

# 11. [Square Roots / Radicals]

## Skill 11.1 Calculating square roots of perfect squares.

MMMaive 1 1 2 2 3 3 4 4  
MMLime 1 1 2 2 3 3 4 4

- Estimate which number, multiplied by itself, produces the number under the square root sign.
- Check your estimation by multiplying your guess by itself.

*Hint: Calculating the square root is the opposite to squaring.*

Q.  $\sqrt{400} =$

A.  $\sqrt{400} =$   
 $= \sqrt{20 \times 20}$   
 $= 20$

a)  $\sqrt{25} =$

$= \sqrt{5 \times 5} = \boxed{5}$

b)  $\sqrt{4} =$

$= \dots = \boxed{\phantom{00}}$

c)  $\sqrt{81} =$

$= \dots = \boxed{\phantom{00}}$

d)  $\sqrt{100} =$

$= \dots = \boxed{\phantom{00}}$

e)  $\sqrt{64} =$

$= \dots = \boxed{\phantom{00}}$

f)  $\sqrt{169} =$

$= \dots = \boxed{\phantom{00}}$

g)  $\sqrt{121} =$

$= \dots = \boxed{\phantom{00}}$

h)  $\sqrt{1} =$

$= \dots = \boxed{\phantom{00}}$

i)  $\sqrt{1600} =$

$= \dots = \boxed{\phantom{00}}$

j)  $\sqrt{9} =$

$= \dots = \boxed{\phantom{00}}$

k)  $\sqrt{144} =$

$= \dots = \boxed{\phantom{00}}$

l)  $\sqrt{6400} =$

$= \dots = \boxed{\phantom{00}}$

m)  $\sqrt{256} =$

$= \dots = \boxed{\phantom{00}}$

n)  $\sqrt{225} =$

$= \dots = \boxed{\phantom{00}}$

o)  $\sqrt{10,000} =$

$= \dots = \boxed{\phantom{00}}$

## Skill 11.2 Calculating square roots of perfect squares in fraction form.

MMMaive 1 2 2 3 3 4 4  
MMLime 1 1 2 2 3 3 4 4

- If the number is a mixed number, convert it to an improper fraction first.
- Estimate which number multiplied by itself produces the numerator.
- Estimate which number multiplied by itself produces the denominator.
- Check your estimation by multiplying your guess by itself.

*Hint: Calculating the square root is the opposite to squaring.*

Q.  $\sqrt{5\frac{4}{9}} =$

A.  $\sqrt{5\frac{4}{9}} =$

$$= \sqrt{\frac{5 \times 9 + 4}{9}}$$

Change the mixed number to an improper fraction

$$= \sqrt{\frac{49}{9}} = \frac{\sqrt{49}}{\sqrt{9}} = \frac{\sqrt{7 \times 7}}{\sqrt{3 \times 3}}$$

Find the square root of the numerator and the denominator

$$= \frac{7}{3} = 2\frac{1}{3}$$

a)  $\sqrt{\frac{1}{36}} =$

$$= \sqrt{\frac{1}{6} \times \frac{1}{6}}$$

$$= \boxed{\frac{1}{6}}$$

b)  $\sqrt{\frac{1}{16}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

c)  $\sqrt{\frac{4}{25}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

d)  $\sqrt{\frac{100}{144}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

e)  $\sqrt{\frac{16}{121}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

f)  $\sqrt{\frac{25}{81}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

g)  $\sqrt{1\frac{7}{9}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

h)  $\sqrt{2\frac{1}{4}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

i)  $\sqrt{1\frac{11}{25}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

j)  $\sqrt{20\frac{1}{4}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

k)  $\sqrt{1\frac{17}{64}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

l)  $\sqrt{3\frac{1}{16}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

m)  $\sqrt{11\frac{1}{9}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

n)  $\sqrt{1\frac{15}{49}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

o)  $\sqrt{4\frac{21}{25}} =$

$$= \dots = \boxed{\phantom{\frac{1}{6}}}$$

### Skill 11.3 Calculating square roots of perfect squares in decimal form.

- Find the square root. (see skill 11.1, page 123)
- Consider the position of the decimal point.

