Form 5 Chapter 8
Mathematical Modeling
Fully-Worked Solutions

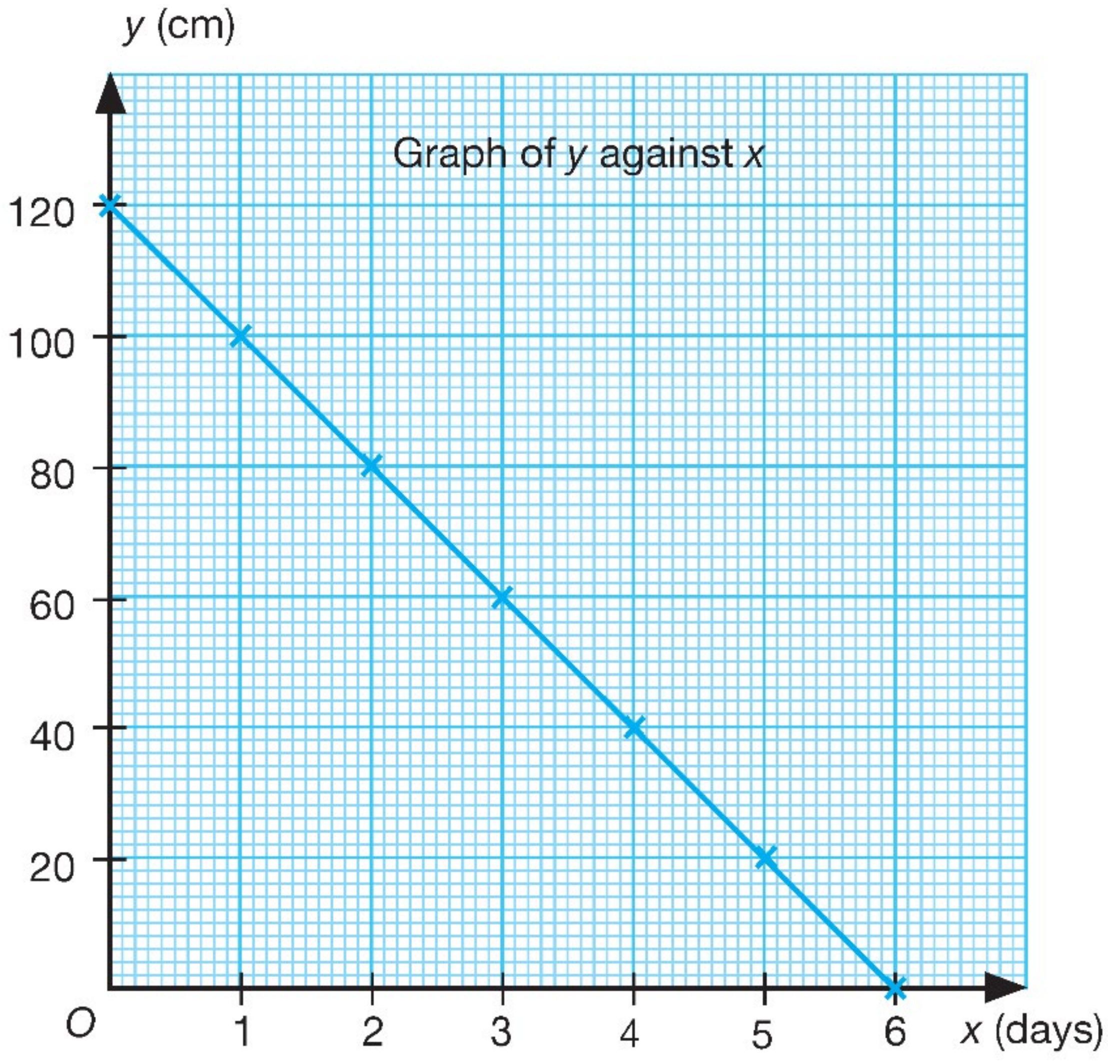
UPSKILL 8.1

1 (a) x represents the number of days and y represents the height of the snow (cm).

