

# EQUITY

## LEARNING PLACE

### Elementary Math Topical (**Proportion**)

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#### Question 1:

Given  $y$  varies directly as  $x^2$  and  $y = 48$  when  $x = 4$  find the equation connecting  $y$  and  $x$ .

$$y = kx^2$$

When  $y = 48, x = 4$

$$48 = 16k$$

$$k = 3$$

$$\therefore y = 3x^2$$

#### Question 2:

It is given that centrifugal force  $F$  is proportional to the square of the velocity,  $v$ , of the moving object.

If  $F$  is 6250 N when the speed is 25 m/s, write down the formula of relating  $F$  and  $v$ .

Hence find the value of  $F$  when the velocity of the object is increased by 5 m/s.

$$F = kv^2$$

When  $F = 6250, v = 25$

$$6250 = k(25)^2$$

$$k = 10$$

$$\therefore F = 10v^2$$

Now  $v = 30$ ,

$$F = 10(30)^2$$

$$F = 9000$$

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#### Question 3:

The speed of a missile fired from its launcher is inversely proportional to the square root of its mass. When the mass is **36kg**, the speed is **480m/s**. Using  $x$  to represent speed in m/s and  $m$  to represent mass in kilograms with  $k$  as a constant,

- a) write an equation connecting  $x$  and  $m$ ,
- b) use the equation in **(a)** to find its mass when its speed is **600m/s**.

a)

$$x = \frac{k}{\sqrt{m}}$$

When  $m = 36, x = 480$

$$480 = \frac{k}{\sqrt{36}}$$

$$k = 2880$$

$$\therefore x = \frac{2880}{\sqrt{m}}$$

b) when  $x = 600$

$$600 = \frac{2880}{\sqrt{m}}$$

$$\sqrt{m} = \frac{2880}{600}$$

$$m = 23.04$$

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Question 4:

$M$  is inversely proportional to the square of  $P$ . When  $M = 6$ ,  $P = 4$ , find

- the equation connecting  $M$  and  $P$ ,
- the value of  $M$  when  $P = 10$ ,
- the values of  $P$  when the  $M$  is 24.

a)

$$M = \frac{k}{P^2}$$

When  $M = 6$ ,  $P = 4$

$$6 = \frac{k}{4^2}$$

$$k = 96$$

$$\therefore M = \frac{96}{P^2}$$

b) when  $P = 10$

$$M = \frac{96}{10^2}$$

$$M = 0.96$$

c) when  $M = 24$

$$24 = \frac{96}{P^2}$$

$$P^2 = 4$$

$$P = \pm 2$$

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#### Question 5:

Given that  $p$  is inversely proportional to  $q^2$  and that  $p = 100$  when  $q = 2$ , express  $p$  in terms of  $q$ .

$$p = \frac{k}{q^2}$$

When  $p = 100, q = 2$

$$100 = \frac{k}{2^2}$$

$$k = 400$$

$$\therefore p = \frac{400}{q^2}$$

#### Question 6:

$y$  is inversely proportional to  $x^3$  and  $y = 2$  when  $x = 5$ . Find  $y$  when  $x = 3$ .

$$y = \frac{k}{x^3}$$

when  $y = 2, x = 5$

$$2 = \frac{k}{5^3}$$

$$k = 250$$

$$\therefore y = \frac{250}{x^3}$$

Now  $x = 3,$

$$y = \frac{250}{3^3}$$

$$y = \frac{250}{27}$$

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#### Question 7:

It is given that  $y$  is inversely proportional to  $(x - 2)$  and that  $y = 2$  when  $x = 11$ .

- a) Find the value of  $y$  when  $x = 5$ .  
b) Express  $x$  in terms of  $y$ .

$$y = \frac{k}{x - 2}$$

When  $y = 2, x = 11$

$$2 = \frac{k}{11 - 2}$$

$$k = 18$$

$$\therefore y = \frac{18}{x - 2}$$

Now  $x = 5$

$$y = \frac{18}{5 - 2}$$

$$y = 6$$

b)

$$yx - 2y = 18$$

$$yx = 2y + 18$$

$$x = \frac{2y + 18}{y}$$

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#### Question 8:

It is given that  $y$  is proportional to  $x^2$ . It is known that  $y = 10$  for a particular value of  $x$ . Find the percentage increase in the value of  $y$  if the value of  $x$  is increased by 200%.

$$y = kx^2$$

When  $y = 10, x = A$

$$10 = kA^2$$

$$k = \frac{10}{A^2}$$

$$\therefore y = \frac{10}{A^2} \times x^2$$

Now  $x = 3A$

$$y = \frac{10}{A^2} \times (3A)^2$$

$$y = \frac{10}{A^2} \times 9A^2$$

$$y = 90$$

$$\text{Percentage increase in } y = \frac{90 - 10}{10} \times 100\%$$

$$= 800\%$$

Note: there are alternative methods.

