

**LESSON
MASTER****2-1
A****Questions on SPUR Objectives**
See pages 134–137 for objectives.**Skills Objective A****In 1–5, translate into a variation equation.**Let k be the constant of variation.

- m varies directly as the fourth power of n . _____
- y is directly proportional to the fifth power of x . _____
- The height h of a cottonwood tree varies directly as the square of its circumference C . _____
- The distance d a star is from the earth is directly proportional to the length of time t it takes for its light to get here. _____
- The volume V of a cylinder with constant height varies directly as the square of the diameter d of its base. _____

Skills Objective B

- y varies directly as x . If $y = 8$ when $x = -3$, find y when $x = 16$. _____
- c is directly proportional to d^4 . If $c = -13,824$ when $d = 12$, find c when $d = 6$. _____

Uses Objective F**In 8 and 9, true or false.**

- The cost of filling a car's gas tank with gas varies directly as the volume of the tank. _____
- The outdoor temperature varies directly as the time of day. _____

Uses Objective G

- The number of volts across an electrical circuit with constant resistance varies directly as the strength of the current in amps. There are 500 volts across a circuit of 25 amps. What would be the voltage across a circuit of 60 amps? _____
- The surface of a sphere is directly proportional to the square of its radius. The surface area of a sphere with radius 3 cm is 36π cm². What is the surface area of a sphere with radius 12 cm? _____

**LESSON
MASTER**

Questions on SPUR Objectives
See pages 134–137 for objectives.

Vocabulary

1. Explain how *direct* and *inverse variation* differ.

Skills Objective A

In 2–6, translate into a variation equation.
Let k be the constant of variation.

2. y is inversely proportional to x . _____
3. F varies inversely with the square of r . _____
4. The gravitational pull F of the earth on a spaceship varies inversely as the square of the distance d of the spaceship from the earth. _____
5. In a spherical balloon with a constant mass of air, the pressure varies inversely as the cube of the radius. _____
6. In photography, the exposure E is inversely proportional to the square of the f-stop f . _____
7. Write the variation equation $y = \frac{k}{x^5}$ in words.

Skills Objective B

8. y varies inversely as the cube of x . If $y = 5$ when $x = 2$, find y when $x = 6$. _____
9. y varies inversely as the fourth power of x .
If $y = 5$ when $x = \frac{1}{2}$, find y when $x = \frac{1}{3}$. _____

► **LESSON MASTER 2-2A** page 2

Uses Objective F

In 10–14, complete with “directly,” “inversely,” or “neither directly nor inversely.”

10. The perimeter of a square varies _____?_____ as the length of the side. _____

11. A telephone bill varies _____?_____ as the number of telephone calls made. _____

12. The temperature in a house varies _____?_____ as the setting on the thermostat. _____

13. The intensity of light from a lamp varies _____?_____ as the square of the distance one sits from it. _____

14. The time required to fly from Charlotte to San Antonio varies _____?_____ with the speed at which the airplane flies. _____

Uses Objective G

15. The length of an organ pipe varies inversely as its pitch. If the pipe is $5\frac{1}{3}$ ft long, its frequency is 96 cycles per second. What is the frequency of a pipe which is 8 ft long? _____

16. The number of spans of steel needed to construct a bridge over a river varies inversely as the length of each span. If 10 spans are used, each span is 18 ft long. How long would each span be if 12 spans were used? _____

17. The resistance in a certain electrical circuit varies inversely as the square of the current through it. The resistance of the circuit is 10 ohms when the current is 15 amps. What is the resistance in the circuit when the circuit is 20 amps? _____

18. The force needed to keep a car on the road varies inversely as the radius of the curve. It requires 1286 N of force to keep a 1000-kg car traveling at 50 km/hr from skidding on a curve of radius 150 m. How much force is necessary to keep the same car traveling at the same speed from skidding on a curve of radius 750 m? _____

**LESSON
MASTER****2-3
A****Questions on SPUR Objectives**
See pages 134–137 for objectives.**Properties Objective D****In 1–4, suppose that in a variation problem the value of x is tripled. How is the value of y changed if**1. y varies directly as x ? _____2. y varies inversely as x ? _____3. y varies directly as x^2 ? _____4. y varies inversely as x^3 ? _____**In 5–8, suppose that m varies directly as the fourth power of q . How does the value of m change if**5. q is doubled? _____6. q is quadrupled? _____7. q is multiplied by 6? _____8. q is multiplied by $\frac{1}{3}$? _____**In 9–12, suppose that p varies inversely as the fifth power of n . How does the value of p change if**9. n is doubled? _____10. n is quadrupled? _____11. n is multiplied by 6? _____12. n is multiplied by $\frac{1}{3}$? _____13. If $w = kz^n$ and z is multiplied by a constant c ,
what happens to w ?
_____14. If $w = \frac{k}{z^n}$ and z is multiplied by a constant c ,
what happens to w ?

**LESSON
MASTER****2-9
A****Questions on SPUR Objectives**
See pages 134–137 for objectives.**Skills Objective A****In 1 and 2, translate into a variation equation.**

1. The volume V of a rectangular prism varies jointly as its length L , its width W , and its height H . _____
2. R varies directly as the square of P , directly as L , and inversely as the square root of A . _____

In 3 and 4, write each variation equation in words.

