, $h = 5$ m

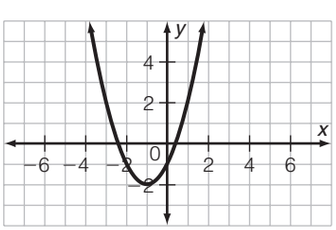
Quadratic Relations

6. Describe how each graph differs from the graph of $y = x^2$.

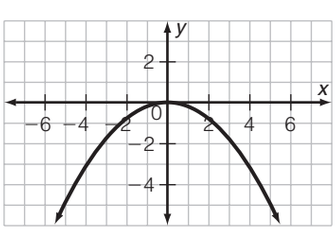
a)



b)



c)



Date: _____

7.1 Exponent Rules

Textbook pp. 356–363

Warm-Up

1. Number Skills

Write each percent as a decimal.

a) 29%

b) 3.1%

c) 235%

2. Algebra

Solve.

$6(x + 1) = 2x + 18$

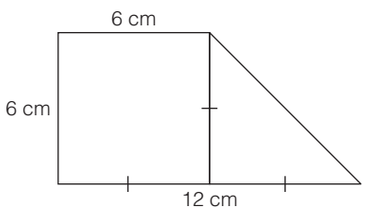
3. Relations

Fine are the slope and the y-intercept of the linear relation.

$$y = -3x + 1$$

4. Geometry/Measurement

Find the area and the perimeter of this figure. Round your answers to the nearest tenth of a unit, if necessary.



5. Data/Probability

A coin is tossed three times. What is the probability of getting two tails?

6. Modelling

John earns $5 per hour, plus $1 for each ticket he sells. Write an equation to model John's total earnings.

7. Math Literacy

A hexagon is

A a 6-sided figure

B a 4-sided figure with opposite sides parallel

C an 8-sided figure

D a figure with all sides equal

8. Previous Section

Identify the coordinates of the vertex of the quadratic relation.

$$y = -2(x + 1)^2 - 5$$

Date: _____

Section 7.1

Practise

1. Fill in the blanks to write each expression as a single power, then evaluate.

a) $2^2 \times 2^3$

$2^{\square} =$ ____

b) $(-4)^2 \times (-4)$

$(-4)^{\square} =$ ____

c) $(-1)^2 \times (-1)^4$

$(-1)^{\square} =$ ____

d) $\left(\frac{3}{4}\right)^2 \times \left(\frac{3}{4}\right) \times \left(\frac{3}{4}\right)^3$

$\left(\frac{3}{4}\right)^{\square} =$ ____

2. Write each expression as a single power, then evaluate.

a) $7^4 \div 7^2$

$7^{\square} =$ ____

b) $3^{10} \div 3^8$

$3^{\square} =$ ____

c) $\frac{(-4)^7}{(-4)^4}$

d) $\frac{3^4}{3} \times 3^2$

3. Write as single powers, then evaluate.

a) $(2^2)^4$

$2^{\square} =$ ____

b) $((-2)^3)^2$

$(-2)^{\square} =$ ____

c) $\left(\frac{1}{4^2}\right)^3$

d) $((-1)^4)^5$

4. Show two ways to evaluate each expression.

a) $3^3 \times 3^2$

b) $\frac{5^4}{5^3} \times 5^2$

5. Write each expression as a single power, then evaluate.

a) $6^2 \times 6^3$

b) $[(-5)^3]^2$

c) $\left(\frac{8}{3^3}\right)^2$

d) $\left(-\frac{3}{5}\right)^5 \div \left(-\frac{3}{5}\right)^2$

6. a) Write 9^7 as the product of two powers in two ways.

b) Write 3^8 as a quotient of two powers in two ways.

Date: _____

7.2 Zero and Negative Exponents

Textbook pp. 364–371

Warm-Up

1. Number Skills

Order the fractions from least to greatest.

$\frac{2}{3}, \frac{3}{10}, \frac{4}{5}, \frac{3}{8}$

2. Algebra

Expand and simplify.

$(x + 3)(x + 5)$

3. Relations

Identify each relation as linear or quadratic.