**Q.**  $\sqrt{0.04} =$

**A.**  $\sqrt{0.04} =$   
 $= \sqrt{0.2 \times 0.2}$   
 $= 0.2$

**a)**  $\sqrt{0.25} =$

$= 0.5 \times 0.5 =$

**b)**  $\sqrt{0.16} =$

$=$

**c)**  $\sqrt{1.44} =$

$=$

**d)**  $\sqrt{0.01} =$

$=$

**e)**  $\sqrt{0.49} =$

$=$

**f)**  $\sqrt{1.69} =$

$=$

**g)**  $\sqrt{0.36} =$

$=$

**h)**  $\sqrt{4.41} =$

$=$

**i)**  $\sqrt{0.25} =$

$=$

**j)**  $\sqrt{0.64} =$

$=$

**k)**  $\sqrt{1.96} =$

$=$

**l)**  $\sqrt{2.56} =$

$=$

**m)**  $\sqrt{6.25} =$

$=$

**n)**  $\sqrt{0.81} =$

$=$

**o)**  $\sqrt{1.21} =$

$=$

**p)**  $\sqrt{0.09} =$

$=$

**q)**  $\sqrt{2.25} =$

$=$

**r)**  $\sqrt{5.76} =$

$=$

**Skill 11.4** Multiplying integers with square roots of perfect squares.

- Find the square root. (see skill 11.1, page 123)
- Multiply the whole numbers.

**Q.**  $3\sqrt{81} =$

**A.**  $3\sqrt{81} =$   
 $= 3 \times \sqrt{9 \times 9}$   
 $= 3 \times 9$   
 $= 27$

**a)**  $2\sqrt{64} =$

$= 2 \times \sqrt{8 \times 8}$

$= 2 \times 8 = \boxed{16}$

**b)**  $4\sqrt{9} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**c)**  $3\sqrt{16} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**d)**  $2\sqrt{49} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**e)**  $4\sqrt{25} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**f)**  $2\sqrt{144} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**g)**  $6\sqrt{100} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**h)**  $7\sqrt{36} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**i)**  $4\sqrt{64} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**j)**  $2\sqrt{169} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**k)**  $2\sqrt{900} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**l)**  $5\sqrt{121} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**m)**  $3\sqrt{400} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**n)**  $6\sqrt{2500} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**o)**  $10\sqrt{0.25} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**p)**  $4\sqrt{225} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**q)**  $5\sqrt{1600} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

**r)**  $2\sqrt{625} =$

$=$   
 $=$   $\boxed{\phantom{00}}$

## Skill 11.5 Multiplying square roots of perfect squares.

- Find the square roots. (see skill 11.1, page 123)
- Multiply the whole numbers.

