

# 10. [Rates / Ratios]

## Skill 10.1 Simplifying ratios.

MM9 1 1 2 2 3 3 4 4  
MM10 1 1 2 2 3 3 4 4

- Write the quantities of the ratio with the same unit of measurement.

EITHER

- Find the largest number that divides evenly into each quantity of the ratio (Highest Common Factor).
- Divide each quantity by the HCF.

OR

- Divide each quantity of the ratio by any factor until the ratio is reduced to its simplest form.

Hints: The order of the quantities in a ratio matters.

' : ' means 'to'.

Examples: The ratio of legs to ears in a dog is  $4 : 2 = 2 : 1$

The ratio of ears to legs in a dog is  $2 : 4 = 1 : 2$

$$a : b = \frac{a}{b} \quad \text{Ratio}$$

**Q.** Simplify  $80 \text{ min} : 3 \text{ h}$

**A.**  $3 \text{ h} = 3 \times 60 \text{ min} = 180 \text{ min}$  **OR** **A.**  $3 \text{ h} = 3 \times 60 \text{ min} = 180 \text{ min}$

$80 \text{ min} : 3 \text{ h}$   $1 \text{ h} = 60 \text{ min}$

$= \overset{4}{80} \text{ min} : \overset{9}{180} \text{ min}$   $\text{HCF of } 80 \text{ and } 180 \text{ is } 20 \text{ so } \div 20$

$= 4 : 9$   $\text{Ignore the units}$

$80 \text{ min} : 3 \text{ h}$

$= 80 \text{ min} : 180 \text{ min}$

$= \overset{4}{8} : \overset{9}{18}$   $\text{Simplify: } \div 10$

$= 4 : 9$   $\text{Simplify: } \div 2$

**a)** Simplify  $600 \text{ mL} : 0.2 \text{ L}$   $1 \text{ L} = 1000 \text{ mL}$

$0.2 \text{ L} = 0.\overset{2}{2}00 \times 1000 \text{ mL} = 200 \text{ mL}$   $3 \text{ zeros, } 3 \text{ places right}$

$600 \text{ mL} : 200 \text{ mL}$   $\text{Simplify: } \div 100$

$= \overset{3}{6} : \overset{1}{2}$   $\text{Simplify: } \div 2$   $= \boxed{3:1}$

**b)** Simplify  $2 \text{ m} : 50 \text{ cm}$

.....

.....

$= \boxed{\phantom{000}}$

**c)** Simplify  $750 \text{ g} : 1 \text{ kg}$

.....

.....

$= \boxed{\phantom{000}}$

**d)** Simplify  $6 \text{ months} : 4 \text{ years}$

.....

.....

$= \boxed{\phantom{000}}$

**e)** Simplify  $0.5 \text{ kg} : 2000 \text{ g} : 4 \text{ kg}$

.....

.....

$= \boxed{\phantom{000}}$

**f)** Simplify  $50 \text{ c} : \$4.00 : \$2.50$

.....

.....

$= \boxed{\phantom{000}}$

**Skill 10.2** Finding the ratio of two or more quantities as a set:set comparison.

- Write the ratio in words.
- Replace the words with numbers.
- Simplify the ratio:

EITHER

Find the largest number that divides evenly into each quantity of the ratio (Highest Common Factor) and divide each quantity by the HCF.

*Hint: The order of the quantities in a ratio matters.*

OR

Divide each quantity of the ratio by any factor till the ratio is reduced to its simplest form.

**Q.** Ocean water represents 70% of the earth's surface and the rest is land. Find the ratio of water to land.

**A.**  $land = 100\% - 70\% = 30\%$

$water : land$

$= 70\% : 30\%$  *Simplify:  $\div 10$*

$= 7 : 3$  *Ignore the % sign*

**a)** An orchestra has 60 strings, 12 brass and 9 woodwinds instruments. What is the ratio of strings to brass to woodwinds instruments?

*strings : brass: woodwind*

$60 : 12 : 9$

*Simplify:  $\div 3$*   $\overset{20}{60} : \overset{4}{12} : \overset{3}{9} = \boxed{20:4:3}$

**b)** Tin foil is made up of 88% tin, 4% copper and the rest lead. What is the ratio of tin to copper to lead in the foil?