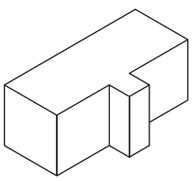
a) $y = -\frac{1}{2}x^2 - 7$

b) $y = 2(x + 3)^2 + 5$

c) $y = 6x$

4. Geometry/Measurement

Sketch the top, front, and side views of this object.



5. Data/Probability

Find the mean, the median, and the mode of the set of data.

22, 16, 29, 6, 35, 18, 1, 12, 22, 4

6. Problem Solving

If half of one-fifth of an amount is $1, what is the amount?

7. Math Literacy

Rearrange the letters to spell the term for the branch of mathematics used to solve problems related to the side lengths and angles of right triangles.

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8. Previous Section

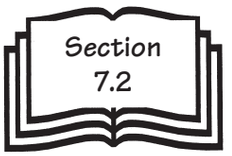
Write each as a single power.

a) $6^7 \times 6^2$

b) $(-4)^9 \div (-4)$

c) $[(-5)^2]^4$

Date: _____



Practise

1. Add an exponent to each base to make each equation correct.

a) $\frac{1}{8^{7}} = 8$ **b)** $6^{5} = \left(\frac{1}{6}\right)$

c) $4^{-2} = \left(\frac{1}{4}\right)$ **d)** $\frac{1}{3^{-6}} = 3$

2. Evaluate each pair. Express your answers as whole numbers or fractions.

a) 2^{3}, 2^{-3} **b)** 4^{2}, 4^{-2} **c)** 10^{5}, 10^{-5} **d)** $(-2)^{6}$, $(-2)^{-6}$

3. Evaluate. Express your answers as whole numbers or fractions.

a) $\left(-\frac{1}{3}\right)^{-3}$ **b)** $(-20)^{-2}$ **c)** 5000^{0}

d) $(-10)^{-4}$ **e)** $\left(\frac{1}{5}\right)^{0}$ **f)** $\left(-\frac{1}{2}\right)^{-4}$

4. Rewrite each as a single power, then evaluate. Express your answers as whole numbers or fractions.

a) $10^{5} \times 10^{-2}$ **b)** $\left(\frac{1}{6}\right)^{-8} \times \left(\frac{1}{6}\right)^{6}$ **c)** $\frac{3^{4}}{3^{-2}}$

d) $(2^{-3})^{2}$ **e)** $\left(\frac{1}{5}\right)^{-6}\left(\frac{1}{5}\right)^{3}$ **f)** $(-5)^{4}(-5)^{-2}$

5. Write each numerator and denominator as a power, then use the exponent rules to simplify. Express your answer as a power with a whole number base.

a) $\frac{625}{25}$ **b)** $\frac{343}{49}$ **c)** $\frac{128}{32}$ **d)** $\frac{6561}{81}$

Date: _____

7.3 Investigate Exponential Relationships

Textbook pp. 372–381

Warm-Up

1. Number Skills

Round each number to the nearest hundred.

a) 1047

b) 6983

c) 32 661

2. Algebra

Evaluate the expression for $x = -7$.

$$3x + 5 - x - 1$$

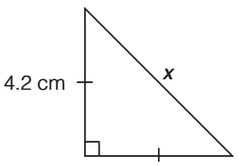
3. Relations

Does the relation have a maximum or a minimum value? Find the maximum or minimum value.

$$y = -4(x + 2)^2 - 6$$

4. Geometry/Measurement

Solve for x. Round your answer to the nearest tenth of a centimetre.



5. Data/Probability

A bag contains 6 blue marbles, 2 yellow marbles, and 8 red marbles. Without looking, Shauna removes one marble from the bag. What is the probability that the marble is

a) red

b) not yellow

6. Problem Solving

A radioactive material decays by 2^{-1} every 8 h. Initially, the mass of a sample was 1600 mg. How much remained after

a) 48 h?

b) 3 days?

7. Math Literacy

What is the name for a three-dimensional geometric shape with one square face and four congruent triangular faces?

