Math 9 Name: Ms. B

3.4 Using Exponents to Solve Problems

Date: Apr. 3

Learning Goals: *I will learn to*

- solve problems that involve exponential expressions

Explore and Analyze

Mountain pine beetles can double their population in one year if conditions are right. They live in mature lodgepole and jack pine trees by boring into the bark. Only 5 mm long, these small beetles can kill pine trees if their numbers are great enough. Suppose the beetle population in a particular area is 10 000 and it doubles each year. What will the population be in 1 year? 2 years? 3 years? n years?

n years?

1. Create a table to show the growth of the population of pine beetles over 3 years.

Year	0 ×2	1 ×2	2 ×2	3
Population	10 000	20 000	40 000	80 000
Population in Exponential Form	$10\,000(2^0)$	10 000 × 2 $10\,000(2^1)$	10 000 × 2 × 2 $10\,000(2^2)$	10 000 × 2 × 2 × 2 $10\,000(2^3)$

2. What patterns do you notice?

- base = 2 ← tells us about "growth" (we used 2 because the population doubles)
- coefficient = 10 000 ← initial population
- exponent changes → number of times the population doubles (same as number of years)

3. Write an equation (formula) in exponential form to determine the number of beetles, B, in n years. Explain what each value represents.

$$B = 10\,000(2^n)$$

- B: Beetle population
- 10 000: starting population
- 2: growth (population doubles)
- n: number of years = number of times the population double

Develop Understanding

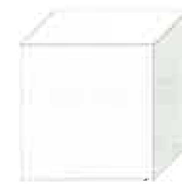
Example 1: Use Formulas to Solve Problems

square sides

s s $A = s^2$

Evaluate.

a) What is the surface area of a cube with an edge length of 4 cm?



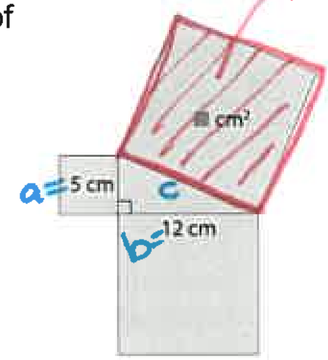
↳ 6 sides

area of all sides together

$$SA = 6s^2$$
$$= 6(4^2)$$
$$= 6(16)$$
$$= \boxed{96\ cm^2}$$

~~6×16~~

b) Three squares are attached to a right triangle. Find the area of the square attached to the hypotenuse in the diagram.

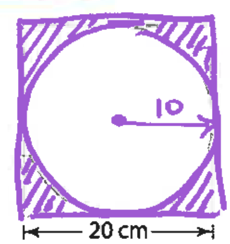


↑ longest side

Pythagoras

$$a^2 + b^2 = c^2$$
$$5^2 + 12^2 = c^2$$
$$25 + 144 = c^2$$
$$169 = c^2 \Longrightarrow \boxed{Area = 169\ cm^2}$$

c) A circle is inscribed in a square with a side length of 20 cm. What is the area of the shaded region?



area of square

20 20

$$A = s^2$$
$$= 20^2$$
$$= 400 cm^2$$

area of circle

10

$$A = \pi r^2$$
$$= \pi(10^2)$$
$$= \pi \times 100$$
$$= 314.16 cm^2$$

Shaded area = area of □ − area of ○

$$= 400 - 314.16$$
$$= \boxed{85.84\ cm^2}$$

Example 2: Develop a Formula to Solve a Problem

A dish holds 100 bacteria. Under ideal conditions, the bacteria double in number every hour. How many bacteria will be present after each number of hours?

a) 1

b) 5

c) n

time (hr)	bacteria	
(start) 0	100	$=100\times2^0$
1	200	$=100\times2^1$
2	400	$=100\times2^2$
3	800	$=100\times2^3$
4	1600	$=100\times2^4$
5	3200	$=100\times2^5$
⋮		
n	$100(2^n)$	

×2

a) $\boxed{200}$

b) $\boxed{3200}$

c) $\boxed{100(2^n)}$

Show You Know

base ×3

coeff.

A type of bacteria triples every hour. There are 50 bacteria to start with. How many will there be after each number of hours?

a) 3

$50\times3\times3\times3$

$=50(3^3)$

$=50(27)$

$=\boxed{1350}$

b) 5

$=50(3^5)$

$=50(243)$

$=\boxed{12150}$

c) t

$\boxed{50(3^t)}$

Formulas to remember…

Area of Circle	$A = \pi r^2$
Area of Square	$A = s^2$
Surface Area of Cube	$SA = 6s^2$
Volume of Cube	$V = s^3$
Pythagorean Theorem	$a^2 + b^2 = c^2$