(b)

Number of days (x)	0	1	2	3	4	5	6
Height of snow (y cm)	120	100	80	60	40	20	0

(c)



(d) Gradient = $-\dfrac{120}{6} = -20$

Y-intercept = 120

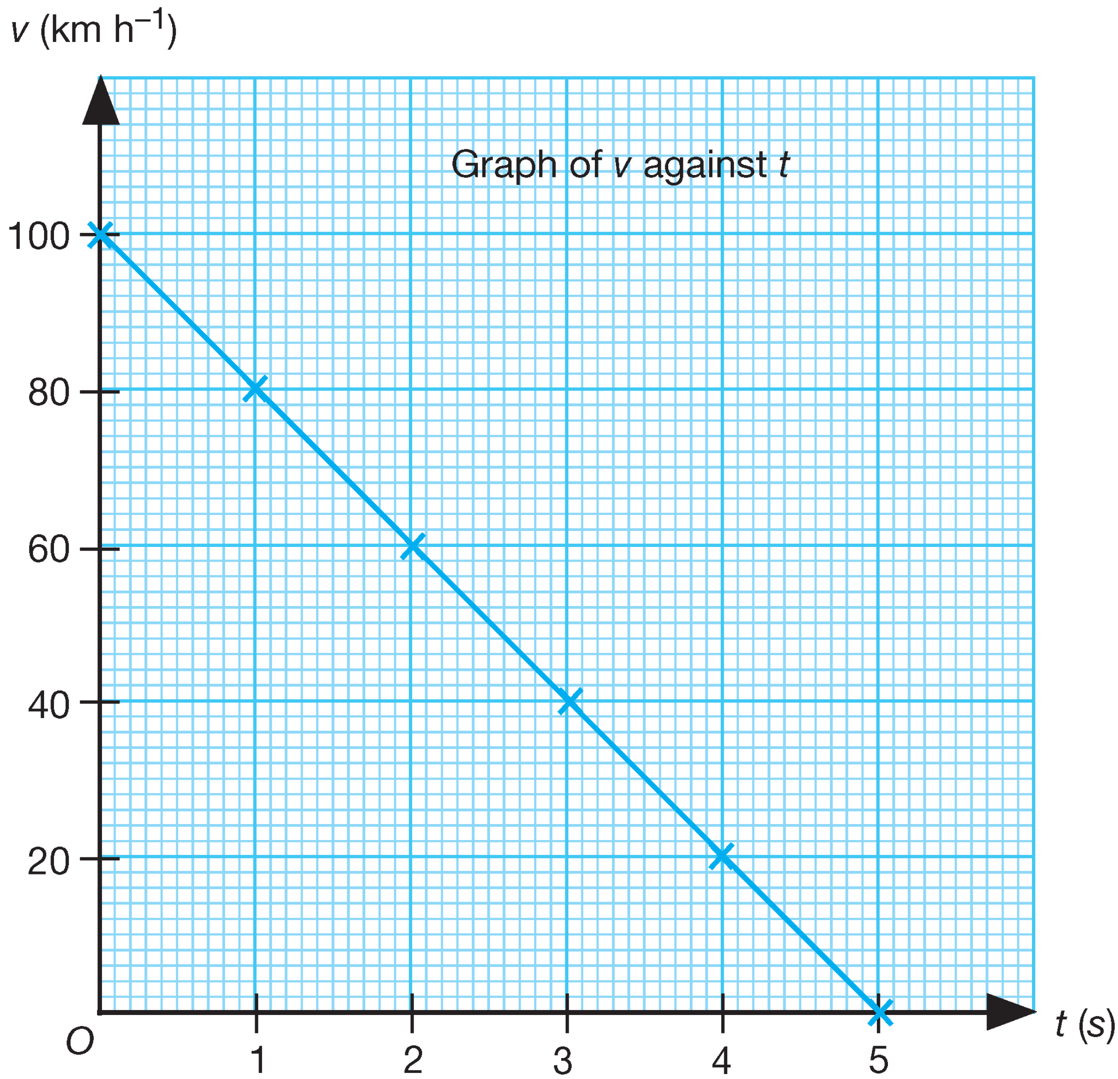
$\therefore y = -20x + 120$

2 (a) v represents speed, in km h^{-1} and t represent time, in seconds.