8. Previous Section

Evaluate. Express your answers as whole numbers or fractions.

a) 5^{-3}

b) 6^0

c) $\left(\frac{3}{4}\right)^{-2}$

Date: _____

Section 7.3

Practise

1. Which of these relations are exponential?

a)

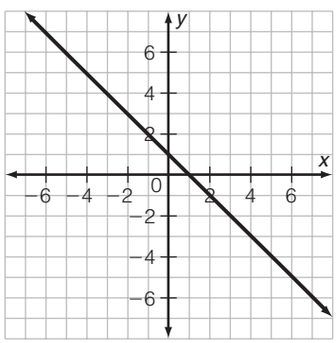
x	y
1	1
2	3
3	5
4	7
5	9
6	11

b)

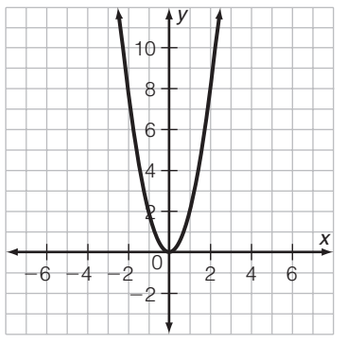
x	y
1	6
2	18
3	54
4	162
5	486
6	1458

2. Which of these graphs could represent an exponential relation?

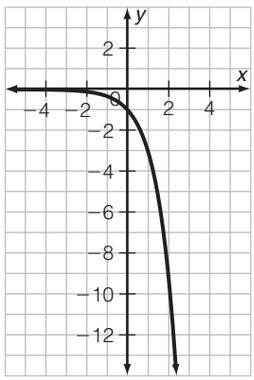
a)



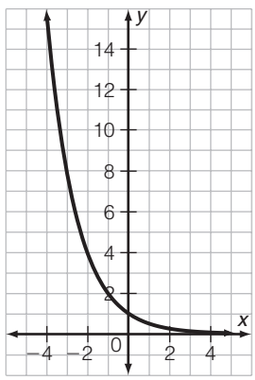
b)



c)



d)



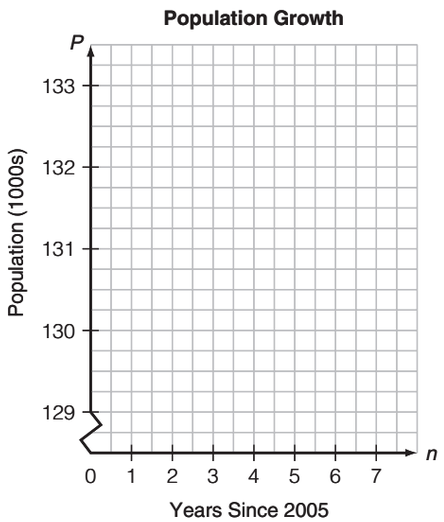
3. A car worth $30 000 loses 25% of its value each year after it is purchased. The value of the vehicle, V, can be modelled by the relation $V = 30\,000(0.75)^t$, where t is the time in years. Complete the table.

Time (years)	Value ($)
0	30 000.00
1	22 500.00
2	16 875.00
3	
4	
5	

Date: _____

4. In 2005, the population of a small city was 129 800. The population, P, can be estimated by the relation $P = 129\,800(1.005)^n$, where n is the number of years after 2005. Complete the table and sketch a graph of the relation. Round your answers to the nearest whole number.

n	P
0	129 800
1	130 449
2	
3	
4	



5. Which model (linear, quadratic, or exponential) would best describe each situation?

a) the number of bacteria in a culture that doubles every hour

b) the height of an object falling from the top of a bridge

c) the path of a volleyball when tossed into the air

d) a car accelerating 5 km/h each second

6. The number of algae cells on a pond doubles every 2 days, until the surface of the pond is completely covered. Today, $\frac{1}{8}$ of the pond is covered in algae.

a) What fraction of the surface of the pond will be covered in 4 days?

b) How long will it take for the pond to be completely covered? Show your work.

Date: _____

7.4 Exponential Relations

Textbook pp. 382–394

Warm-Up

1. Number Skills

Evaluate.

a) $6 + 3 \times (-5) - 4$

b) $(8 - 2) \times (3 + 4)$

2. Algebra

Solve.