$:\quad :$   
 $:\quad :$

$= \boxed{\phantom{000}}$

**c)** Find the ratio of the average weight of a Blue Whale (120 t) to the average weight of a Humpback Whale (30 t).

$:\quad :$   
 $:\quad :$

$= \boxed{\phantom{000}}$

**d)** Find the ratio of the Boeing 747 wingspan (64 m) to the Airbus A380 wingspan (80 m).

$:\quad :$   
 $:\quad :$

$= \boxed{\phantom{000}}$

**e)** A ticket to the musical "The Boy from Oz" is \$90. A movie ticket to the Village cinemas is \$15. What is the ratio of musical to movie ticket prices?

$:\quad :$   
 $:\quad :$

$= \boxed{\phantom{000}}$

**f)** To purchase a "Two Day Park Hopper" to Disneyland, Florida, costs \$96 for a child and \$116 for an adult. What is the ratio of an adult to child ticket prices?

$:\quad :$   
 $:\quad :$

$= \boxed{\phantom{000}}$

**g)** Commercial butter is approximately 80% milk fat and 20% other components. What is the ratio of milk fat to other components?

$:\quad :$   
 $:\quad :$

$= \boxed{\phantom{000}}$

**h)** Of the 76 seats in the Senate, 28 belong to the Labor Party. What is the ratio of Labor Party to other parties seats in the Senate?

$:\quad :$   
 $:\quad :$

$= \boxed{\phantom{000}}$

- Write the ratio in words.
- Replace the words with numbers.
- Simplify the ratio:

EITHER

Find the largest number that divides evenly into each quantity of the ratio (Highest Common Factor) and divide each quantity by the HCF.

Hint: The order of the quantities in a ratio matters.

OR

Divide each quantity of the ratio by any factor till the ratio is reduced to its simplest form.

**Q.** Of the 20 million Australian people, approximately 4 million live in Sydney. What is the ratio of Sydney's population to Australian population?

**A.** Sydney's population : Australian population

= 4 million : 20 million Ignore the units

=  $\frac{4}{4} : \frac{20}{4}$  Simplify: ÷ 4

= 1 : 5

**a)** Of the 226 seats in the Australian Parliament, 76 are in the Senate. What is the ratio of Senate to Parliament seats?

Senate seats : Parliament seats

76 : 226

Simplify: ÷ 2  $\frac{76}{2} : \frac{226}{2}$  = 38:113

**b)** Land represents 30% of the earth's surface. Find the ratio of land to earth's surface.

⋮

..... =  

**c)** What is the ratio of carbon to total number of atoms in the ethane formula C<sub>2</sub>H<sub>6</sub>?

⋮

..... =  

**d)** What is the ratio of hydrogen to total number of atoms in the ethylene formula C<sub>2</sub>H<sub>4</sub>?

⋮

..... =  

**e)** A viscose/polyester blouse has 44% polyester. What is the ratio of viscose to total composition?

⋮

..... =  

**f)** Of the 2 L of cordial drink, 250 mL is concentrated cordial. Find the ratio of concentrated cordial to cordial drink.

⋮

..... =  

**g)** Of the \$500 000 paid for the property, \$150 000 was for the block of land, and the rest was for building the house. Find the ratio of land to total property price.

⋮

..... =  

**h)** In his career, Pete Sampras won 14 Grand Slam titles in 52 finals. What is the ratio of wins to finals played?

⋮

..... =

**Skill 10.4** Deciding if two ratios form a proportion.

- Write the two ratios as equal fractions side by side.
- Cross multiply the numerators and the denominators of the fractions.
- If the two products are equal, then the two ratios are in proportion.