3. $P = kIRT$

4. $E = \frac{2(V_1 - V_0)}{X}$

Skills Objective B

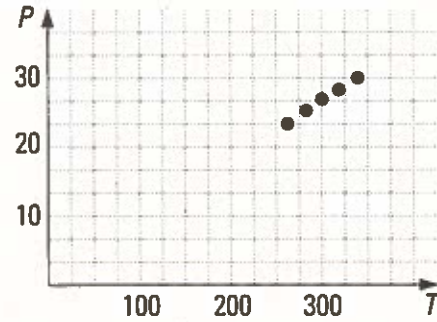
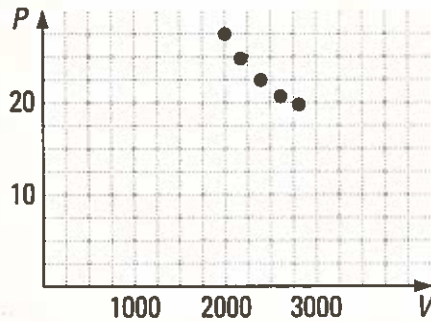
5. w varies directly as the square of x and inversely as y . When $x = 5$ and $y = 2$, $w = 23.75$. Find w when $x = -3$ and $y = -6$. _____
6. z varies jointly as the square root of x and the cube of y . When $x = 9$ and $y = 2$, $z = 4$. Find z when $x = 25$ and $y = -5$. _____

Uses Objective G

7. The amount that a piece of copper wire 50 ft long stretches varies directly as the force applied to it and inversely as the cross-sectional area of the wire. When a 250-lb force is applied to a wire with cross-sectional area 0.0032 in^2 , the wire stretches 1.08 in. How far would the wire stretch if a force of 300 lb were applied to a wire of cross-sectional area 0.005 in^2 ? _____
8. The kinetic energy of an object varies jointly as its mass and the square of its velocity. The kinetic energy of an object with mass 12 kg moving at 8 m/s is 384 joules. Find the kinetic energy of an object with mass 8 kg moving at 12 m/s. _____

**LESSON
MASTER****2-8
A****Questions on SPUR Objectives**
See pages 134–137 for objectives.**Uses Objective H**

1. An automotive engineer performed tests on a new tire to find the relationship between the air pressure P in pounds per square inch, the volume V in cubic inches, and the temperature T in degrees Kelvin. The engineer obtained the graph on the left by measuring pressure and volume when the temperature was 280°K . The graph on the right was obtained by measuring the pressure and the temperature when the volume was 2200 in^3 .



Write an equation relating P , V , and T . Do *not* find the constant of variation.

2. Jeremy and Jenny performed an experiment to discover the relationship between the power of an electric light and the resistance in the circuit and the voltage supplied. They first collected the following data relating the power P and the resistance R on circuits with 2 volts.

I.

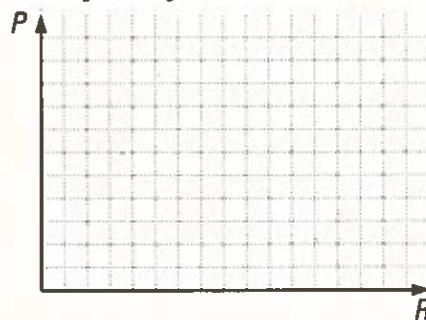
Resistance (ohms)	50	100	150	200	250
Power (watts)	800	400	267	200	160

Then they collected data when the resistance in the circuit was 200 ohms. These data relate the power P and the voltage V .

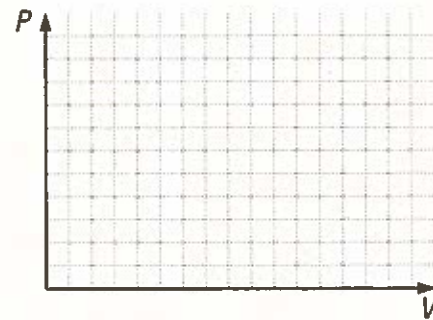
II.

Voltage (volts)	1	2	3	4	5
Power (watts)	50	200	450	800	1250

- a. Graph the points from Table I.



- b. Graph the points from Table II.



- c. How does P vary with R ?
- _____

- d. How does P vary with V ?
- _____

- e. Use the Converse of the Fundamental Theorem of Variation to write an equation relating P , R , and V . Do *not* find the constant of variation.
- _____

**LESSON
MASTER**

**6-3
A**

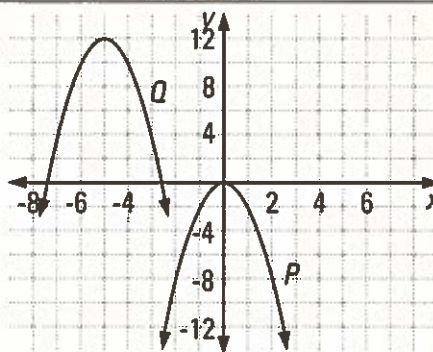
Questions on SPUR Objectives
See pages 413-415 for objectives.

Uses Objective I

1. The graph of $y = x^2$ is translated 12 units to the left and 6 units up.
 - a. Write an equation for its image. _____
 - b. Name the vertex of the image. _____
2. The graph of $y = -5x^2$ is translated 3 units to the right and 7 units down.
 - a. Write an equation for its image. _____
 - b. $(1, -5)$ is a point on the preimage. What is the corresponding point on the image? _____

Representations Objective J

In 3 and 4, assume parabola P is a translation image of parabola Q .



