Adult Learning Academy Elementary Algebra Workbook

## Module 5: Integer Exponents \& Laws, Scientific Notation, Polynomials \& Operations

## Learning Objectives

By the time you finish this module, you should be able to:
$\square$ Simplify expressions involving positive or negative exponents according to the exponent rulesConvert a number in standard notation into scientific notationConvert a number in scientific notation into standard notationIdentify a monomial, binomial, trinomial, and polynomialSort polynomials according to their degreeAdd, subtract, and multiply polynomials of any sizeDivide a polynomial by a monomial

## IMPORTANT INFORMATION FROM MODULE 5:

$x^{m} \cdot x^{n}=x^{m+n}$
$\left(x^{m}\right)^{n}=x^{m n} \quad$ "when you raise a power to a power, mutiply the powers"
$\frac{x^{m}}{x^{n}}=x^{m-n}$
$x^{0}=1,0^{m}=0,0^{0}$ is undefined
$\left(\frac{x}{y}\right)^{m}=\frac{x^{m}}{y^{m}} \quad x^{-m}=\frac{1}{x^{m}} \quad$ A negative exponent does NOT make a number negative!
one term: monomial; two terms: binomial; three terms: trinomial
To find the degree of a single term, add all the exponents on all the variables in that term. To find the degree of a polynomial, have a contest: the term with the highest degree wins!

FOIL: for multiplying a binomial times a binomial (also for squaring a binomial!!)
$(a+b)^{2}=a^{2}+2 a b+b^{2} \quad(a-b)^{2}=a^{2}-2 a b+b^{2} \quad(a+b)(a-b)=a^{2}-b^{2}$
Birthday Song: You must have like terms, you must have like terms to ADD or SUBTRACT, you must have like terms!

When you subtract a polynomial, be sure to subtract EVERY term!!

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Module 5 Video \& ExERCISE LIST

| Topic | Website | Videos | Exercises |
| :---: | :---: | :---: | :---: |
| Exponents | www.khanacademy.org | Level 1 Exponents | Positive and Zero Exp |
|  |  | Understanding Exponents 2 | Negative Exponents |
|  |  | Understanding Exponents | Exponent Rules |
|  |  | Level 2 Exponents (negative exp) |  |
|  |  | Exponent Rules Part 1 |  |
|  |  | Exponent Rules Part 2 |  |
|  |  | Exponent Prop involving Quotients |  |
|  | www.stlcc.edu | Exponent Rules ppt on Blackboard |  |
|  | http://www.youtube.com/watch?v=h063AzwjGlc | Mathman: 3 Exponent Mistakes |  |
| Scientific Notation | www.khanacademy.org | Scientific Notation | Scientific Notation |
|  |  | Scientific Notation 1 |  |
| Polynomials | http://www.youtube.com/watch?v=D-3NIysYshM | Diff betw Trinom, Bi, Monomial |  |
|  | http://www.youtube.com/watch?v=l_kY3sHViSA | Identifying Degree, Name of Polyn. |  |
|  | www.khanacademy.org | Tems Coefficients and Exponents |  |
|  |  | Evaluating a Polynomial at a Given V |  |
|  |  | Simplify a Polynomial |  |
| Add, Subt. Polynom. | www.khanacademy.org | Adding Polynomials | Adding, Sub Polynom. |
|  |  | Ex: Adding Polynomials w/Mult Var. |  |
|  |  | Add \& Subt of Polynomials |  |
|  |  | Adding and Sub Polynomials 1 |  |
|  |  | Adding \& Subt Polynomials 2 |  |
|  |  | Adding and Sub Polynomials 3 |  |
|  |  | Subtracting Polynomials |  |
|  |  | Sub Polynomials w/ Mult Variables |  |
|  |  |  |  |


| Topic | Website | Videos | Exercises |
| :--- | :--- | :--- | :--- |
| Multiplying Polynom. | www.khanacademy.org | Multiplying Monomials | Multip. Express. 0.5 |
|  |  | Multiplying Monomials by Polynom. | Multiplying Exp. 1 |
|  |  | Multiplying Binomials | Multiplying Polynom. |
|  |  | Multiplying Polynomials1 |  |
|  | Multiplication of Polynomials |  |  |
|  | Square a Binomial |  |  |
|  |  | Special Products of Binomials |  |
|  |  | Special Polynomials Products 1 |  |
| Dividing Polynomials | www.khanacademy.org | Special Products of Polynomials 1 |  |
|  |  | Special Products of Polynomials 2 |  |
| Module 5 Test Review | www.stlcc.edu | Multiplying Polynomials |  |
|  |  | Polynomial Divided by Monomial |  |
|  |  | Dividing Multivariable Poly. w/ Mono |  |
|  |  | Blackboard PowerPoint |  |
|  |  |  | Exponent Rules |
|  |  |  | Module 5 Review Flashcards |