A proportion

$$a : b = c : d \quad \text{2 ratios}$$

$$\frac{a}{b} = \frac{c}{d}$$

$$a \times d = b \times c$$

$$ad = bc$$

**Q.** 5 : 2 is in proportion with 25 : 10  
True or false?

**A.**  $\frac{5}{2} = \frac{25}{10}$  *Cross multiply*

$$5 \times 10 = 2 \times 25$$

$$50 = 50$$

**true**

**a)** 5 : 6 is in proportion with 3 : 5  
True or false?

$$\frac{5}{6} = \frac{3}{5}$$

$$5 \times 5 = 6 \times 3$$

$$25 = 18$$

**false**

**b)** 8 : 12 is in proportion with 6 : 8  
True or false?

**c)** 2 : 12 is in proportion with 3 : 18  
True or false?

**d)** 9 : 15 is in proportion with 30 : 50  
True or false?

**e)**  $\frac{12}{15}$  is in proportion with  $\frac{3}{5}$   
True or false?

$$\frac{12}{15} = \frac{3}{5}$$

$$12 \times 5 = 15 \times 3$$

$$60 = 45$$

**g)**  $\frac{15}{50}$  is in proportion with  $\frac{6}{20}$   
True or false?

**f)**  $\frac{8}{20}$  is in proportion with  $\frac{20}{50}$   
True or false?

**h)**  $\frac{8}{10}$  is in proportion with  $\frac{20}{25}$   
True or false?

**Skill 10.5** Finding the missing term in a proportion.

- Write the proportion as two equal fractions.
- Cross multiply the numerators and the denominators of the fractions.
- Equate the products.
- Solve the equation to find the missing number (x).

A proportion

$a:b = c:d$  2 ratios

$$\frac{a}{b} = \frac{c}{d}$$

$$a \times d = b \times c$$

$$ad = bc$$

**Q.** Complete the missing term in the proportion:

10 is to  = 5 is to 25

**A.**  $\frac{10}{x} = \frac{5}{25}$

$$\frac{10}{x} = \frac{5}{25}$$

Cross multiply

$$10 \times 25 = x \times 5$$

$$5x = 250$$

$$\frac{5x}{5} = \frac{250}{5}$$

Simplify:  $\div 5$

$$x = 50$$

**a)** Complete the missing term in the proportion:

$4 : 6 = 16 :$

$$\frac{4}{6} = \frac{16}{x}$$

Cross multiply

$$4x = 96$$

$$\frac{4x}{4} = \frac{96}{4}$$

Simplify:  $\div 4$

$$\Rightarrow x = 24$$

**b)** Complete the missing term in the proportion:

$5 :$  $= 50 : 100$

**c)** Complete the missing term in the proportion:

20 is to 15 = 8 is to

**d)** Complete the missing term in the proportion:

$8 :$  $= 10 : 15$

**e)** Find the missing term in the proportion:

$$\frac{4}{12} = \frac{y}{9}$$

$$4 \times 9 = 12 \times y$$

Cross multiply

$$12y = 36$$

**f)** Find the missing term in the proportion:

$$\frac{6}{x} = \frac{2}{3}$$

- Write the proportion using words.
- Replace the words with numbers:  
First the given ratio.  
Then the ratio of the given quantity to the unknown quantity ( $x$ ).
- Rewrite the proportion as two equal fractions.
- Cross multiply the numerators and the denominators of the fractions.
- Equate the products.
- Solve the equation to find  $x$ .

A proportion

$a : b = c : d$  — 2 ratios

$$\frac{a}{b} \times \frac{c}{d}$$

$$a \times d = b \times c$$

$$ad = bc$$

**Q.** The ratio of concentrated cordial to water is 1 : 4. How much water is needed to dilute 1.5 L of concentrated cordial?

**A.** *cordial : water = cordial : water*

$$1 : 4 = 1.5 : x$$

$$\frac{1}{4} \times \frac{1.5}{x}$$

Cross multiply

$$1 \times x = 4 \times 1.5$$

$$x = 6 \text{ L}$$

**a)** A risotto recipe uses a ratio of 2 cups of rice to 6 cups of water. How many cups of water have to be added to 6 cups of rice?

$$\text{rice} : \text{water} = \text{rice} : \text{water}$$

$$2 : 6 = 6 : x$$

$$\frac{2}{6} \times \frac{6}{x}$$

Cross multiply

$$2x = 36$$

Simplify:  $\div 2$

$$\text{So } x = \boxed{\phantom{00}}$$

**c)** The ratio of silver to bronze medals won by Britain at the 2004 Olympics is 3 : 4. If Britain won 9 silver medals, how many bronze medals did it win?

$$=$$

$$=$$

$$\text{So } x = \boxed{\phantom{00}}$$

**e)** The fuel mix for a chainsaw is 4 parts oil to 21 parts petrol. How much petrol needs to be added to 240 mL of oil?

$$=$$

$$=$$

$$\text{So } x = \boxed{\phantom{00}} \text{ mL}$$

**b)** To mix concrete, 2 buckets of sand are needed for every 3 buckets of gravel. How many buckets of gravel are needed for 10 buckets of sand?

$$\text{sand} : \text{gravel} =$$

$$=$$

$$\text{So } x = \boxed{\phantom{00}}$$

**d)** To make a 25% saline solution, 1 part of salt is used for every 3 parts of water. If you use 120 g of salt, how much water do you need to make the saline solution?