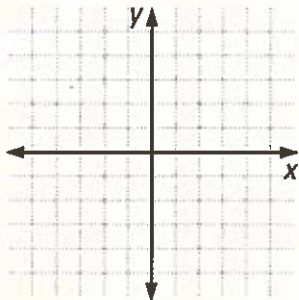
3. What translation maps parabola P onto parabola Q ?

4. Parabola P has equation $y = -2x^2$. Write an equation for parabola Q .

In 6–8, an equation for a parabola is given. a. Graph the parabola and show its axis of symmetry. b. Identify its vertex. c. Write an equation for the axis of symmetry.

6. $y = 3(x + 1)^2$

a.

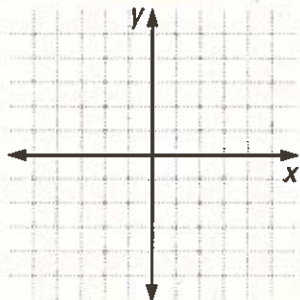


b. _____

c. _____

7. $y + 4 = -3x^2$

a.

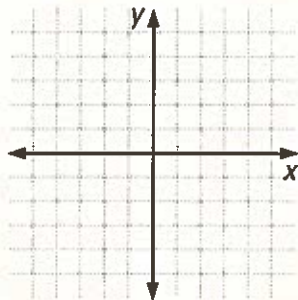


b. _____

c. _____

8. $y - 5 = (x + 3)^2$

a.



b. _____

c. _____

**LESSON
MASTER****6-4
A****Questions on SPUR Objectives**
See pages 413-415 for objectives.**Skills** Objective B

In 1–3, write the equation in standard form.

1. $y = 2(x + 5)^2 - 7$ 2. $y + 5 = -2(x - 6)^2$ 3. $y - 3 = \frac{1}{4}(x - 2)^2$

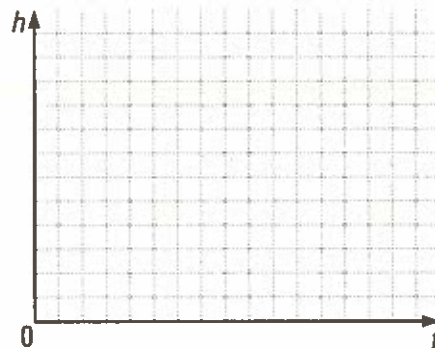
Uses Objective G

4. Suppose a ball is thrown upward from a height of 5 feet with an initial velocity of 30 ft/sec.

- a. Write an equation relating the time t in seconds and the height h of the ball in feet. _____
- b. Find the height of the ball after 1.5 seconds. _____

5. Suppose a ball is dropped from the top of a 79-foot-tall tree.

- a. Write an equation that describes the relationship between h , the height in feet of the ball above the ground, and time t in seconds.
- _____



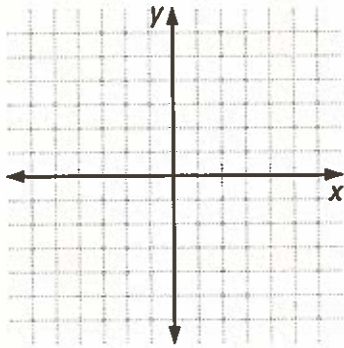
- b. On the grid at the right, graph the height h after t seconds.
- c. Estimate how long it would take the ball to reach the ground. Explain your reasoning.
- _____
- _____

6. Johanna threw a water balloon upward at a speed of 10m/sec while standing on the roof of a building 12 meters high.

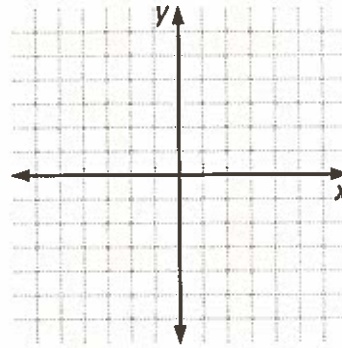
- a. What was the height of the balloon after 2 seconds? _____
- b. Assume that the balloon did not land on the roof, and estimate how long it took the balloon to reach the ground. _____

▶ **LESSON MASTER 6-4 A** page 2**Representations** Objective JIn 7 and 8, graph the parabola for $-3 \leq x \leq 3$.

7. $y = x^2 + x - 6$



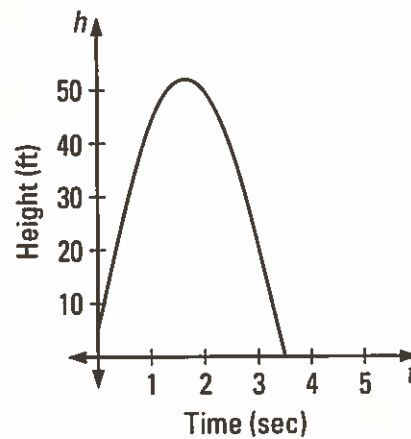
8. $y = -2x^2 + 5x + 7$



9. On the graph at the right, the height of a baseball hit upward is shown as a function of time.

a. What was the initial height of the ball?

b. When did the ball reach its maximum height?



c. What was the maximum height? _____

d. When was the ball 30 ft in the air? _____

**LESSON
MASTER****6-5
A****Questions on SPUR Objectives**
See pages 413-415 for objectives.**Vocabulary**

1. Fill in the blank to make a perfect square.

$4d^2 - 16d + \underline{\quad?}$

Skills Objective B

In 2-5, write the equation in vertex form.