$$\sqrt{9} \times \sqrt{9} = \sqrt{9 \times 9} = 9$$

The square root of any number multiplied by itself equals the number

**Q.**  $2\sqrt{49} \times \sqrt{49} =$

**A.**  $2\sqrt{49} \times \sqrt{49} =$   
 $= 2 \times 49$   
 $= 98$

**a)**  $\sqrt{36} \times \sqrt{36} =$

36

**b)**  $\sqrt{7} \times \sqrt{7} =$

**c)**  $\sqrt{25} \times \sqrt{25} =$

**d)**  $\sqrt{81} \times \sqrt{25} =$

$= 9 \times 5$

= 45

**e)**  $\sqrt{16} \times \sqrt{9} =$

=

=

**f)**  $\sqrt{49} \times \sqrt{64} =$

=

=

**g)**  $\sqrt{121} \times 3\sqrt{9} =$

=

**h)**  $\sqrt{16} \times \sqrt{100} =$

=

**i)**  $\sqrt{36} \times 4\sqrt{25} =$

=

**j)**  $\sqrt{9} \times 2\sqrt{49} =$

=

**k)**  $\sqrt{144} \times 4\sqrt{4} =$

=

**l)**  $2\sqrt{36} \times \sqrt{25} =$

=

**m)**  $2\sqrt{25} \times \sqrt{64} =$

=

**n)**  $\sqrt{169} \times 2\sqrt{9} =$

=

**o)**  $2\sqrt{4} \times 3\sqrt{121} =$

=

**p)**  $5\sqrt{16} \times \sqrt{81} =$

=

**q)**  $\sqrt{100} \times 8\sqrt{4} =$

=

**r)**  $4\sqrt{9} \times 2\sqrt{100} =$

=

**s)**  $3\sqrt{64} \times 2\sqrt{49} =$

=

**t)**  $5\sqrt{36} \times 2\sqrt{144} =$

=

**u)**  $9\sqrt{9} \times 4\sqrt{400} =$

=

## Skill 11.6 Dividing square roots of perfect squares.

MMMaive 11 2 2 3 4 4  
MMLime 11 2 2 3 3 4 4

- Find the square roots.  
(see skill 11.1, page 123)
- Divide the whole numbers.

The square root of any number divided by itself equals 1

$$\frac{\sqrt{9}}{\sqrt{9}} = \sqrt{9} \div \sqrt{9} = 1$$

**Q.**  $\frac{\sqrt{81}}{\sqrt{9}} =$

**A.**  $\frac{\sqrt{81}}{\sqrt{9}} =$   
 $\frac{9}{3}$   
 $= 3$

Find the square root of the numerator and the denominator

**a)**  $\sqrt{64} \div \sqrt{16} =$

$= 8 \div 4$

$=$

**b)**  $\sqrt{100} \div \sqrt{25} =$

$=$

$=$

**c)**  $\sqrt{36} \div \sqrt{9} =$

$=$

$=$

**d)**  $\sqrt{900} \div \sqrt{36} =$

$=$

$=$

**e)**  $\sqrt{144} \div \sqrt{4} =$

$=$

$=$

**f)**  $\sqrt{196} \div \sqrt{49} =$

$=$

$=$

**g)**  $\frac{\sqrt{400}}{\sqrt{16}} =$

$=$

$=$

**h)**  $\frac{\sqrt{144}}{\sqrt{9}} =$

$=$

$=$

**i)**  $\frac{\sqrt{900}}{\sqrt{25}} =$

$=$

$=$

**j)**  $8\sqrt{4} \div 2\sqrt{4} =$

$= (8 \times 2) \div (2 \times 2)$

$= 16 \div 4$

$=$

**k)**  $4\sqrt{100} \div 2\sqrt{25} =$

$=$

$=$

**l)**  $4\sqrt{900} \div 2\sqrt{9} =$

$=$

$=$

**m)**  $\frac{4\sqrt{9}}{\sqrt{9}} =$

$=$

$=$

**n)**  $\frac{2\sqrt{400}}{\sqrt{4}} =$

$=$

$=$

**o)**  $\frac{3\sqrt{25}}{\sqrt{9}} =$

$=$

$=$

**p)**  $\frac{2\sqrt{100}}{\sqrt{25}} =$

$=$

$=$

**q)**  $\frac{5\sqrt{64}}{\sqrt{16}} =$

$=$

$=$

**r)**  $\frac{4\sqrt{36}}{2\sqrt{4}} =$

$=$

$=$

## Skill 11.7 Adding and subtracting square roots of perfect squares.

- Find the square roots. (see skill 11.1, page 123)
- Add or subtract the whole numbers.