$$=$$

$$=$$

$$\text{So } x = \boxed{\phantom{00}} \text{ g}$$

**f)** The “superjumbo” jet Airbus A 380 has a length of 73 m and a wingspan of 80 m. A model of this plane has a wingspan of 160 cm. How long is the model?

$$=$$

$$=$$

$$\text{So } x = \boxed{\phantom{00}} \text{ cm}$$

- Find the total number of equal parts, by adding the numbers in the ratio.
- Calculate what fraction each share represents out of the total number of parts.
- Multiply this fraction by the original quantity.

**Q.** The ratio of cement to sand to gravel in a concrete mix is 1 : 2 : 3. How much sand is in a 24 kg concrete mix?

**A.**  $equal\ parts = 1 + 2 + 3 = 6$   
 $sand\ share = 2\ out\ of\ 6 = \frac{2 \div 2}{6 \div 2} = \frac{1}{3}$   
 $sand\ in\ 24\ kg = \frac{1}{3}\ of\ 24\ kg$   
 $= \frac{1}{\cancel{3}} \times \overset{8}{\cancel{24}}\ kg$  Simplify:  $\div 3$   
 $= 8\ kg$

**a)** The 18-carat gold is used for jewellery in a ratio of 3 : 1 pure gold to other metals. How many grams of pure gold are needed for a 12 g necklace?

$equal\ parts = 3 + 1 = 4$

$pure\ gold\ share = \frac{3}{4}$

$pure\ gold\ in\ 12\ g = \frac{3}{4}\ of\ 12\ g$

$= \frac{3}{\cancel{4}} \times \overset{3}{\cancel{12}}\ g$  Simplify:  $\div 4$  = g

**b)** The ratio of marriages to divorces in Australia in 2006 was 2 : 1. How many divorces would be likely in 1500 couples?

$equal\ parts =$

$divorce\ share =$

$divorces\ in\ 1500\ couples =$

= =

**c)** The ratio of vowels to consonants in the English language is 5 : 21. How many vowels are likely to be in a 52 000 letter article?

$equal\ parts =$

$vowels\ share =$

$vowels\ in\ 52\ 000\ letters =$

= =

**d)** The fuel mix for a chainsaw is 4 parts oil to 21 parts petrol. How much petrol is in a 1500 mL chainsaw tank?

$equal\ parts =$

$petrol\ share =$

$petrol\ in\ 1500\ mL =$

= = mL

**e)** The ratio of gold to silver to bronze medals won by Canada at the 2004 Olympics is 1 : 2 : 1. If they won 12 medals in total, how many gold medals did Canada win?

$equal\ parts =$

$gold\ share =$

$gold\ in\ 12\ medals =$

= =

**f)** The combined monthly bill for the phone, mobile phone and internet is \$180. If the ratio of phone to mobile phone to internet costs is 5 : 6 : 4, how much is the phone cost?

$equal\ parts =$

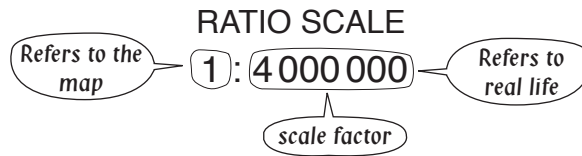
$phone\ share =$

$phone\ cost =$

= = \$

**Skill 10.8** Working with ratio scales (1).

MM9 11 22 33 44  
MM10 11 22 33 44



*Hint: 1 unit on the map represents 4 000 000 of the same units in real life.  
The real distance is 4 000 000 times bigger than the map distance.*

**Finding the real life distance (ratio scale and distance on the map are given)**

- Multiply the distance on the map (usually in cm) by the scale factor.
- Convert the result from cm to km, by dividing by 100 000.

**Finding the distance on the map (ratio scale and real life distance are given)**

- Convert the real distance from km to cm by multiplying by 100 000.
- Divide the real distance in cm by the scale factor.

**Finding the scale factor (real life distance and distance on the map are given)**

- Convert the real distance from km to cm by multiplying by 100 000.
- Divide the real distance in cm by the map distance in cm.

**Q.** On a map the scale is 1 : 10 000 000. What is the distance on the map between Brisbane and Adelaide, if they are 2000 km apart?