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Question 9:

$Q$  is proportional to the square of  $R$ . It is known that  $Q = 6$  for a particular value of  $R$ . Find the value of  $Q$  when this value of  $R$  is doubled.

$$Q = kR^2$$

When  $Q = 6, R = A$

$$6 = kA^2$$

$$k = \frac{6}{A^2}$$

$$\therefore Q = \frac{6}{A^2} \times R^2$$

Now  $R = 2A$

$$Q = \frac{6}{A^2} \times (2A)^2$$

$$Q = \frac{6}{A^2} \times 4A^2$$

$$Q = 24$$

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#### Question 10:

Given that  $p$  is proportional to the square of  $q$ , it is known that  $p = 12$  for a particular value of  $q$ . Find the value of  $p$  when the value of  $q$  is increased by 100%.

$$p = kq^2$$

When  $p = 12, q = A$

$$12 = kA^2$$

$$k = \frac{12}{A^2}$$

$$\therefore p = \frac{12}{A^2} \times q^2$$

Now  $x = 2A$

$$p = \frac{12}{A^2} \times (2A)^2$$

$$p = \frac{12}{A^2} \times 4A^2$$

$$y = 48$$

$$\text{Percentage increase in } y = \frac{48 - 12}{12} \times 100\%$$

$$= 300\%$$

Note: there are alternative methods.

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#### Question 11:

The gravitational force,  $F$ , between two huge objects is inversely proportional to square of the distance between the two objects. Given that the force is 40 N when the distance is  $r$  km, find the gravitational force if the distance is halved.

$$F = \frac{k}{D^2}$$

When  $F = 40$ ,  $D = r$

$$40 = \frac{k}{r^2}$$

$$k = 40r^2$$

$$\therefore F = \frac{40r^2}{D^2}$$

Now  $D = \frac{1}{2}r$ ,

$$F = \frac{40r^2}{\left(\frac{1}{2}r\right)^2}$$

$$F = \frac{40r^2}{\frac{1}{4}r^2}$$

$$F = 160$$

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#### Question 12:

$F$  is inversely proportional to the cube of  $g$ . It is known that  $F = 192$  for a particular value of  $g$ . Find the value of  $F$  when this value of  $g$  is increased by 100%.

$$F = \frac{k}{g^3}$$

When  $F = 192, g = A$

$$192 = \frac{k}{A^3}$$

$$k = 192A^3$$

$$\therefore F = \frac{192A^3}{g^3}$$

Now  $g = 2A$ ,

$$F = \frac{192A^3}{(2A)^3}$$

$$F = \frac{192A^3}{8A^3}$$

$$F = 24$$

#### Question 13:

Sally can paint a room in 5 hours. Johnny can paint the same room in 4 hours. Find the time taken by Sally and Johnny if they work together to paint the room.

Sally: 5 hours  $\rightarrow$  1 room

Johnny: 4 hours  $\rightarrow$  1 room

20 hours  $\rightarrow$  4 rooms

20 hours  $\rightarrow$  5 rooms

Together

20 hours  $\rightarrow$  9 rooms

$\frac{20}{9}$  hour  $\rightarrow$  1 room

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#### Question 14:

In a fried chicken joint “6 Fingers”, it takes 3 hours for 4 workers to fry 1200 pieces of chicken. How long will it take for 5 workers to fry 2000 pieces of chicken at the same rate?

3 hours → 4 workers → 1200 chicken

12 hours → 1 worker → 1200 chicken

$\frac{12}{5}$  hours → 5 workers → 1200 chicken

$\frac{1}{500}$  hours → 5 workers → 1 chicken

4 hours → 5 workers → 2000 chicken

#### Question 15:

An experienced worker takes 10 minutes to cover a 1 metre cement pavement whereas a normal worker takes 20 minutes to cover the same cement pavement. How much cement pavement will they cover if they work together for an hour?