$\frac{1}{4}x + 17 = 3x - 16$

3. Relations

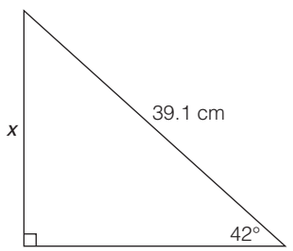
Complete the table of values for the relation.

$y = \left(\frac{1}{4}\right)^x$

x	y
–4	
–3	
–2	
–1	
0	
1	

4. Geometry/Measurement

Solve for x. Round you answer to the nearest tenth of a centimetre.

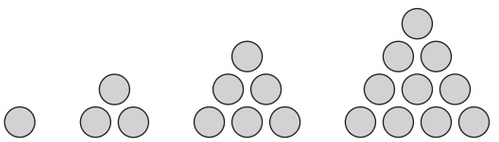


5. Data/Probability

A die is rolled and a coin is tossed at the same time. What is the probability of getting an even number and heads?

6. Problem Solving

Here are the first four triangular numbers.



How many dots are needed for the 7th triangular number?

7. Math Literacy

Explain the meaning of the slope of a linear relation.

8. Previous Section

Show that this relation is exponential.

x	y
0	1
1	4
2	16
3	64
4	256
5	1024

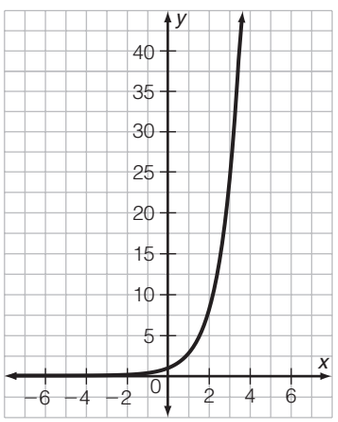
Date: _____

Practise

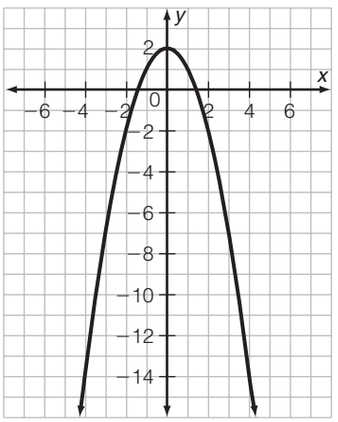
Section 7.4

1. Identify the type of growth (linear, quadratic, or exponential) illustrated by each graph.

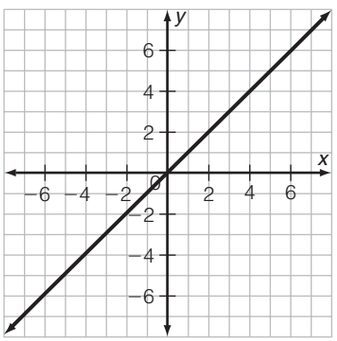
a)



b)



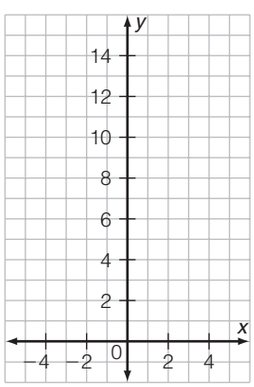
c)



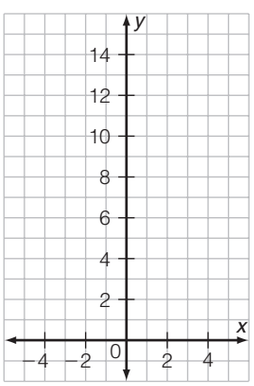
2. How do the graphs of $y = 3^x$ and $y = \left(\frac{1}{3}\right)^x$ compare?