**A.** *real life distance = 2000 km*  
*scale factor = 10 000 000*  
*map distance = ?*

*2000 km = 2000 × 100 000 cm =*  
*= 200 000 000 cm*

Convert km to cm

*200 000 000 cm ÷ 10 000 000 =*  
*= 20 cm*

Cross off respective 0's

**a)** On a map the scale ratio is 1 : 20 000 000. What is the real distance between Tokyo and Geneva, if they are 80 cm apart on the map?

*real distance = 80 cm × 20 000 000*

*= 1 600 000 000 cm*

Cross off respective 0's

*1 600 000 000 cm ÷ 100 000 =*            km

**b)** On a map the scale ratio is 1 : 30 000 000. What is the real distance between Sydney and London, if they are 70 cm apart on the map?

*real distance =*

*=*

*=*            km

**c)** On a map the scale ratio is 1 : 25 000 000. What is the real distance between Broome and Melbourne, if they are 20 cm apart on the map?

*real distance =*

*=*

*=*            km

**d)** On a map the scale ratio is 1 : 3 000 000. What is the real distance between Sydney and Canberra, if they are 10 cm apart on the map?

*real distance =*

*=*

*=*            km



$$\text{average speed } (v) = \frac{\text{distance travelled } (d)}{\text{time taken } (t)} \quad \text{OR} \quad v = \frac{d}{t}$$

- Write the formula for the average speed.
- Convert the given units into the required units if necessary. (see Maths Facts, page 427)  
*Hints: If the speed must be calculated in km/h, convert the units for distance to km and the units for time to h.*  
*Changing from smaller units into larger units, always divide by the conversion factor.*  
*Changing from larger units into smaller units, always multiply by the conversion factor.*
- Substitute the values for distance and time into the formula.
- Evaluate and simplify.

**Q.** The marine green turtle was recorded swimming 480 km in 10 days. What was its average speed in km/h?

**A.**  $v = \frac{d}{t}$   
 where  $t = 10 \text{ days} = 10 \times 24 \text{ h} = 240 \text{ h}$

$$v = \frac{480 \text{ km}}{240 \text{ h}} \quad \text{Substitute into the formula}$$

$$= \frac{\overset{2}{480}}{\underset{1}{240}} \text{ km/h} \quad \text{Simplify: } \div 240$$

$$= 2 \text{ km/h}$$

**a)** A garden snail named Archie covered a 33 cm course in 2 minutes at the 1995 World Snail Racing Championships, held in England. What was Archie's average speed?

$$t = 2 \text{ min} = \frac{1 \cancel{2}}{30 \cancel{60}} \text{ h} = \frac{1}{30} \text{ h} \quad \text{Simplify: } \div 2$$


---


$$v = \frac{33 \text{ cm}}{\frac{1}{30} \text{ h}} = 33 \div \frac{1}{30} \text{ cm/h}$$


---


$$= 33 \times \frac{30}{1} \text{ cm/h} = \boxed{\phantom{000}} \text{ cm/h}$$

**b)** The Gentoo penguin in the Antarctic Islands can swim 20 km in half an hour. What is its average speed?

$$t = 30 \text{ min} = \dots\dots\dots$$


---


$$v = \dots\dots\dots$$


---


$$\dots\dots\dots \boxed{\text{km/h}}$$

**c)** The Suzuki Hayabusa is the world's fastest motorbike. It can travel 100 km in 20 minutes. What is its average speed?

$$t = 20 \text{ min} = \dots\dots\dots$$


---


$$v = \dots\dots\dots$$


---


$$\dots\dots\dots \boxed{\text{km/h}}$$

**d)** Some species of dolphins can swim 9 km in 10 minutes. What is their average speed in kilometres per hour?

$$t = \dots\dots\dots$$


---


$$v = \dots\dots\dots$$


---


$$\dots\dots\dots \boxed{\text{km/h}}$$

distance travelled ( $d$ ) = average speed ( $v$ )  $\times$  time taken ( $t$ ) OR  $d = vt$

- Write the formula for distance travelled.
- Convert the given units into the required units if necessary. (see Maths Facts, page 427)  
Hints: Changing from smaller units into larger units, always divide by the conversion factor.  
Changing from larger units into smaller units, always multiply by the conversion factor.
- Substitute the values for average speed and time into the formula.
- Evaluate and simplify.

**Q.** The ride duration of the Disneyland monorail in California is approximately 15 minutes. What is the length of the ride if the train's average speed is 16 km/h?  
[Give the answer in km.]