2. $y = x^2 - 6x + 10$

3. $y = x^2 + 14x + 5$

4. $y = 5x^2 - 15x - 4$

5. $6y = 3x^2 + 30x + 25$

In 6 and 7, find the vertex of the parabola determined by the equation.

6. $y = x^2 - 12x + 24$

7. $y = -4x^2 + 6x - 7$

In 8 and 9, write an equation in vertex form equivalent to the standard equation given.

8. $y = 2x^2 - 20x + 57$

9. $y = 10x^2 + 10x + 1$

- 10.
- Multiple choice.*
- Which equation is equivalent to
- $y = 18x^2 + 60x + 45$
- ? _____

(a) $y + 3 = 2(3x + 3)^2$

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

(c) $y + 5 = 2(3x - 5)^2$

(d) $y - 5 = 2(3x + 5)^2$

- 11.
- True or false.*
- $y = 4x^2 + 4x - 6$
- and

$y + 7 = 4(x + \frac{1}{2})^2$ have the same vertex. _____

Name _____

LESSON MASTER**6-1**
AQuestions on SPUR Objectives
See pages 413-415 for objectives.**Skills Objective A**

In 1-6, expand and simplify.

1. $(x + 11)^2$
 $x^2 + 22x + 121$

2. $\frac{1}{3}(3d + 6)^2$
 $3d^2 + 12d + 12$

3. $(6n - \frac{1}{4})^2$
 $36n^2 - 6n + \frac{1}{4}$

4. $(5y - 8)^2$
 $25y^2 - 80y + 64$

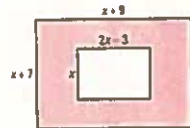
5. $(c + 5)^2 - (c - 5)^2$
 $20c$

6. $-7(8z + 12)^2$
 $-448z^2 - 1344z - 1008$

In 7 and 8, use the rectangles pictured at the right.

7. Write an expression for the area of the shaded region.
 $-x^2 + 19x + 63$

8. Determine the area of the shaded region if $x = 3$ cm.
 111 cm^2

**Uses Objective G**9. Cindy has an 11" by 14" photograph that she wishes to frame. She wants matting of width w around the edge of the photograph.

a. Give an expression for the total area of the photograph and the matting.
 $4w^2 + 50w + 154 \text{ in}^2$

b. If $w = 2$ in., what are the inner dimensions of the frame that will hold the photograph and the matting?
 $15 \text{ in.}; 18 \text{ in.}$

c. What is the total area of the photograph and the matting in Part b?
 270 in^2

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Name _____

LESSON MASTER**6-2**
AQuestions on SPUR Objectives
See pages 413-415 for objectives.**Skills Objective C**

In 1-4, solve.

1. $m^2 = 20$
 $m = \pm\sqrt{20}$
 $\approx \pm 4.47$

2. $(n - 2)^2 = 0$
 $n = 2$

3. $r^2 = 16$
 $r = \pm 4$

4. $(2p - 4)^2 = 0$
 $p = 2$

5. $|n - 3| = 8$
 $n = 11 \text{ or } n = -5$

6. $|2s + 7| = 10$
 $s = 1.5 \text{ or } s = -8.5$

Properties Objective E7. For what real numbers does $|x| = |-x|$? **all real numbers**

8. Simplify $-\sqrt{(2 - 6)^2}$. **-4**

9. Describe how the graphs of $y = \sqrt{x^2}$ and $y = -|x|$ are related.**Sample: Both graphs contain (0, 0); the graphs are reflections of each other over the x-axis.****Uses Objective G**

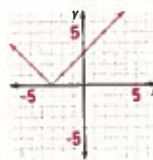
10. A rectangle measures 6 in. by 12 in. What is the radius of a circle which has the same area as the rectangle?

$\sqrt{\frac{72}{\pi}}$, or ≈ 4.79 , in.

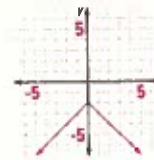
Representations Objective J

In 11 and 12, graph the equation.

11. $y = |x + 3|$



12. $y + 2 = -|x|$



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Name _____

LESSON MASTER**6-3**
AQuestions on SPUR Objectives
See pages 413-415 for objectives.**Uses Objective I**1. The graph of $y = x^2$ is translated 12 units to the left and 6 units up.

a. Write an equation for its image.
 $y - 6 = (x + 12)^2$

b. Name the vertex of the image.
 $(-12, 6)$

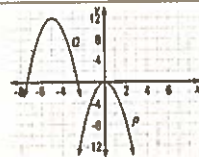
2. The graph of $y = -5x^2$ is translated 3 units to the right and 7 units down.

a. Write an equation for its image.
 $y + 7 = -5(x - 3)^2$

b. $(1, -5)$ is a point on the preimage. What is the corresponding point on the image?
 $(4, -12)$

Representations Objective JIn 3 and 4, assume parabola P is a translation image of parabola Q .3. What translation maps parabola P onto parabola Q ?