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5.1 Simplifying Expressions

1. $x^{6} \cdot x^{2}$
2. $x^{6}+x^{2}$
3. $x^{6} \div x^{2}$
4. $\left(x^{6}\right)^{2}$
5. $10 x^{8} \cdot 2 x^{2}$
6. $\left(10 x^{8}\right)^{2}$
7. $\frac{10 x^{8}}{2 x^{2}}$
8. $10 x^{8}-2 x^{2}$
9. $10 x^{8}-2 x^{8}$
10. $-5^{2}$
11. $5^{-2}$
12. $0^{5}$
13. $0^{0}$
14. $-5^{-2}$
15. $(-5)^{2}$
16. $(-5)^{-2}$
17. $5 x^{-2}$
18. $(5 x)^{-2}$
19. $x^{0}$
20. $5 x^{0}$
21. $(5 x)^{0}$
22. $\left(\frac{5}{x}\right)^{-2}$
23. $\frac{12 x^{4} x^{8}}{4 x^{3}}$
24. $\frac{-10 x^{5} y^{-3}}{15 x^{-3} y^{2}}$
25. $\frac{4 x^{7} x^{-3} y^{7}}{4 x^{5} y^{6}}$
26. $\left(\frac{7 x^{5} y^{-2}}{14 x^{-3} y^{4}}\right)^{3}$
27. $\left(\frac{12 x^{-2} y^{4}}{4 x^{-3} y^{-3}}\right)^{-3}$

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5.2 Color Matching Simplified Expressions

### 5.2 Color Matching Simplified Expressions

## Simplify each expression, and color the matching simplified expressions.



| 1. $x \cdot x$ | 11. $(x+7)(x-5)$ | 21. $(3 x-5)^{2}$ |
| :---: | :---: | :---: |
| 2. $\mathrm{x} \cdot \mathrm{x}^{2}$ | 12. $(\mathrm{x}+7)(\mathrm{x}-5)$ | 22. $(2 x+7)^{2}$ |
| 3. $x^{2} \cdot x^{3}$ | 13. $(x+7)(x-7)$ | 23. $(3 x-5)(3 x+5)$ |
| 4. $x^{5} \cdot x^{2}$ | 14. $(x-5)(x+5)$ | 24. $(2 x+7)(2 x-7)$ |
| 5. $5 x^{3} \cdot-2 x^{4}$ | 15. $(x+7)^{2}$ | 25. $(x+y)(x-y)$ |
| 6. $-6 x^{5} \cdot-4 x^{3}$ | 16. $(\mathrm{x}-7)^{2}$ | 26. $(x+y)^{2}$ |
| 7. $3 x\left(4 x^{2}-5 x+1\right)$ | 17. $(x+5)^{2}$ | 27. $(x-y)^{2}$ |
| 8. $-2 x^{3}\left(5 x^{4}-3\right)$ | 18. $(\mathrm{x}-5)^{2}$ | 28. $(3 x+2 y)(3 x-2 y)$ |
| 9. $7 x^{2}\left(x^{3}-3 x+2\right)$ | 19. $(3 x+5)(2 x-7)$ | 29. $(3 x+2 y)^{2}$ |
| 10. $(\mathrm{x}+7)(\mathrm{x}+5)$ | 20. $(3 x-5)(2 x+7)$ | 30. $(3 x-2 y)^{2}$ |

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5.4 ScIENTIFIC NOTATION

Fill in the table:

| Item | Scientific Notation | Standard Notation |
| :---: | :---: | :---: |
| Approximate number of hairs on <br> your head |  | 140,000 |
| Number of cells in your brain |  | $100,000,000,000$ |
| Length of a rhinovirus in meters | $2.7 \times 10^{9}$ | .000000020 |
| Number of heartbeats in a lifetime | $1.0 \times 10^{-8}$ |  |
| Speed that human hair grows in <br> miles per hour | $3.0 \times 10^{13}$ |  |
| Number of red blood cells in a <br> human body | $2.75 \times 10^{-3}$ | $5,000,000$ |
| Lung capacity of a blue whale in <br> milliliters |  |  |
| Speed of a snail in kilometers per <br> second | Thickness of a sheet of paper in <br> inches |  |
| The |  |  |