**A.**  $d = vt$   
where  $t = 15 \text{ min} = \frac{15}{60} \text{ h} = \frac{1}{4} \text{ h}$   
 $d = 16 \text{ km/h} \times \frac{1}{4} \text{ h}$  Substitute into the formula  
 $= \cancel{16}^4 \times \frac{1}{\cancel{4}_1} \text{ km}$  Simplify:  $\div 4$   
 $= 4 \text{ km}$

**a)** The Russian Alpha class nuclear-powered submarine has a maximum speed of 75 km/h, or 40 knots. At this speed, what distance can it cover in 12 hours?

$d = 75 \text{ km/h} \times 12 \text{ h}$   
.....  
 $= 75 \times 12 \text{ km} = \boxed{\phantom{000}} \text{ km}$

**b)** The Japanese Bullet train is the fastest scheduled train service in the world with an average speed of 260 km/h. At this speed, what distance can it cover in 3 hours?

$d =$   
.....  
 $= \phantom{000} = \boxed{\phantom{000}} \text{ km}$

**c)** The Nile flows at an average speed of around 7.5 km/h during inundation season. At this speed, what distance might a boat floating on the Nile travel in 6 hours?

$d =$   
.....  
 $= \phantom{000} = \boxed{\phantom{000}} \text{ km}$

**d)** The Eurostar trains operate from London to Brussels and run at an average speed of 140 km/h. If the trip takes two and half hours, what is the distance from London to Brussels?

$d =$   
.....  
 $= \phantom{000} = \boxed{\phantom{000}} \text{ km}$

**e)** A garden snail can travel at 0.012 m/s. At this speed, what distance can it cover in 10 minutes?

$t = 10 \text{ min} = 10 \times 60 \text{ s} = 600 \text{ s}$   
.....  
Use  $d = vt$   $d = \phantom{000} = \boxed{\phantom{000}} \text{ m}$

**f)** The F-16 Falcon fighter aircraft can fly at a speed of 1500 miles per hour at sea level. At this speed, what distance can it cover in 20 min?

$t =$   
.....  
 $d = \phantom{000} = \boxed{\phantom{000}} \text{ mi}$

$$\text{time taken } (t) = \frac{\text{distance travelled } (d)}{\text{average speed } (v)} \quad \text{OR} \quad t = \frac{d}{v}$$

- Write the formula for the time taken.
- Convert the given units into the required units if necessary. (see Maths Facts, page 427)  
Hints: Changing from smaller units into larger units, always divide by the conversion factor.  
Changing from larger units into smaller units, always multiply by the conversion factor.
- Substitute the values for the distance travelled and the average speed into the formula.
- Evaluate and simplify.

**Q.** Donghai Bridge China is the longest cross-sea bridge in the world, with a length of 32 km. How long will it take a car travelling at 80 km/h to cross the bridge? [Give the answer in hours.]

**A.**  $t = \frac{d}{v}$

$$= \frac{32 \text{ km}}{80 \text{ km/h}}$$

Substitute into the formula

$$= \frac{2 \cancel{32}}{5 \cancel{80}} \text{ h}$$

Simplify:  $\div 16$

$$= 2 \div 5 \text{ h}$$

$$= 0.4 \text{ h}$$

**a)** The speed of long distance jogging for an average person is around 10 km/h. At this speed, how long will it take a person to run 15 km?

$$t = \frac{15 \text{ km}}{10 \text{ km/h}}$$


---


$$= 15.0 \div 10 \text{ h} = \boxed{\phantom{00}} \text{ h}$$

**b)** A golf ball leaves the tee and flies at an average speed of 40 m/s till it reaches the 200 m mark. How long did it take the ball to fly this distance?

$$t =$$


---


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

**c)** Top athletes can sprint at a speed around 10 m/s within a short distance. How long will it take an athlete to sprint 200 m?

$$t =$$


---


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

**d)** The average speed of a space shuttle in orbit is 8000 m/s. At this speed, how long will it take a space shuttle to travel 1000 km?

$$t =$$


---


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

**e)** The average walking speed for adults is 5 km/h. At this speed, how long will it take an adult to walk 7 km?

$$t =$$


---


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

**f)** The Metro monorail in Sydney is 3.6 km long. At an average speed of 24 km/h, how long would it take the train to complete a loop?