*Hint: Square roots that are not alike cannot be added or subtracted.*

$$\sqrt{16} + \sqrt{4} \neq \sqrt{16 + 4}$$

$$4 + 2 \neq \sqrt{20}$$

$$\sqrt{16} - \sqrt{4} \neq \sqrt{16 - 4}$$

$$4 - 2 \neq \sqrt{12}$$

**Q.**  $\sqrt{25} + \sqrt{25} + \sqrt{25} + \sqrt{25} = \sqrt{100}$   
True or false?

**A.**  $\sqrt{25} + \sqrt{25} + \sqrt{25} + \sqrt{25} = \sqrt{100}$   
 $5 + 5 + 5 + 5 = 10$   
 $20 = 10$   
*false*

**a)**  $\sqrt{64} - \sqrt{9} =$

$= 8 - 3 =$

**b)**  $\sqrt{100} + \sqrt{36} =$

$=$

**c)**  $\sqrt{25} + \sqrt{49} =$

$=$

**d)**  $\sqrt{196} - \sqrt{49} =$

$=$

**e)**  $\sqrt{144} - \sqrt{64} =$

$=$

**f)**  $\sqrt{81} + \sqrt{121} =$

$=$

**g)**  $\sqrt{25} + \sqrt{100} =$

$=$

**h)**  $\sqrt{36} + \sqrt{64} =$

$=$

**i)**  $\sqrt{49} - \sqrt{25} =$

$=$

**j)**  $\sqrt{400} - \sqrt{81} =$

$=$

**k)**  $\sqrt{121} - \sqrt{100} =$

$=$

**l)**  $\sqrt{169} - \sqrt{144} =$

$=$

**m)**  $\sqrt{169} - \sqrt{25} = \sqrt{144}$   
True or false?

$=$

**n)**  $\sqrt{4} + \sqrt{4} = \sqrt{9}$   
True or false?

$=$

**o)**  $\sqrt{64} + \sqrt{36} = \sqrt{100}$   
True or false?

$=$

**p)**  $\sqrt{64} - \sqrt{25} = \sqrt{9}$   
True or false?

$=$

**q)**  $\sqrt{100} - \sqrt{36} = \sqrt{64}$   
True or false?

$=$

**r)**  $\sqrt{9} + \sqrt{9} + \sqrt{9} + \sqrt{9} = \sqrt{36}$   
True or false?

$=$

**Skill 11.8** Estimating square roots.

- Find the perfect squares greater than ( $>$ ) and less than ( $<$ ) the number.

**Q.** Between which two consecutive whole numbers does  $\sqrt{8}$  lie?

**A.**  $4 < 8 < 9$

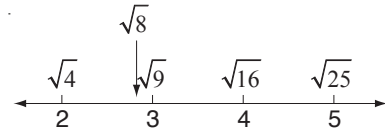
$\sqrt{4} < \sqrt{8} < \sqrt{9}$

$\sqrt{4} = 2$

$\sqrt{9} = 3$

$2 < \sqrt{8} < 3$

The answer is **2 & 3**



**a)** Between which two consecutive whole numbers does  $\sqrt{72}$  lie?

$\sqrt{64} = 8$       $\sqrt{81} = 9$

**8 & 9**

**b)** Between which two consecutive whole numbers does  $\sqrt{10}$  lie?

**&**

**c)** Between which two consecutive whole numbers does  $\sqrt{5}$  lie?

**&**

**d)** Between which two consecutive whole numbers does  $\sqrt{60}$  lie?

**&**

**e)** Between which two consecutive whole numbers does  $\sqrt{34}$  lie?

**&**

**f)** Between which two consecutive whole numbers does  $\sqrt{24}$  lie?

**&**

**g)** Between which two consecutive whole numbers does  $\sqrt{80}$  lie?

**&**

**h)** Between which two consecutive whole numbers does  $\sqrt{145}$  lie?

**&**

**i)** Between which two consecutive whole numbers does  $\sqrt{99}$  lie?

**&**

**j)** Between which two consecutive whole numbers does  $\sqrt{138}$  lie?

**&**

## Skill 11.9 Multiplying radicals.

MMMaue 11 22 33 44  
MMLime 11 22 33 44

- Multiply the whole numbers outside the square roots.
- Multiply the whole numbers inside the square roots.
- Find the square root of the perfect square.
- Multiply the results.