$T_{-5, 12}$

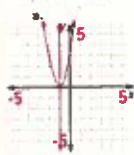
4. Parabola P has equation $y = -2x^2$.Write an equation for parabola Q .
 $y - 12 = -2(x + 5)^2$ 

In 6-8, an equation for a parabola is given. a. Graph the parabola and show its axis of symmetry. b. Identify its vertex. c. Write an equation for the axis of symmetry.

6. $y = 3(x + 1)^2$

7. $y + 4 = -3x^2$

8. $y - 5 = (x + 3)^2$



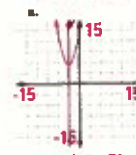
b. $(-1, 0)$

c. $x = -1$



b. $(0, -4)$

c. $x = 0$



b. $(-3, 5)$

c. $x = -3$

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Name _____

LESSON MASTER**6-4**
AQuestions on SPUR Objectives
See pages 413-415 for objectives.**Skills Objective B**

In 1-3, write the equation in standard form.

1. $y = 2(x + 3)^2 - 7$

2. $y + 5 = -2(x - 6)^2$

3. $y - 3 = \frac{1}{4}(x - 2)^2$

$y = 2x^2 + 20x + 43$

$y = -2x^2 + 24x - 77$

$y = \frac{1}{4}x^2 - x + 4$

Uses Objective G

4. Suppose a ball is thrown upward from a height of 5 feet with an initial velocity of 30 ft/sec.

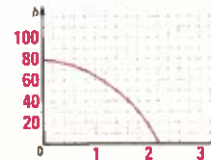
a. Write an equation relating the time t in seconds and the height h of the ball in feet.
 $h = -16t^2 + 30t + 5$

b. Find the height of the ball after 1.5 seconds.
 14 ft

5. Suppose a ball is dropped from the top of a 79-foot tall tree.

a. Write an equation that describes the relationship between h , the height in feet of the ball above the ground, and time t in seconds.

$h = -16t^2 + 79$

b. On the grid at the right, graph the height h after t seconds.

c. Estimate how long it would take the ball to reach the ground. Explain your reasoning.

Sample: About 2.2 seconds; this is the approximate value of t when $h = 0$.

6. Juhanna threw a water balloon upward at a speed of 10 m/sec while standing on the roof of a building 12 meters high.

a. What was the height of the balloon after 2 seconds?
 12.4 m

b. Assume that the balloon did not land on the roof, and estimate how long it took the balloon to reach the ground.
 $\approx 2.9 \text{ sec}$

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Name _____

LESSON MASTER 6-4 Page 2

Representations Objective J

In 7 and 8, graph the parabola for $-3 \leq x \leq 3$.

7. $y = x^2 + x - 6$



8. $y = -2x^2 + 3x + 7$



9. On the graph at the right, the height of a baseball hit upward is shown as a function of time.

a. What was the initial height of the ball?

~ 5 ft

b. When did the ball reach its maximum height?

~ 1.8 sec

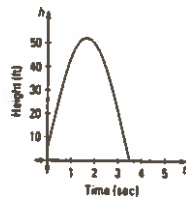
c. What was the maximum height?

~ 52 ft

d. When was the ball 30 ft in the air?

~ 0.3 sec and ~ 3.2 sec

Answers to Question 9 may vary slightly.



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Name _____

LESSON MASTER 6-5

6-5
AQuestions on SPUR Objectives
See pages 413-415 for objectives.

Vocabulary

1. Fill in the blank to make a perfect square.

$4d^2 - 16d + \underline{\quad}$

16

Skills Objective B

In 2-5, write the equation in vertex form.

2. $y = x^2 - 6x + 10$

$y - 1 = (x - 3)^2$

3. $y = x^2 + 14x + 5$

$y + 44 = (x + 7)^2$

4. $y = 3x^2 - 15x - 4$

$y + \frac{61}{4} = 5(x - \frac{3}{2})^2$

5. $6y = 3x^2 + 30x + 25$

$y + \frac{25}{3} = \frac{1}{2}(x + 5)^2$

In 6 and 7, find the vertex of the parabola determined by the equation.

6. $y = x^2 - 12x + 24$

(6, -12)

7. $y = -4x^2 + 6x - 7$

(\frac{3}{4}, -\frac{19}{4})

In 8 and 9, write an equation in vertex form equivalent to the standard equation given.

8. $y = 2x^2 - 20x + 57$

$y - 7 = 2(x - 5)^2$

9. $y = 10x^2 + 10x + 1$

$y + \frac{3}{2} = 10(x + \frac{1}{2})^2$

10. Multiple choice. Which equation is equivalent to

$y = 18x^2 + 60x + 45?$

b

(a) $y + 3 = 2(3x + 3)^2$

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

(c) $y + 5 = 2(3x - 5)^2$

(d) $y - 5 = 2(3x + 5)^2$

11. True or false. $y = 4x^2 + 4x - 6$ and

$y + 7 = 4(x + \frac{1}{2})^2$ have the same vertex.

true

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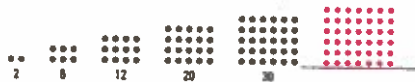
Name _____

LESSON MASTER 6-6

6-6
AQuestions on SPUR Objectives
See pages 413-415 for objectives.