Adult Learning Academy Elementary Algebra Workbook 5.5 THINKING AbOUT POLYNOMIALS

| Expression | CHOOSE: Monomial, Binomial, Trinomial, Polynomial | Degree |
| :---: | :---: | :---: |
| $3 x^{2}-2 x+1$ |  |  |
| $5 x y z$ |  |  |
| $4 x+2 y$ |  |  |
| $5 x^{2} y-11$ |  |  |
| 139 |  |  |
| $-642 \mathrm{x}^{39}$ |  |  |
| $2 y+3 x-5 w+p$ |  |  |
| $57 \mathrm{x}^{5}-2 \mathrm{x}^{3}+11 \mathrm{x}$ |  |  |
| X |  |  |
| $4 x^{2}+3 x+x$ |  |  |
| $2 \mathrm{x}+\mathrm{y}+\mathrm{z}^{12}$ |  |  |
| $5 x^{0}$ |  |  |
| $100 \mathrm{x}^{2}-\mathrm{py}^{3}$ |  |  |
| $3 x+2$ |  |  |
| $10 x-y+z+p-5$ |  |  |

1. Create a $2^{\text {nd }}$-degree trinomial:
2. Create a $4^{\text {th }}$-degree monomial:

3. Create a $3^{\text {rd }}$-degree binomial:
4. Can the sum of two binomials ever be a trinomial? If so, show an example:
5. Can the sum of two binomials ever be a monomial? If so, show an example:
6. Can the sum of two binomials ever be a binomial? If so, show an example:
7. Can the product of two binomials ever be a binomial? If so, show an example:
8. Can the product of two binomials ever be a trinomial? If so, show an example:
9. Can the product of two binomials ever have four terms? If so, show an example:

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### 5.6 Evaluating, Adding, and Subtracting <br> Polynomials

Here are three functions:

$$
f(x)=3 x^{2}-2 x+1 \quad g(x)=-2 x^{2}-5 \quad h(x)=-4 x+2
$$

To "evaluate" means to plug in the value of x and see what you get. When you plug in a negative number for x , always put parentheses around it!

1. Evaluate the following:
a) $f(2)$
b) $g(-3)$
c) $\mathrm{h}(0)$
d) $\mathrm{f}(-5)$
e) $g(0)$
f) $h(-5)$
2. When you add and subtract polynomials, combine like terms. When you subtract, be sure to subtract EVERY term!
a) $f(x)+g(x)$
b) $g(x)+h(x)$
c) $f(x)+h(x)$
d) $f(x)-g(x)$
d) $f(x)-h(x)$
e) $g(x)-h(x)$
3. You can also multiply every term of a polynomial by a number. Find these:
a) $4 f(x)+3 g(x)$
b) $5 f(x)-2 h(x)$
4. The day's revenue (income) for a computer company depends on how many clients come to get their computers fixed. The revenue can be modeled by the function

$$
\begin{array}{ll}
R(x)=x^{3}-x^{2} \quad \begin{array}{l}
\text { where } \mathrm{R}(\mathrm{x}) \text { is the revenue in dollars, } \\
\text { and } \mathrm{x} \text { is the number of clients that day }
\end{array}
\end{array}
$$

The day's costs (expenses) for the same company also depend on how many clients come to get their computers fixed. The costs can be modeled by the function

$$
\begin{aligned}
C(x)=.75 x^{3}-.7 x^{2}-.5 x+10 & \text { where } \mathrm{C}(\mathrm{x}) \text { is the cost in dollars, } \\
& \text { and } \mathrm{x} \text { is the number of clients that day }
\end{aligned}
$$

Any business calculates its PROFIT by starting with Revenue (income) and subtracting expenses (costs). So the profit function, $\mathrm{P}(\mathrm{x})$, can be modeled by

$$
P(x)=R(x)-C(x) .
$$

a. For this company, what is the profit function? (subtract $R(x)-C(x))$ :
b. If 3 clients come to get their computers fixed on a given day, what is the Revenue? The Cost? The Profit?
c. If 20 clients come to get their computers fixed on a given day, what is the Revenue? The Cost? The Profit?
d. Say that Revenue doubles (get multiplied by 2), but costs remain the same. Show the new function for Profit:
2. Write an algebraic expression for the PERIMETER (add all the sides) and the AREA (length times width) of each rectangle on the page. Remember that area is measured in square units.
DIMENSIONS

a. | PERIMETER |
| :--- | AREA

x inches
x inches
b.

