

# Variation

**Variation** is when a quantity's change is proportional to another quantity's change.

$$y \propto x^n$$

$$y = kx^n$$

where -  $k$  is the constant of proportionality

$$- k \neq 0, n \neq 0$$

## Direct Variation ( $n > 0$ )

When an increase in one quantity causes an increase in another quantity.

e.g. The safe working load that a cable can lift varies directly as the square of its diameter.

A load of 1500 kg can be safely lifted by a 3 cm diameter cable, find the safe working load for a 5 cm cable.

$$L \propto d^2$$

$$L = kd^2$$

when  $L = 1500$ ,  $d = 3$ ;  $1500 = k(3)^2$

$$k = \frac{1500}{9}$$

$$= \frac{500}{3}$$

$$\therefore L = \frac{500d^2}{3}$$

when  $d = 5$ ,  $L = \frac{500(5)^2}{3}$

$$= \frac{12500}{3}$$

$\therefore$  the safe working load is  $4166\frac{2}{3}$  kg

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## Inverse Variation ( $n < 0$ )

inverse variation  
is also called  
indirect variation

When an increase in one quantity causes a decrease in another quantity.

e.g. **2022 Advanced HSC Question 12**

A student believes that the time it takes for an ice cube to melt ( $M$  minutes) varies inversely with the room temperature ( $T^\circ\text{C}$ ).

The student observes that at a room temperature of  $15^\circ\text{C}$  it takes 12 minutes for an ice cube melt.

a) Find the equation relating  $M$  and  $T$ .

$$M \propto \frac{1}{T}$$

$$M = \frac{k}{T}$$

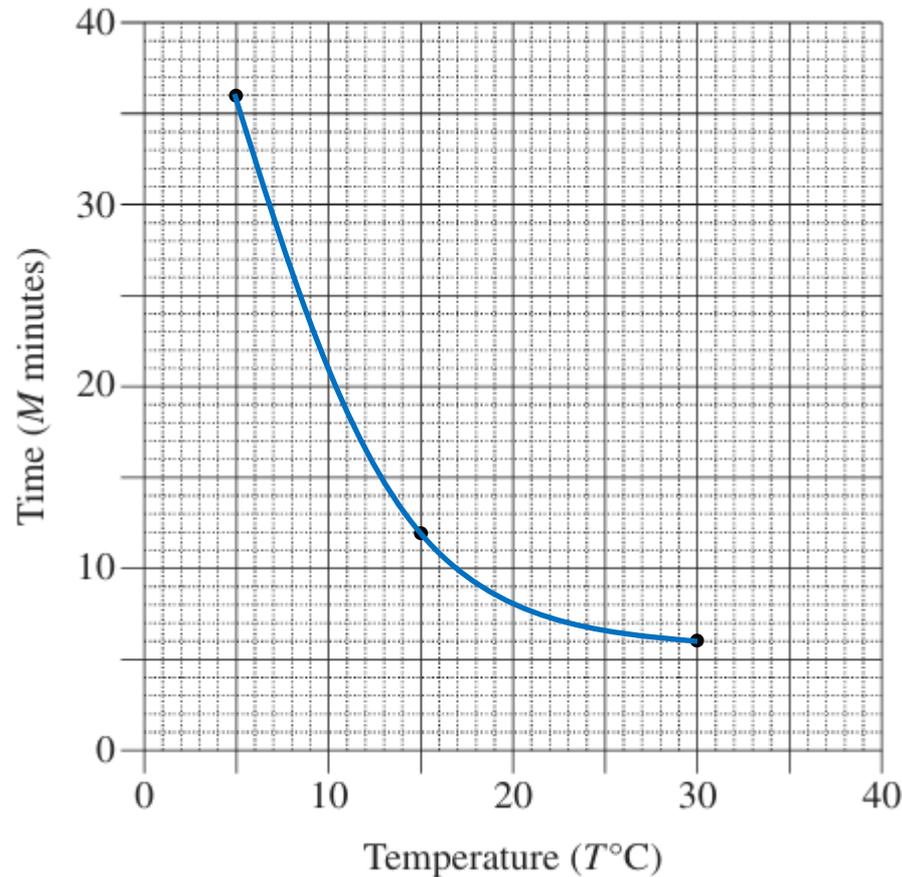
$$\text{when } M = 12, T = 15; \quad 12 = \frac{k}{15}$$

$$k = 180$$

$$\therefore M = \frac{180}{T}$$

b) By first completing this table of values, graph the relationship between temperature and time from  $T = 5^{\circ}\text{C}$  to  $T = 30^{\circ}\text{C}$ .

$T$	5	15	30
$M$	36	12	6



**Exercise 3I;  
7, 8, 9, 11,  
13b, 15, 17**