$$t =$$


---


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

$$\text{rate} = \frac{\text{amount}}{\text{time}}$$

$$\text{amount} = \text{rate} \times \text{time}$$

$$\text{time} = \frac{\text{amount}}{\text{rate}}$$

**Rate of change**  
(amount and time are given)

- Convert the given units to the required units.  
(see Maths Facts, page 427)
- Divide the amount by the time taken.  
Example: A 300 L bathtub can be filled in 10 minutes.

$$\text{Rate} = \frac{300 \text{ L}}{10 \text{ min}} = 30 \text{ L/min}$$

**Amount**  
(rate and time are given)

- Convert the given units to the required units.  
(see Maths Facts, page 427)
- Multiply the rate by the time taken.  
Example: Sam worked 7 hours and was paid at a rate of \$16/h.

$$\text{Amount (pay)} = 16 \times 7 = \$112$$

**Time taken**  
(amount and rate are given)

- Convert the given units to the required units.  
(see Maths Facts, page 427)
- Divide the amount by the rate.  
Example: A Lexmark E232 prints 990 pages at a rate of 22 pages/min (ppm).

$$\text{Time} = \frac{990 \text{ p}}{22 \text{ ppm}} = 45 \text{ min}$$

**Q.** The average pulse for a new born baby is around 130 beats per minute. How many beats in 3 hours is this?

**A.**  $\text{amount} = \text{rate} \times \text{time}$   
 $\text{rate} = 130 \text{ beats/min}$   
 $\text{time} = 3 \text{ h} = 3 \times 60 \text{ min} = 180 \text{ min}$   
 $\text{amount} = 130 \text{ beats/min} \times 180 \text{ min}$   
 $= 23\,400 \text{ beats}$

**a)** The ruby throated hummingbird can beat its wings around 21 000 times in 5 minutes. What is its wing beat rate in beats per second?

$$\text{time} = 5 \times 60 \text{ s} = 300 \text{ s}$$

$$\text{rate} = \frac{21\,000 \text{ beats}}{300 \text{ s}} = \boxed{\text{beats/s}}$$

Simplify:  $\div 100$  then  $\div 3$

**b)** The heart of an unborn baby beats at around 9000 times in an hour. What is the heart rate of an unborn baby in beats per minute?

$$\text{time} = 1 \times 60 \text{ min} = 60 \text{ min}$$

$$\text{rate} = \frac{\text{beats}}{\text{min}} = \boxed{\text{beats/min}}$$

**c)** Find the time taken to print 875 sheets of paper, if a Lexmark T640 printer can print 35 pages per minute.

$$\text{time} = \frac{\text{amount}}{\text{rate}}$$

$$= \frac{875}{35} = \boxed{\text{min}}$$

**d)** An adult's air intake adds up to 7500 L per day. How many litres of air does an adult breathe in a week?

$$\text{amount} = \text{rate} \times \text{time}$$

$$= 7500 \text{ L/day} \times 7 \text{ days} = \boxed{\text{L}}$$

**e)** Victoria has an average population density of around 22 people per square kilometre. If Victoria has an area of approximately 228 000 km<sup>2</sup>, what is its population?

$$\text{population} = \text{area} \times \text{density rate}$$

$$= 228\,000 \text{ km}^2 \times 22 \text{ people/km}^2 = \boxed{\text{people}}$$

**f)** Bangladesh is the most densely populated country, with around 1050 people per km<sup>2</sup> in 2007. If in 2007 Bangladesh had a population of 151 200 000, what is its area in km<sup>2</sup>?

$$\text{area} = \text{population} \div \text{density rate}$$

$$= \frac{151\,200\,000}{1050} = \boxed{\text{km}^2}$$

$$\text{speed} = \frac{\text{distance}}{\text{time}} \quad \text{OR} \quad v = \frac{d}{t}$$

**Convert km/h to m/s**

- Write the speed as distance over time.
- Change km to m by multiplying by 1000.
- Change h to s by multiplying by  $60 \times 60 = 3600$ .
- Evaluate and simplify.

**Convert m/s to km/h**

- Write the speed as distance over time.
- Change m to km by dividing by 1000.
- Change s to h by dividing by 60 to get to mins and by 60 again to get to hours.
- Evaluate and simplify.