$2 x$ feet +1
c.


3 xcm
d.

e.

f.

3. Barnes-Jewish Hospital in St. Louis is 177 feet tall. If you stood at the top of the hospital and dropped a penny (NOTE: this is NOT recommended!), the following function tells you high off the ground the penny would be after t seconds:

$$
h(t)=-16 t^{2}+177
$$

where $t$ is the number of seconds since you
 dropped the penny, and $h(t)$ is the penny's height in feet off the ground.
a. Find $\mathrm{h}(0)$. What does this information tell you?
b. Find $h(1)$, the height of the penny 1 second after being dropped:
c. Find $\mathrm{h}(2)$, the height of the penny 2 seconds after being dropped:
d. Find $\mathrm{h}(3)$, the height of the penny 3 seconds after being dropped:
e. Would the penny still be falling 4 seconds after being dropped? How do you know?
5.2 Color Matching Expressions

$$
\begin{aligned}
& 2^{0}=\frac{3 x}{3 x}=1 \\
& \frac{2 x}{x}=\left(53 x^{4}+3\right)-\left(53 x^{4}+1\right)=2 x^{0} \\
& -5^{2}=0 x-25=-25 \\
& \hline x+x=5 x-3 x=2 x \\
& \hline 100 x^{2}-99 x^{2}=x \cdot x=x^{2} \\
& \hline 3 x^{2}-x^{2}=\frac{10 x^{5}}{5 x^{3}}=2 x^{2} \\
& \hline \frac{x^{3}+x}{x}=x^{2}+1=\left(5 x^{2}-1\right)-\left(4 x^{2}-2\right)=x^{2}+1 \\
& \hline(x+1)(x-1)=\left(5 x^{2}-2\right)-\left(4 x^{2}-1\right)=x^{2}-1 \\
& \hline(x+1)^{2}=x^{2}+2 x+1 \\
& \hline(x-1)^{2}=\frac{5 x^{2}-10 x+5}{5}=x^{2}-2 x+1 \\
& \hline
\end{aligned}
$$

### 5.3 Multiplying Polynomials

1. $x^{2}$
2. $x^{3}$
3. $x^{5}$
4. $x^{7}$
5. $-10 x^{7}$
6. $24 x^{8}$
7. $12 x^{3}-15 x^{2}+3 x$
8. $-10 x^{7}+6 x^{3}$
9. $7 x^{5}-21 x^{3}+14 x^{2}$
10. $x^{2}+12 x+35$
11. $x^{2}+2 x-35$
12. $x^{2}-12 x+35$
13. $x^{2}-49$
14. $x^{2}-25$
15. $x^{2}+14 x+49$
16. $x^{2}-14 x+49$
17. $x^{2}+10 x+25$
18. $x^{2}-10 x+25$
19. $6 x^{2}-11 x-35$
20. $6 x^{2}+11 x-35$
21. $9 x^{2}-30 x+25$

### 5.3 Multiplying Polynomials (cont.)

22. $4 x^{2}+28 x+49$
23. $9 x^{2}-25$
24. $4 x^{2}-49$
25. $x^{2}-y^{2}$
26. $x^{2}+2 x y+y^{2}$
27. $x^{2}-2 x y+y^{2}$
28. $9 x^{2}-4 y^{2}$
29. $9 x^{2}+12 x y+4 y^{2}$
30. $9 x^{2}-12 x y+4 y^{2}$