Uses Objective N

1. The following pictures illustrate the first five numbers in a sequence we shall call the "rectangular numbers."



a. Draw the next rectangular number above at the right.

b. Find the next three rectangular numbers after 30.

42, 56, 72

c. Give a formula for $R(n)$, the n th rectangular number.

$R(n) = n^2 + n$

d. Use your formula to find the 100th rectangular number.

10,100

2. The following table gives the monthly salaries in 1993 for U.S. generals having various years of service.

Years of Service y	Monthly Salary s
2	\$6,889.20
4	\$6,889.20
8	\$7,153.50
12	\$7,543.80
16	\$8,089.80
20	\$8,831.60
24	\$9,169.50

a. On the grid at the right, make a scatterplot of these data.

b. Fit a quadratic model to these data and plot it.

$s = 1.3y^2 + 62.5y + 6415$

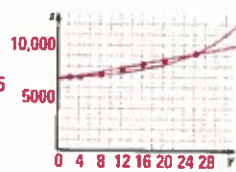
c. Fit a linear model to these data and plot it.

$s = 95y + 6699$

d. Use either model to estimate the monthly salary of a U.S. general with 10 years of service.

~ \$7170 or ~ \$7649

Sample answers are given for 2b-2d.



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LESSON MASTER 6-7

6-7
AQuestions on SPUR Objectives
See pages 413-415 for objectives.

Skills Objective C

In 1-6, use the Quadratic Formula to solve the equation.

1. $x^2 + 6x - 7 = 0$

$x = 1$ or $x = -7$

2. $7 = 3x^2 - 4x$

$x = \frac{7}{3}$ or $x = -1$

3. $m(m + 6) = 36$

$m = \frac{-6 + \sqrt{180}}{2} \approx 3.71$

4. $w^2 = 5w + 3$

$w = \frac{5 + \sqrt{37}}{2} \approx 5.54$

or $\frac{-6 - \sqrt{180}}{2} \approx -9.71$

or $\frac{5 + \sqrt{37}}{2} \approx -5.54$

5. $50d^2 - 12 = -25d$

$d = \frac{3}{10}$ or $d = -\frac{4}{5}$

6. $(3a + 2)(5a - 1) = 2(5a - 1)$

$a = 0$ or $a = \frac{1}{5}$

Uses Objective G

7. Juan Torres hit a fast ball thrown by Liz Buckner. Let x be the distance on the ground in feet of the ball from home plate and $h(x)$ be the height in feet of the ball at that distance. Suppose the path of the ball is described by the function $h(x) = -0.06x^2 + 2.5x + 4$.

a. How high was the ball when Juan hit it?

4 ft

b. How far from the plate, along the ground, was the ball when it was the same height at which Juan hit it?

416 $\frac{2}{3}$ ft

c. How far from the plate, along the ground, was the ball when it was 100 feet high?

~ 42.8 ft, ~ 373.9 ft

d. The fence is 405 feet away from home plate, and it is 12 feet high. Did the ball go over the fence? Explain your reasoning.

Yes; when the ball was 405 feet from home plate, it was about 32 feet above the ground.

8. A toy rocket was shot straight up with an initial velocity of 75 m/sec. The platform from which the rocket was shot is 2.3 meters high.

a. When was the rocket 100 meters above the ground?

~ 1.4 sec, ~ 13.9 sec

b. When did the rocket hit the ground?

~ 15.3 sec

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LESSON MASTER**2-1**
AQuestions on SPUR Objectives
See pages 134–137 for objectives.**Skills Objective A**In 1–5, translate into a variation equation.
Let k be the constant of variation.

- m varies directly as the fourth power of n . $m = kn^4$
- y is directly proportional to the fifth power of x . $y = kx^5$
- The height h of a cottonwood tree varies directly as the square of its circumference C . $h = kC^2$
- The distance d a star is from the earth is directly proportional to the length of time t it takes for its light to get here. $d = kt$
- The volume V of a cylinder with constant height varies directly as the square of the diameter d of its base. $V = kd^2$

Skills Objective B

- y varies directly as x . If $y = 8$ when $x = -3$, find y when $x = 16$. $y = -\frac{128}{3}$, or $-42\frac{2}{3}$
- c is directly proportional to d^4 . If $c = -13.824$ when $d = 12$, find c when $d = 6$. $c = -864$

Uses Objective F

In 8 and 9, true or false.

- The cost of filling a car's gas tank with gas varies directly as the volume of the tank. true
- The outdoor temperature varies directly as the time of day. false

Uses Objective G

- The number of volts across an electrical circuit with constant resistance varies directly as the strength of the current in amps. There are 500 volts across a circuit of 25 amps. What would be the voltage across a circuit of 60 amps? 1200 volts
- The surface of a sphere is directly proportional to the square of its radius. The surface area of a sphere with radius 3 cm is 36π cm². What is the surface area of a sphere with radius 12 cm? 576π cm²

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LESSON MASTER 2-2A, page 2**Uses Objective F**

In 10–14, complete with "directly," "inversely," or "neither directly nor inversely."