**Q.** The fastest combat jet is the former Soviet MIG 25, which reached a speed of 940 m/s. What is the speed in km/h?

**A.**  $v = \frac{d}{t}$

$$= \frac{940 \text{ m}}{1 \text{ s}}$$

change m to km:  $\div 1000$

$$= \frac{940 \div 1000}{1 \div 3600}$$

change s to h:  $\div 3600$

fraction line means division

$$= \frac{940}{1000} \div \frac{1}{3600} \text{ km/h}$$

Simplify:  $\div 100$  then  $\div 10$

$$= \frac{940}{10000} \times \frac{36000}{1} \text{ km/h}$$

$$= 3384 \text{ km/h}$$

**a)** Shoaib Akhtar, Pakistan, has bowled the fastest ball in Test cricket with a speed of nearly 162 km/h. How many m/s is this?

$$v = \frac{162 \text{ km}}{1 \text{ h}}$$

Simplify:  $\div 100$  then  $\div 6$

$$= \frac{162 \times 1000 \text{ m}}{1 \times 3600 \text{ s}} = \frac{270}{6} = \boxed{\text{m/s}}$$

**b)** The fastest propelled aircraft is the former Soviet Tupolev Tu-95/142, which reached a speed of 250 m/s. How many km/h is this?

$$v = 250 \text{ m/s} = \frac{250 \div 1000 \text{ km}}{1 \div 3600 \text{ h}}$$

$$= \boxed{\text{km/h}}$$

**c)** The average speed of a space shuttle in orbit is 28 800 km/h. How many m/s is this?

$$v =$$

$$= \boxed{\text{m/s}}$$

**d)** The earth is moving around the sun at a speed of about 30 000 m/s. How many km/h is this?

$$v =$$

$$= \boxed{\text{km/h}}$$

**e)** The fastest electric vehicle reached 396 km/h in Utah, USA, in 1999. What is the speed in m/s?

$$v =$$

$$= \boxed{\text{m/s}}$$

**f)** While crossing the Eurotunnel the Eurostar train can reach speeds of up to 85 m/s. How many km/h is this?

$$v =$$

$$= \boxed{\text{km/h}}$$

- Write the rates as fractions.
- Bring the rates to the same unit. (see Maths Facts, page 427)  
*Hint: It's easier to change from larger units into smaller units, because you have to multiply by the conversion factor.*
- Evaluate and simplify.
- Compare the numbers.

**Q.** Which density is lower?

- A) 670 kg/m<sup>3</sup> (gasoline)  
B) 1.025 g/cm<sup>3</sup> (seawater)

**A.** kg/m<sup>3</sup> to g/cm<sup>3</sup>: kg to g ⇒ × 1000

$$m^3 \text{ to } cm^3 \Rightarrow \times 1\,000\,000$$

$$A) \text{ density} = \frac{670 \text{ kg}}{1 \text{ m}^3}$$

$$= \frac{670 \times 1\,000\,000 \text{ g}}{1 \times 1\,000\,000\,000 \text{ cm}^3}$$

cross off  
respective 0's

$$= \frac{67}{100} \text{ g/cm}^3$$

$$= 0.67 \text{ g/cm}^3$$

$$B) \text{ density} = 1.025 \text{ g/cm}^3$$

0.67 < 1.025, so the answer is **A)**

**a)** Which heartbeat rate is higher?

- A) 70 beats/min (adult)  
B) 2 beats/s (baby)

$$B) \text{ rate} = \frac{2 \text{ beats}}{1 \text{ s}} = \frac{2 \text{ beats}}{\frac{1}{60} \text{ min}}$$

$$= 2 \div \frac{1}{60} = 2 \times \frac{60}{1} = 120 \text{ beats/min}$$

120 beats/min > 70 beats/min

**B**

**b)** Which heartbeat rate is lower?

- A) 1.5 beats/s (child)  
B) 70 beats/min (adult)

$$A) \text{ rate} =$$

**c)** Which birth rate is lower?

- A) 12.1 per 1000 people (Australia)  
B) 82 per 10000 people (Germany)

$$A) \text{ rate} = \frac{12.1}{1000} =$$

**d)** Which birth rate is higher?

- A) 14.1 per 1000 people (USA)  
B) 94 per 10000 people (Japan)

**e)** Which density is lower?

- A) 800 kg/m<sup>3</sup> (petrol)  
B) 1 g/cm<sup>3</sup> (water)

**f)** Which density is higher?

- A) 2.2 g/cm<sup>3</sup> (graphite)  
B) 1300 kg/m<sup>3</sup> (PVC)