$$\sqrt{a} \times \sqrt{b} = \sqrt{a \times b} \quad \text{and} \quad m\sqrt{p} \times n\sqrt{q} = mn\sqrt{pq}$$

$$\sqrt{8} \times \sqrt{8} = \sqrt{8 \times 8} = 8$$

The square root of any number multiplied by itself equals the number

**Q.**  $4\sqrt{2} \times \sqrt{32} =$

**A.**  $4\sqrt{2} \times \sqrt{32} =$   
 $= 4\sqrt{2 \times 32}$   
 $= 4\sqrt{64}$   
 $= 4 \times 8$   
 $= 32$

**a)**  $4\sqrt{5} \times 5\sqrt{5} =$

$$= 4 \times 5 \times \sqrt{5 \times 5}$$

$$= 20 \times 5$$

$$= \boxed{100}$$

**b)**  $2\sqrt{3} \times \sqrt{3} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**c)**  $2\sqrt{2} \times 5\sqrt{2} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**d)**  $2\sqrt{7} \times \sqrt{7} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**e)**  $\sqrt{3} \times 3\sqrt{3} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**f)**  $4\sqrt{6} \times 3\sqrt{6} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**g)**  $\sqrt{8} \times \sqrt{2} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**h)**  $\sqrt{48} \times \sqrt{3} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**i)**  $\sqrt{2} \times 5\sqrt{18} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**j)**  $2\sqrt{3} \times \sqrt{27} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**k)**  $7\sqrt{20} \times \sqrt{5} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**l)**  $\sqrt{24} \times 2\sqrt{6} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**m)**  $\sqrt{32} \times 2\sqrt{2} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**n)**  $2\sqrt{12} \times \sqrt{3} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

**o)**  $2\sqrt{6} \times \sqrt{54} =$

$$=$$

$$=$$

$$= \boxed{\phantom{00}}$$

### Skill 11.10 Dividing radicals.

- Divide the whole numbers outside the square roots.
- Divide the whole numbers inside the square roots.
- Find the square root of the perfect square.
- Multiply the results.

$$\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}} \quad \text{and} \quad \frac{m\sqrt{p}}{n\sqrt{q}} = \frac{m}{n} \times \sqrt{\frac{p}{q}}$$

$$\sqrt{8} \div \sqrt{8} = \sqrt{8 \div 8} = \sqrt{1} = 1$$

The square root of any number divided by itself equals 1

Q.  $\frac{10\sqrt{54}}{5\sqrt{6}} =$

A.  $\frac{10\sqrt{54}}{5\sqrt{6}} =$   
 $= \frac{10}{5} \times \sqrt{\frac{54}{6}}$   
 $= 2 \times \sqrt{9}$   
 $= 2 \times 3 = 6$

a)  $\sqrt{18} \div \sqrt{2} =$   
 $= \sqrt{18 \div 2}$   
 $= \sqrt{9} = \boxed{\phantom{00}}$

b)  $6\sqrt{13} \div 2\sqrt{13} =$   
 $= \phantom{00}$   
 $= \phantom{00} = \boxed{\phantom{00}}$

c)  $\sqrt{8} \div \sqrt{2} =$   
 $= \phantom{00}$   
 $= \phantom{00} = \boxed{\phantom{00}}$

d)  $4\sqrt{72} \div 2\sqrt{2} =$   
 $= 4 \div 2 \times \sqrt{72 \div 2}$   
 $= 2 \times \sqrt{36}$   
 $= 2 \times 6 = \boxed{\phantom{00}}$

e)  $6\sqrt{45} \div 3\sqrt{5} =$   
 $= \phantom{00}$   
 $= \phantom{00} = \boxed{\phantom{00}}$

f)  $10\sqrt{63} \div 2\sqrt{7} =$   
 $= \phantom{00}$   
 $= \phantom{00} = \boxed{\phantom{00}}$

g)  $\frac{4\sqrt{8}}{2\sqrt{8}} =$   
 $= \phantom{00}$   
 $= \phantom{00} = \boxed{\phantom{00}}$

h)  $\frac{4\sqrt{32}}{\sqrt{2}} =$   
 $= \phantom{00}$   
 $= \phantom{00} = \boxed{\phantom{00}}$