3. Sketch each exponential relation.

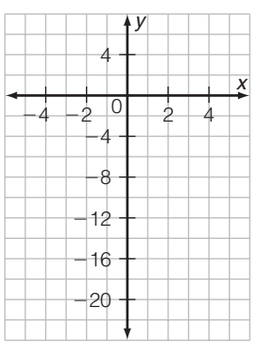
a) $y = \left(\frac{1}{2}\right)^x$



b) $y = 4^x$



c) $y = -2 \times 3^x$



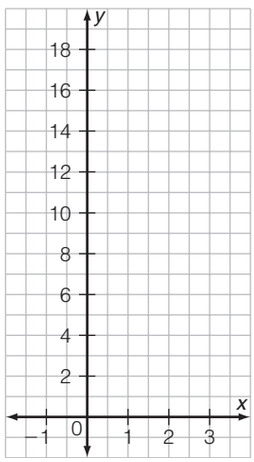
Date: _____

Section 7.4

4. Complete the table of values. Graph each pair of the relations on the same set of axes.

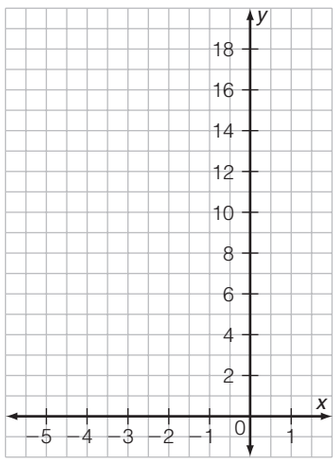
a)

x	$y = 2^x$	$y = 2^{2x}$
−2		
−1		
0	1	1
1	2	4
2	4	
3		
4		



b)

x	$y = (0.6)^x$	$y = \frac{1}{2}(0.6)^x$
−6		
−5		
−4		
−3		
−2		
−1		
0	1	0.5
1	0.6	0.3
2		



5. The cost increase in an item, C, due to inflation can be modelled by the relation $C = 100(1.025)^t$, where t is the number of years after 1920. Use this relation to determine the year when an item costing \$100 in 1920 would cost \$300.

Date: _____

7.5 Modelling Exponential Growth and Decay

Textbook pp. 395–405

Warm-Up

1. Number Skills

Estimate each sum or difference.

a) 3.619 + 4.261

b) 52.994 + 47.304

c) 24.879 – 15.023

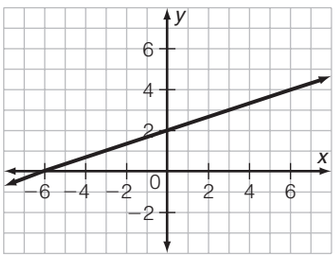
2. Algebra

Factor.

$x^2 + 10x - 11$

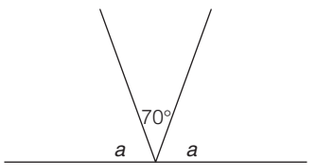
3. Relations

Write an equation for the linear relation.



4. Geometry/Measurement

Find the measures of the indicated angles.



5. Data/Probability

In an experiment, you randomly select a token from a container that has 5 green, 4 orange, and 7 purple tokens.

a) State an outcome that is impossible.

b) State an outcome that is likely.

6. Modelling

Katherine is 8 cm taller than Christine. The sum of their heights is 238 cm. Write an equation to model this situation.

7. Math Literacy

Describe the difference between the height of a cone and the slant height of the cone.

8. Previous Section

Identify the coordinates of the y-intercept of the relation.

$y = -2\left(\frac{1}{2}\right)^x$

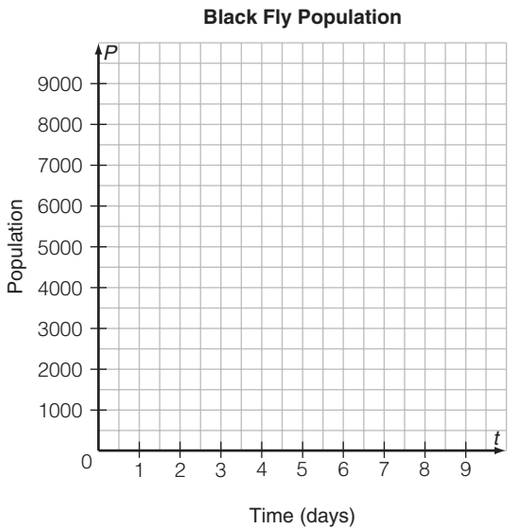
Date: _____

Section 7.5

Practise

1. Late in the summer, as the evening temperature decreases, the population of black flies decreases at a rate of 3% per day. The population being studied can be modelled by the relation $P = 8850(0.97)^t$, where P is the number of black flies and t is the time in days from the start of the study.

a) Graph the relation.



b) What is the population of black flies at the start of the study?

c) What is the population at the end of the first week?

d) Approximately how long will it take for the population to be reduced by 50%?