- The perimeter of a square varies _____ as the length of the side. directly
- A telephone bill varies _____ as the number of telephone calls made. neither
- The temperature in a house varies _____ as the setting on the thermostat. neither
- The intensity of light from a lamp varies _____ as the square of the distance one sits from it. inversely
- The time required to fly from Charlotte to San Antonio varies _____ with the speed at which the airplane flies. inversely

Uses Objective G

- The length of an organ pipe varies inversely as its pitch. If the pipe is $5\frac{1}{2}$ ft long, its frequency is 96 cycles per second. What is the frequency of a pipe which is 8 ft long? 64 cycles/sec
- The number of spans of steel needed to construct a bridge over a river varies inversely as the length of each span. If 10 spans are used, each span is 18 ft long. How long would each span be if 12 spans were used? 15 ft
- The resistance in a certain electrical circuit varies inversely as the square of the current through it. The resistance of the circuit is 10 ohms when the current is 15 amps. What is the resistance in the circuit when the current is 20 amps? 5.625 ohms
- The force needed to keep a car on the road varies inversely as the radius of the curve. It requires 1286 N of force to keep a 1000-kg car traveling at 50 km/hr from skidding on a curve of radius 150 m. How much force is necessary to keep the same car traveling at the same speed from skidding on a curve of radius 750 m? ~ 257 N

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LESSON MASTER**2-2**
AQuestions on SPUR Objectives
See pages 134–137 for objectives.**Vocabulary**1. Explain how *direct* and *inverse* variation differ.

Sample: In direct variation, the constant is multiplied by a positive power of the independent variable; in inverse variation the constant is divided by a positive power of the independent variable.

Skills Objective AIn 2–6, translate into a variation equation.
Let k be the constant of variation.

- y is inversely proportional to x . $y = k/x$
- F varies inversely with the square of r . $F = k/r^2$
- The gravitational pull F of the earth on a spaceship varies inversely as the square of the distance d of the spaceship from the earth. $F = k/d^2$
- In a spherical balloon with a constant mass of air, the pressure varies inversely as the cube of the radius. $p = k/r^3$
- In photography, the exposure E is inversely proportional to the square of the f -stop f . $E = k/f^2$
- Write the variation equation $y = \frac{k}{x^5}$ in words. y varies inversely as the fifth power of x .

Skills Objective B

- y varies inversely as the cube of x . If $y = 5$ when $x = 2$, find y when $x = 6$. $y = \frac{5}{27}$
- y varies inversely as the fourth power of x . If $y = 5$ when $x = \frac{1}{2}$, find y when $x = \frac{1}{3}$. $y = \frac{405}{16}$, or $25\frac{5}{16}$

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LESSON MASTER**2-3**
AQuestions on SPUR Objectives
See pages 134–137 for objectives.**Properties Objective D**In 1–4, suppose that in a variation problem the value of x is tripled. How is the value of y changed if

- y varies directly as x ? y is tripled.
- y varies inversely as x ? y is divided by 3.
- y varies directly as x^2 ? y is multiplied by 9.
- y varies inversely as x^2 ? y is divided by 27.

In 5–8, suppose that m varies directly as the fourth power of q . How does the value of m change if

- q is doubled? m is multiplied by 16.
- q is quadrupled? m is multiplied by 256.
- q is multiplied by 6? m is multiplied by 1296.
- q is multiplied by $\frac{1}{3}$? m is multiplied by $\frac{1}{81}$.

In 9–12, suppose that p varies inversely as the fifth power of n . How does the value of p change if

- n is doubled? p is divided by 32.
- n is quadrupled? p is divided by 1024.
- n is multiplied by 6? p is divided by 7776.
- n is multiplied by $\frac{1}{3}$? p is divided by $\frac{1}{243}$.
- If $w = 4z^n$ and z is multiplied by a constant c , what happens to w ? w is multiplied by c^n .
- If $w = \frac{4}{z^n}$ and z is multiplied by a constant c , what happens to w ? w is divided by c^n .


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**LESSON
MASTER****1-7
A**Questions on SPUR Objectives
See pages 66–69 for objectives.**Vocabulary**

- Write the notation for "s sub 4 equals 81." $s_4 = 81$
- Write the notation for the eighteenth term of a sequence p . p_{18}
- Tell how the equation " $r_3 = -7$ " should be read.
 r sub three equals negative seven.

Skills Objective E

- Give the first 6 terms of the sequence defined by the formula $a_n = 3n^2 + 1$. **4, 13, 28, 49, 76, 109**
- If $p_n = 4^{n-1}$, find p_7 . **$p_7 = 4096$**
- a. Draw the next term in the sequence.

 b. Give a formula for T_n , the number of dots in the n th term. **$T_n = n(n+2)$**
- Write the third, fourth and fifth terms of the sequence whose explicit formula is $a_n = \frac{n+1}{n+2}$. **$\frac{4}{5}, \frac{5}{6}, \frac{6}{7}$**
- Multiple choice. Which is an explicit formula for the n th term of the sequence 3, 6, 11, 18, 27, ...?
 (a) $t_n = 3n$ (b) $t_n = 2n + 2$ (c) $t_n = n^2 + 2$ **c**

Uses Objective J

- At the end of each week at a discount store, the price of all remaining items is reduced 10%. So after week n , the price of a \$60 jacket is given by $p_n = 60(0.9)^n$. Find the price of the jacket after 3 weeks if it remains unsold. **\$43.74**
- A group of students took a bike trip across the country, averaging 60 miles of riding each day. The sequence $d_n = 60n$ gives the distance they have biked after n days. How far has the group biked after 7 days? **420 miles**

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**LESSON
MASTER****1-9
A**Questions on SPUR Objectives
See pages 66–69 for objectives.**Vocabulary**

- a. If t_n represents the n th term of a sequence, what notation is used to denote the previous term? t_{n-1}
- What notation denotes the term following t_n ? t_{n+1}
- With a sequence a_n , would you use an explicit formula or a recursive formula if you wanted to find a_{200} ? Explain your choice.
Sample: Explicit formula; with a recursive formula, the first 199 terms would need to be determined; with an explicit formula, determining the 200th term would take one step.