**Experienced worker**

10 mins → 1 metre

20 mins → 2 metres

**Normal worker**

20 mins → 1 metre

**Together**

20 mins → 3 metres

1 hour → 9 metres

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#### Question 16:

A map Eastern Europe has a scale of 1 : 2 500 000.

a) The length of the river Danube on the map is 114.4 cm. Calculate the actual length, in kilometres, of the river Danube.

b) The area of Poland is approximately 312 679 km<sup>2</sup>. Calculate the area, in square centimeters, of Poland on the map.

a) 1 cm : 2500000 cm

1 cm : 25 km

114.4 cm : 2860 km

b) 1 cm : 25 km

(1 cm)<sup>2</sup> : (25 km)<sup>2</sup>

1 cm<sup>2</sup> : 625 km<sup>2</sup>

500.2864 cm<sup>2</sup> : 312679 km<sup>2</sup>

#### Question 17:

A map of Singapore has a scale of 1 : 200 000.

a) The length of Yio Chu Kang Road on the map is 4.7 cm. Calculate the actual length, in kilometres, of Yio Chu Kang Road.

b) The area of Singapore largest island, Pulau Tekong, is 24.43 km<sup>2</sup>. Calculate the area, in square centimetres, of Pulau Tekong, on the map. Leave your answer to 2 decimal places.

a) 1 cm : 200000 cm

1 cm : 2 km

4.7 cm : 9.4 km

b) 1 cm : 2 km

(1 cm)<sup>2</sup> : (2 km)<sup>2</sup>

1 cm<sup>2</sup> : 4 km<sup>2</sup>

6.1075 cm<sup>2</sup> : 24.43 km<sup>2</sup>

6.11 cm<sup>2</sup> : 24.43 km<sup>2</sup>

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#### Question 18:

A map is drawn to a scale of 1 : 50 000.

a) A road is represented by a line of length 1.8 cm on the map. Calculate the actual length of the road, giving your answer in kilometres.

b) The actual area of an airport is 3.4 km<sup>2</sup>. Find the area, in cm<sup>2</sup>, of the airport on the map.

a) 1 cm : 50000 cm

1 cm : 0.5 km

1.8 cm : 0.9 km

b) 1 cm : 0.5 km

(1 cm<sup>2</sup>) : (0.5 km)<sup>2</sup>

1 cm<sup>2</sup> : 0.25 km<sup>2</sup>

13.6 cm<sup>2</sup> : 3.4 km<sup>2</sup>

#### Question 19:

A plan of a house is drawn to scale of 2 cm to 15 m.

a) Express the scale of the plan in the form 1 :  $n$

b) Find the area of a rectangular garden in m<sup>2</sup> if it measures 4 cm by 3.5 cm on the plan

a) 2 cm : 15 m

2 cm : 1500 cm

1 : 750

b) 4 cm : 30 m

3.5 cm : 52.5 m

Area = 30 × 52.5 = 157.5 m<sup>2</sup>

#### Question 20:

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The scale of a map of Singapore is  $1 : n$

The length of Lim Chu Kang Road on the map is 16 cm.

The actual length of Lim Chu Kang Road is 8 km.

a) Find the value of  $n$ .

b) The area of Hougang Town is  $13.9 \text{ km}^2$ . Calculate the area, in square centimetres, of Hougang Town on the map.

a)  $16 \text{ cm} : 8 \text{ km}$

$16 \text{ cm} : 800000 \text{ cm}$

$1 : 50000$

$n = 50000$

b)  $2 \text{ cm} : 1 \text{ km}$

$(2 \text{ cm})^2 : (1 \text{ km})^2$

$4 \text{ cm}^2 : 1 \text{ km}^2$

$55.6 \text{ cm}^2 : 13.9 \text{ km}^2$

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#### Question 21:

The area of a piece of land is  $2.5 \text{ km}^2$ . On a map, the area of the piece of land is  $10 \text{ cm}^2$ .

- a) Express the scale of the map in the form  $1: n$ , where  $n$  is a positive integer.
- b) Find, in square cm, the area representing the same piece of land on another map whose scale is 1: 100 000.

a)  $10 \text{ cm}^2 : 2.5 \text{ km}^2$

$1 \text{ cm}^2 : 0.25 \text{ km}^2$

$\sqrt{1 \text{ cm}^2} : \sqrt{0.25 \text{ km}^2}$

$1 \text{ cm} : 0.5 \text{ km}$

$1 \text{ cm} : 50000 \text{ cm}$

$1 : 50000$

b)  $1 \text{ cm} : 100000 \text{ cm}$

$1 \text{ cm} : 1 \text{ km}$

$1 \text{ cm}^2 : 1 \text{ km}^2$

$2.5 \text{ cm}^2 : 2.5 \text{ km}^2$