### 5.4 Scientific Notation

| Item | Scientific <br> Notation | Standard Notation |
| :---: | :---: | :---: |
| Number of hairs on <br> your head | $\mathbf{1 . 4 \times \mathbf { 1 0 } ^ { 5 }}$ | 140,000 |
| Number of cells in <br> your brain | $\mathbf{1 . 0 \times 1 0 ^ { 1 1 }}$ | $100,000,000,000$ |
| Length of a <br> rhinovirus in meters | $\mathbf{2 . 0 \times 1 0 ^ { - 8 }}$ | .000000020 |
| Number of <br> heartbeats in a <br> lifetime | $2.7 \times 10^{9}$ | $\mathbf{2 , 7 0 0 , 0 0 0 , 0 0 0}$ |
| Speed that human <br> hair grows in miles <br> per hour | $1.0 \times 10^{-8}$ | $\mathbf{. 0 0 0 0 0 0 0 1}$ |
| Number of red <br> blood cells in a <br> human body | $3.0 \times 10^{13}$ | $\mathbf{3 0 , 0 0 0 , 0 0 0 , 0 0 0 , 0 0 0}$ |
| Lung capacity of a <br> blue whale in mL | $\mathbf{5 . 0 \times 1 0 ^ { 6 }}$ | $5,000,000$ |
| Speed of a snail in <br> kilometers per <br> second | $\mathbf{1 . 3 \times 1 0 ^ { - 5 }}$ | .000013 |
| Thickness of a sheet <br> of paper in inches | $2.75 \times 10^{-3}$ | $\mathbf{. 0 0 2 7 5}$ |

### 5.5 Thinking About Polynomials

| Expression | CHOOSE: | Degree |
| :---: | :---: | :---: |
| $3 \mathrm{x}^{2}-2 \mathrm{x}+1$ | Trinomial | $\mathbf{2}^{\text {nd }}$ |
| 5 xyz | Monomial | $\mathbf{3}^{\text {rd }}$ |
| $4 \mathrm{x}+2 \mathrm{y}$ | Binomial | $\mathbf{1}^{\text {st }}$ |
| $5 \mathrm{x}^{2} \mathrm{y}-11$ | Binomial | $\mathbf{3}^{\text {rd }}$ |
| 139 | Monomial | $\mathbf{0}^{\text {degree }}$ |
| $-642 \mathrm{x}^{39}$ | Monomial | $\mathbf{3 9}^{\text {th }}$ |
| $2 \mathrm{y}+3 \mathrm{x}-5 \mathrm{w}+\mathrm{p}$ | Polynomial | $\mathbf{1}^{\text {st }}$ |
| $57 \mathrm{x}^{5}-2 \mathrm{x}^{3}+11 \mathrm{x}$ | Trinomial | $\mathbf{5}^{\text {th }}$ |
| x | Monomial | $\mathbf{1}^{\text {st }}$ |
| $4 \mathrm{x}^{2}+3 \mathrm{x}+\mathrm{x}$ | Trinomial | $\mathbf{2}^{\text {nd }}$ |
| $2 \mathrm{x}+\mathrm{y}+\mathrm{z}^{12}$ | Trinomial | $\mathbf{1 2}^{\text {th }}$ |
| $5 \mathrm{x}^{0}$ | Monomial | $\mathbf{0}^{\text {degree }}$ |
| $100 \mathrm{x}^{2}-\mathrm{py}^{3}$ | Binomial | $\mathbf{4}^{\text {th }}$ |
| $3 \mathrm{x}+2$ | Binomial | $\mathbf{1}^{\text {st }}$ |
| $10 \mathrm{x}-\mathrm{y}+\mathrm{z}+\mathrm{p}-5$ | Polynomial | $\mathbf{1}^{\text {st }}$ |

### 5.5 Thinking About Polynomials (cont.)

1. answers will vary, ex. $x^{2}+3 x-5$
2. answers will vary, ex. $5 \mathrm{x}^{4}$
3. answers will vary, ex. $5 x^{3}-3 x$
4. Yes, $(x+3)+(y+5)=x+y+8$
5. Yes, $(x+3)+(x-3)=2 x$
6. Yes, $(x+3)+(x+5)=2 x+8$
7. Yes, $(x+3)(x-3)=x^{2}-9$
8. Yes, $(x+3)(x+2)=x^{2}+5 x+6$
9. Yes, $(x+3)(y+w)=x y+x w+3 y+3 w$

### 5.6 Evaluating, Adding, and Subtracting Poly.

1a. $f(2)=3(4)-2(2)+1=9$
1b. $g(-3)=-2(9)-5=-23$
1c. $h(0)=-4(0)+2=2$
1d. $f(-5)=3(25)-2(-5)+1=86$
1e. $g(0)=-2(0)-5=-5$
1f. $h(-5)=-4(-5)+2=22$
2a. $x^{2}-2 x-4$
2b. $-2 x^{2}-4 x-3$
2c. $3 x^{2}-6 x+3$
2d. $5 x^{2}-2 x+6$
2e. $-2 x^{2}+4 x-7$
2f. $3 x^{2}+2 x-1$
3a. $12 x^{2}-8 x+4-6 x^{2}-15$ $=6 x^{2}-8 x-11$
3b. $15 x^{2}-10 x+5+8 x-4$
$=15 x^{2}-2 x+1$
5.7 Career Applications: STEM