Skills Objective A

- Write the first four terms of the sequence defined by the following recursive formula.

$$\begin{cases} w_1 = 81 \\ w_n = \frac{1}{3}w_{n-1} + 9, \text{ for integers } n \geq 2. \end{cases}$$
 81, 36, 21, 16
- Find p_6 if
$$\begin{cases} p_1 = 3 \\ p_n = 5p_{n-1}, \text{ for integers } n \geq 2. \end{cases}$$
 $p_6 = 9375$
- The formula
$$\begin{cases} a_1 = 1 \\ a_2 = 3 \\ a_n = 2a_{n-1} + a_{n-2}, \text{ for integers } n \geq 3 \end{cases}$$
 describes a sequence recursively. Find the first seven terms of this sequence. **1, 3, 7, 17, 41, 99, 239**

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**LESSON
MASTER****1-8
A**Questions on SPUR Objectives
See pages 66–69 for objectives.**Skills Objective E**

- In 1–3, write the first six terms of the sequence defined by the recursive formula.
- The first term is 3; each term after the first is 7 less than the previous term.
-3, -10, -17, -24, -31, -38
 - $$\begin{cases} a_1 = 9 \\ a_n = (3 \cdot \text{previous term}) + 11, \text{ for integers } n \geq 2. \end{cases}$$

9, 38, 125, 386, 1169, 3518
 - $$\begin{cases} t_1 = \frac{1}{2} \\ t_n = \left(\frac{1}{2}\right)^{n-1} + 1, \text{ for integers } n \geq 2. \end{cases}$$

1, 2, 5, 26, 677, 458,330

Skills Objective F

- Consider the sequence 9, 7, 5, 3.
 - Use words to describe this sequence recursively.
The first term is 9; each succeeding term is 2 less than the previous term.
 - Use symbols to write a recursive formula for the sequence.
$$\begin{cases} a_1 = 9 \\ a_n = \text{ANS} - 2, \text{ for } n \geq 2. \end{cases}$$
- Consider the sequence defined explicitly as $t_n = 3n + 18$.
 - Give the first six terms of the sequence.
21, 24, 27, 30, 33, 36
 - Write a recursive definition for the sequence.
$$\begin{cases} a_1 = 21 \\ a_n = \text{ANS} + 3, \text{ for } n \geq 2. \end{cases}$$

Uses Objective A

- Debbie has 520 books in her library. Each year she buys an average of 50 new books.
 - Write a recursive formula that gives the number of books b_n in Debbie's library in year n .
$$\begin{cases} b_1 = 520 \\ b_n = \text{previous term} + 50, \text{ for } n \geq 2. \end{cases}$$
 - How many books will Debbie have in her library ten years from now? **1020 books**

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LESSON MASTER 1-9A page 2**Skills Objective F**

- Consider the sequence 7, 35, 175, 875, ...
 - Describe this sequence recursively using words.
The first term is 7; each succeeding term is 5 times the previous term.
 - Write a recursive formula for this sequence.
$$\begin{cases} s_1 = 7 \\ s_n = 5 \cdot s_{n-1}, \text{ for } n \geq 2. \end{cases}$$
- Consider the sequence 1, 16, 81, 256, 625, ...
 - Write an appropriate formula for the sequence. $a_n = n^4$
 - Write a recursive formula for the sequence -2, 6, 14, 22, ...
$$\begin{cases} e_1 = -2 \\ e_n = e_{n-1} + 8, \text{ for } n \geq 2. \end{cases}$$
- Multiple choice. Which explicit formula also describes the sequence in Part a?
 (i) $t_n = (-2)^n$ (ii) $t_n = 8n - 10$ (iii) $t_n = -4n + 2$ **ii**

Skills Objective A

- A new company projects that its annual revenue will grow by roughly 10% each year. The company's projected annual revenue for the first year is \$100,000.
 - Let r_n be the company's projected annual revenue in year n . Find r_1, r_2, r_3, r_4 , and r_5 .
\$100,000; \$110,000; \$121,000; \$133,100; \$146,410
 - Write a recursive formula for the sequence.
$$\begin{cases} r_1 = 100,000 \\ r_n = 1.1r_{n-1}, \text{ for } n \geq 2. \end{cases}$$
 - Multiple choice. Which of the following is an explicit formula for the sequence?
 (i) $t_n = 100,000(1)^n$ (ii) $t_n = 100,000(1.1)^n$ (iii) $t_n = 100,000(1.1)^{n-1}$ **iii**
 - If you wanted to find the projected annual revenue in the company's fifteenth year, which formula, explicit or recursive, would you use? Explain your choice.
Sample: Explicit formula; $100,000(1.1)^{14}$ is easily determined with a calculator.

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