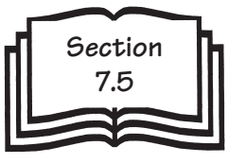
2. The population of elk on a reserve is declining by 2.8% per year. The population can be modelled by the relation $P = 1500(0.972)^n$, where P is the population after n years.

a) What is the current elk population?

b) What is the population expected to be after 10 years?

c) Suppose the elk population continues to decline at this rate. What is the half-life of the elk population?

Date: _____



3. Joel invested some money. The value of his investment can be modelled by the relation $A = 12\,000(1.04)^t$, where A is the value of the investment and t is the time in years.

a) What is the A-intercept? What does this value represent?

b) What will be the value of this investment in 5 years?

4. The world's population in 1980 was about 4.5 billion. Suppose the population increased at a rate of 2% per year since then.

a) Write an exponential relation to model the world's population.

b) Use your model to predict the world's population in 2015.

c) What was the population in 1970? What assumptions have you made?

d) According to this model, in what year will the population reach 10.5 billion?

5. The table shows the amount of radioactive material remaining from a 1000-g sample.

Time (days)	Amount (g)
0	1000
1	940
2	884
3	831
4	781
5	734

a) Write an exponential relation to model the situation.

b) Use this equation to determine the amount that will remain after 10 days.

c) When will there be 20 g remaining?

Date: _____

7.6 Solve Problems Involving Exponential Growth and Decay

Textbook pp. 406–413

Warm-Up

1. Number Skills

Write each fraction as a decimal.

a) $\frac{7}{8}$

b) $\frac{4}{9}$

c) $\frac{2}{15}$

2. Algebra

Factor.

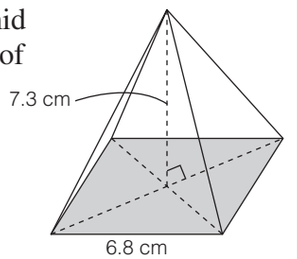
$6x^2 + 18x$

3. Relations

How does the graph of $y = -(x - 3)^2 - 1$ compare to the graph of $y = x^2$?

4. Geometry/Measurement

Find the volume of the square-based pyramid to the nearest tenth of a cubic centimetre.



5. Data/Probability

Ali has a spinner with three congruent sections labelled 1, 2, and 3. He spins the pointer twice. Make a tree diagram to show all the possible outcomes.

6. Problem Solving

Continue each pattern for three more terms.

a) 2, –6, 18, –54, 162

b) 2, 3, 5, 9, 17

7. Math Literacy

What is the name for an angle that measures more than 90° but less than 180°?

8. Previous Section

The population, P, of cells in a culture can be estimated using the formula $P = 400(2.4)^t$, where t is the time in hours.

a) What is the initial population of cells in the culture?

b) What is the population after 6 h?

Date: _____

Practise

Section 7.6

1. The half-life of carbon-14 is 5730 years. The relation $C = \left(\frac{1}{2}\right)^{\frac{n}{5730}}$ is used to calculate the concentration, C, in parts per trillion, remaining n years after death. Determine the carbon-14 concentration, rounded to three decimal places, in

a) a 5730 year-old fossil

b) a 10 000-year old animal bone

2. The population, P, of penguins in a certain region of Antarctica can be modelled by the relation $P = P_0 2^{\frac{t}{90}}$, where t is the time, measured in months and P_0 is the initial number of penguins.

a) What does the value of 90 represent in this formula?

b) If there are 800 penguins in the region today, how many will there be in 2 years?

3. Stage lights are often covered with gels to colour the light, but this also reduces the intensity of the light. The intensity of light, I, in watts per square centimetre is given by the relation $I = 1400\left(\frac{3}{5}\right)^n$, where n is the number of gels used. Find the intensity of light with 5 gels.