i)  $\frac{2\sqrt{48}}{\sqrt{3}} =$   
 $= \phantom{00}$   
 $= \phantom{00} = \boxed{\phantom{00}}$

j)  $\frac{9\sqrt{80}}{3\sqrt{5}} =$   
 $= \phantom{00}$   
 $= \phantom{00} = \boxed{\phantom{00}}$

k)  $\frac{14\sqrt{27}}{7\sqrt{3}} =$   
 $= \phantom{00}$   
 $= \phantom{00} = \boxed{\phantom{00}}$

l)  $\frac{8\sqrt{125}}{2\sqrt{5}} =$   
 $= \phantom{00}$   
 $= \phantom{00} = \boxed{\phantom{00}}$

### Skill 11.11 Simplifying radicals to simplest form.

- Find two factors of the whole number, one of which must be a perfect square.
- Write the radical as a product of two radicals.
- Find the square root of the perfect square.
- Leave the second radical unchanged.

**Q.** Simplify  $\sqrt{500}$

**A.**  $\sqrt{500}$   
 $= \sqrt{100 \times 5}$   
 $= \sqrt{100} \times \sqrt{5}$   
 $= 10\sqrt{5}$

**a)** Simplify  $\sqrt{45}$

$= \sqrt{9 \times 5}$   
 $= \sqrt{9} \times \sqrt{5} = \boxed{3\sqrt{5}}$

**b)** Simplify  $\sqrt{8}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**c)** Simplify  $\sqrt{28}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**d)** Simplify  $\sqrt{18}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**e)** Simplify  $\sqrt{12}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**f)** Simplify  $\sqrt{75}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**g)** Simplify  $\sqrt{32}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**h)** Simplify  $\sqrt{48}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**i)** Simplify  $\sqrt{63}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**j)** Simplify  $\sqrt{300}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**k)** Simplify  $\sqrt{125}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**l)** Simplify  $\sqrt{108}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**m)** Simplify  $\sqrt{80}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**n)** Simplify  $\sqrt{50}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**o)** Simplify  $\sqrt{84}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**p)** Simplify  $\sqrt{90}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**q)** Simplify  $\sqrt{500}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**r)** Simplify  $\sqrt{120}$

$=$   
 $=$   $\boxed{\phantom{00}}$

**Skill 11.12** Adding and subtracting radicals.

- Add and subtract only terms that contain the same radicals.

Hint:

Same

Different

$$\sqrt{8} + \sqrt{8} = 2\sqrt{8}$$

$$\sqrt{8} + \sqrt{5} \neq \sqrt{13}$$

- Where necessary, simplify the radical. (see skill 11.11, page 133)

**Q.**  $3\sqrt{32} - \sqrt{50} =$

**A.**  $3\sqrt{32} - \sqrt{50} =$   
 $= 3\sqrt{16 \times 2} - \sqrt{25 \times 2}$   
 $= 3 \times \sqrt{16} \times \sqrt{2} - \sqrt{25} \times \sqrt{2}$   
 $= 12\sqrt{2} - 5\sqrt{2}$   
 $= 7\sqrt{2}$

**a)**  $5\sqrt{13} + \sqrt{13} =$

$6\sqrt{13}$

**b)**  $4\sqrt{6} + 3\sqrt{6} =$

$\square$

**c)**  $7\sqrt{2} - 3\sqrt{2} =$

$\square$

**d)**  $\sqrt{3} + 8\sqrt{3} =$

$\square$

**e)**  $4\sqrt{5} + 7\sqrt{5} =$

$\square$

**f)**  $15\sqrt{7} - 7\sqrt{7} =$

$\square$

**g)**  $2\sqrt{50} - \sqrt{18} =$

$= 2\sqrt{25 \times 2} - \sqrt{9 \times 2}$   
 $= 2 \times \sqrt{25} \times \sqrt{2} - \sqrt{9} \times \sqrt{2}$   
 $= 10\sqrt{2} - 3\sqrt{2} = 7\sqrt{2}$