1a. $R(x)-C(x)=x^{3}-x^{2}-\left(.75 x^{3}-.7 x^{2}-.5 x+10\right)$

$$
\begin{aligned}
& =x^{3}-x^{2}-.75 x^{3}+.7 x^{2}+.5 x-10 \\
& =.25 x^{3}-.3 x^{2}+.5 x-10
\end{aligned}
$$

1b. $\mathbf{R ( 3 )}=3^{3}-3^{2}=27-9=\$ 18$
$\mathbf{C}(3)=.75\left(3^{3}\right)-.7\left(3^{2}\right)-.5(3)+10$
$=.75(27)-.7(9)-1.5+10$
= 20.25-6.3-1.5 + 10
$=\$ 22.45$
$\mathbf{P}(3)=18-22.45=-\$ 4.45$ (loss)
1c. $\mathbf{R}(\mathbf{2 0})=20^{3}-20^{2}=8000-400=\$ 7600$
$\mathbf{C}(\mathbf{2 0})=.75\left(20^{3}\right)-.7\left(20^{2}\right)-.5(20)+10$
$=.75(8000)-.7(400)-10+10$
$=6000-280$
= \$5720
$\mathbf{P ( 2 0 )}=7600-5720=\$ \mathbf{1 8 8 0}$

### 5.7 Career Applications: STEM (cont.)

1d. $\mathbf{P}(x)=2 R(x)-C(x)$
$=2 \mathrm{x}^{3}-2 \mathrm{x}^{2}-\left(.75 \mathrm{x}^{3}-.7 \mathrm{x}^{2}-.5 \mathrm{x}+10\right)$
$=1.25 x^{3}-1.3 x^{2}+.5 x-10$

2a. $P=x+x+x+x=4 x$ in.
A $=x * x=x^{2}$ sq. in.
2b. $\mathbf{P}=\mathrm{x}+(2 \mathrm{x}+1)+\mathrm{x}+(2 \mathrm{x}+1)$

$$
=6 \mathrm{x}+2 \mathrm{ft} .
$$

$$
\mathbf{A}=x(2 x+1)
$$

$$
=2 x 2+x \text { sq. ft. }
$$

2c. $\mathbf{P}=3 \mathrm{x}+(\mathrm{x}-5)+3 \mathrm{x}+\mathrm{x}-5$

$$
=8 \mathrm{x}-10 \mathrm{~cm}
$$

$$
A=3 x(x-5)
$$

$$
=3 x 2-15 x \text { sq. cm }
$$

2d. $\mathbf{P}=(x+5)+(x-3)+(x+5)+(x-3)$

$$
=4 x+4 \text { meters }
$$

A $=(\mathrm{x}+5)(\mathrm{x}-3)$
$=x^{2}-3 x+5 x-15$

$$
=x^{2}+2 x-15 \text { sq. meters }
$$

2e. $\mathbf{P}=(x+7)+(x-7)+(x+7)+(x-7)$

$$
=4 x \text { miles }
$$

$\mathbf{A}=(\mathrm{x}+7)(\mathrm{x}-7)$
$=x^{2}-49$ sq. miles
2f. $\mathbf{P}=(x+5)+(x+5)+(x+5)+(x+5)$

$$
=4 x+20 \mathrm{~km}
$$

A $=(x+5)(x+5)$

$$
=x^{2}+10 x+25 \text { sq. } k m
$$

3a. $\mathbf{h}(\mathbf{0})=-\mathbf{1 6}(\mathbf{0})^{2}+177=177$
This tells us that the penny is 177 feet off the ground (on top of the building) when you haven't thrown it yet
3b. $\mathbf{h ( 1 )}=-16(1)^{2}+177=-16+177=\mathbf{1 6 1}$ feet.
3c. $\mathbf{h ( 2 )}=-16(2)^{2}+177=-64+177=\mathbf{1 1 3}$ feet
3d. $\mathbf{h ( 3 )}=-16(3)^{2}+177=\mathbf{3 3}$ feet
3e. No ; $\mathrm{h}(4)=-16(4)^{2}+177=-79$ feet (underground?)!