4. The population of a village is decreasing by 7% per year. In 2006, the population was 19 800.

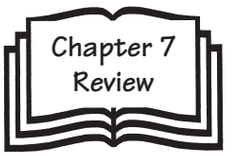
a) Write an exponential relation that models the population, P, over time t. Use $t = 0$ to represent the year 2006.

b) Use the relation from part a) to estimate the population in 2010.

c) In what year will the population decrease to half its 2006 value?

Date: _____

Chapter 7 Review



7.1 Exponent Rules, textbook pages 356–363

1. Write each as a single power, then evaluate.

a) $4^7 \div 4^4$ **b)** $\left(\frac{1}{3}\right)^2 \times \left(\frac{1}{3}\right)^3$ **c)** $[(-5)^2]^2$

d) $\left(-\frac{1}{2}\right)^3 \times \left(-\frac{1}{2}\right)^4$ **e)** $(-3)^3 \div (-3)^2$ **f)** $\left[\left(-\frac{1}{4}\right)^2\right]^2$

7.2 Zero and Negative Exponents, textbook pages 364–371

2. Evaluate. Express each answer as a whole number or a fraction.

a) 10^0 **b)** 6^{-1} **c)** 3^{-2}

d) $5^3 \times 5^{-5}$ **e)** $[(-4)^2]^{-2}$ **f)** $\left(\frac{4}{3}\right)^{-3}$

7.3 Investigate Exponential Relationships, textbook pages 372–381

3. A certain type of bacteria doubles every 8 h. A culture begins with 6000 bacteria. How many bacteria are there after

a) 8 h? **b)** 16 h? **c)** 2 days?

7.4 Exponential Relations, textbook pages 382–394

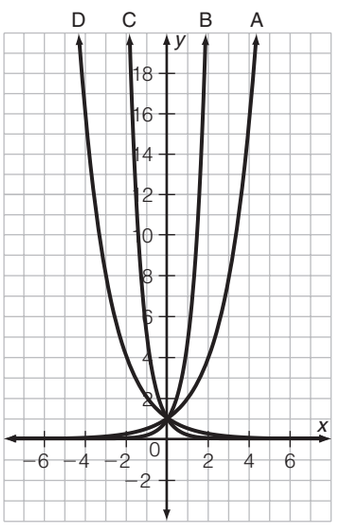
4. Match each relation with its graph.

a) $y = \left(\frac{1}{5}\right)^x$

b) $y = 2^x$

c) $y = \left(\frac{1}{2}\right)^x$

d) $y = 5^x$



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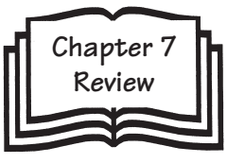

5. Sound pressure, in micropascals, is the air pressure exerted by sound waves on objects such as your eardrums. The relationship between sound intensity, measured in decibels (dB), and sound pressure (P), is given by the relation $P = 20 \times 10^{\frac{dB}{20}}$.

a) Normal conversation measures 60 dB. Sound at a rock concert can reach 120 dB. Compare the sound pressures for these two situations.

b) If the sound level reaches 160 dB, it can perforate your eardrums. What sound pressure will cause this?

7.5 Modelling Exponential Growth and Decay, textbook pages 395–405

6. The population of rabbits in an area is growing according to the relation $P = 1300(1.015)^n$, where P is the population and n is the number of years.

a) What is the current rabbit population?

b) What is the expected population in 5 years?

7. A motion detector recorded the amplitude of an oscillating spring. The table shows the results over a 5-min period.

Time (s)	0	30	60	90	120	150	180	210	240	270	300
Amplitude (cm)	9.2	7.2	5.5	4.4	3.4	2.6	2.0	1.6	1.3	1.0	0.7

a) What is the approximate rate of decay?

b) How long will it take for the amplitude to become less than 0.5 cm?

7.6 Solve Problems Involving Exponential Growth and Decay, textbook pages 406–413

8. The remaining mass, M, in milligrams, of a drug in a person's bloodstream after t hours is modelled by the relation $M = 500\left(\frac{1}{2}\right)^{\frac{t}{2}}$.

a) What is the half-life of the drug?

b) What mass of the drug is in the bloodstream after 4 h?

c) How long would it take to reduce the amount of drug in the bloodstream to 62.5 mg?