**h)**  $\sqrt{8} + \sqrt{2} =$

$=$   
 $=$   
 $=$   
 $=$   
 $=$   
 $=$

**i)**  $\sqrt{2} + 5\sqrt{18} =$

$=$   
 $=$   
 $=$   
 $=$   
 $=$   
 $=$

**j)**  $\sqrt{125} - \sqrt{45} =$

$=$   
 $=$   
 $=$   
 $=$   
 $=$   
 $=$

**k)**  $\sqrt{27} + 5\sqrt{12} =$

$=$   
 $=$   
 $=$   
 $=$   
 $=$   
 $=$

**l)**  $\sqrt{8} + 2\sqrt{18} =$

$=$   
 $=$   
 $=$   
 $=$   
 $=$   
 $=$

**m)**  $\sqrt{300} - 2\sqrt{12} =$

$=$   
 $=$   
 $=$   
 $=$   
 $=$   
 $=$

**n)**  $4\sqrt{54} - 3\sqrt{24} =$

$=$   
 $=$   
 $=$   
 $=$   
 $=$   
 $=$

**o)**  $3\sqrt{200} + 2\sqrt{18} =$

$=$   
 $=$   
 $=$   
 $=$   
 $=$   
 $=$

### Skill 11.13 Simplifying expressions with radicals.

- Use rules for the multiplication and division of radicals.  
(see skill 11.9, page 131 and skill 11.10, page 132)
- Where necessary, simplify the radical. (see skill 11.11, page 133)

**Hint:** When multiplying and dividing radicals the same rules apply as for normal numbers.

$$\sqrt{a} \times \sqrt{b} = \sqrt{a \times b}$$

$$\frac{\sqrt{a}}{\sqrt{b}} = \sqrt{\frac{a}{b}}$$

**Q.** Evaluate  $\frac{\sqrt{14} \times \sqrt{6}}{\sqrt{7}}$

**A.**  $\frac{\sqrt{14} \times \sqrt{6}}{\sqrt{7}} =$   
 $= \frac{\sqrt{14 \times 6}}{\sqrt{7}}$   
 $= \sqrt{\frac{84}{7}}$   
 $= \sqrt{12}$   
 $= 2\sqrt{3}$

**a)** Evaluate  $\frac{\sqrt{3} \times \sqrt{24}}{\sqrt{2}}$   
 $= \frac{\sqrt{3 \times 24}}{\sqrt{2}}$

$= \sqrt{\frac{72}{2}} = \sqrt{36} = \boxed{6}$

**b)** Evaluate  $\frac{\sqrt{15} \times \sqrt{3}}{\sqrt{5}}$   
 $=$

$=$   $=$   $= \boxed{\phantom{00}}$

**c)** Evaluate  $\frac{\sqrt{14} \times \sqrt{2}}{\sqrt{7}}$   
 $=$

$=$   $=$   $= \boxed{\phantom{00}}$

**d)** Evaluate  $\frac{\sqrt{100} \times \sqrt{2}}{\sqrt{8}}$   
 $=$

$=$   $=$   $= \boxed{\phantom{00}}$

**e)** Evaluate  $\frac{\sqrt{4} \times \sqrt{28}}{\sqrt{7}}$   
 $=$

$=$   $=$   $= \boxed{\phantom{00}}$

**f)** Evaluate  $\frac{3\sqrt{12} \times \sqrt{6}}{\sqrt{8}}$   
 $=$

$=$   $=$   $= \boxed{\phantom{00}}$

**g)** Evaluate  $\frac{5\sqrt{18} \times \sqrt{2}}{\sqrt{36}}$   
 $=$

$=$   $=$   $= \boxed{\phantom{00}}$

**h)** Evaluate  $\frac{\sqrt{5} \times \sqrt{8}}{\sqrt{2}}$   
 $=$

$=$   $=$   $= \boxed{\phantom{00}}$

**i)** Evaluate  $\frac{2\sqrt{6} \times \sqrt{8}}{\sqrt{3}}$   
 $=$

$=$   $=$   $= \boxed{\phantom{00}}$