(b)

Speed (v m s^{-1})	100	80	60	40	20	0
Time (t s)	0	1	2	3	4	5

(c)



(d) Gradient $= -\dfrac{100}{5} - 20$

v- intercept $= 100$

$\therefore v = -20t + 100$

3 (a) The height of the spear when it is initially thrown

(b) 2 m

(c) Maximum horizontal distance of the spear

(d)
$$y = 0$$
$$-\frac{7}{900}x^2 + \frac{13}{30}x + 2 = 0$$
$$-7x^2 + 390x + 1\ 800 = 0$$
$$7x^2 - 390x - 1\ 800 = 0$$
$$(x - 60)(7x + 30) = 0$$
$$x = 60 \text{ or } x = -\frac{30}{7}$$

$x = -\frac{30}{7}$ is not accepted.

$\therefore x = 60$

The maximum horizontal distance is 60 m.

4 (a) The length of the bridge (PQ)

(b) $h(x) = -\frac{x^2}{60} + 2x$

When $h(x) = 0$,
$$-\frac{x^2}{60} + 2x = 0$$
$$-x^2 + 120x = 0$$
$$-x(x - 120) = 0$$
$$x = 120$$

Distance between each rods = $\frac{120}{10} = 12$ m

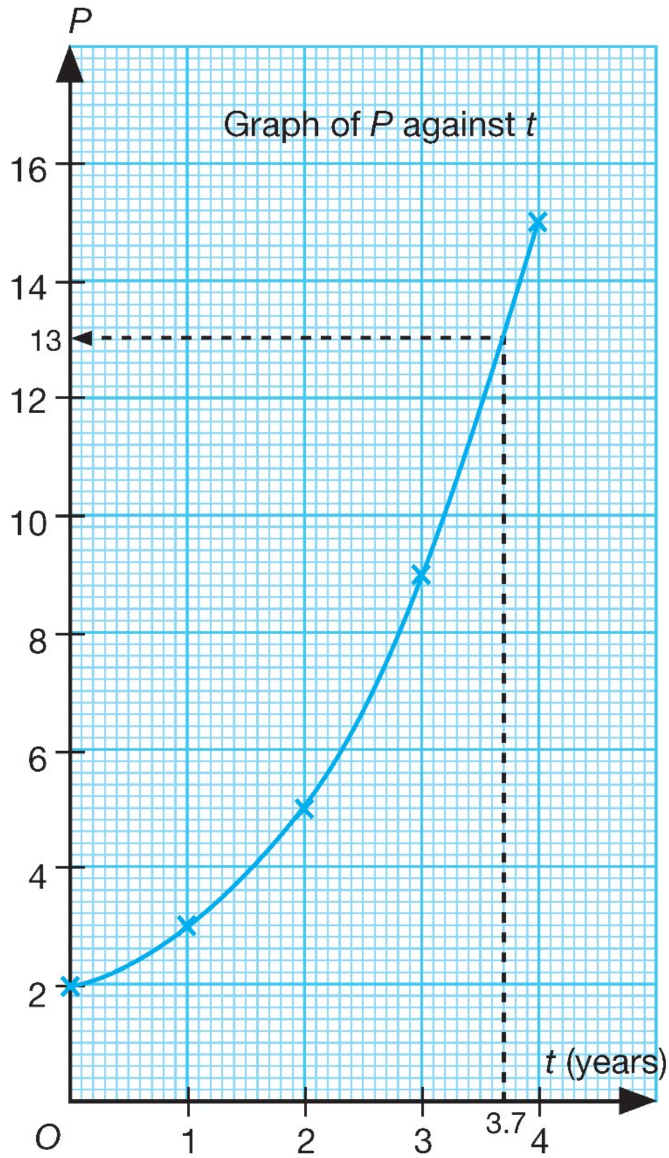
(c) When $h(x) = 60$,
$$-\frac{x^2}{60} + 2x = 60$$
$$-x^2 + 120x = 3\ 600$$
$$-x^2 + 120x - 3\ 600 = 0$$
$$x^2 - 120x + 3\ 600 = 0$$
$$(x - 60)(x - 60) = 0$$
$$x = 60$$

Hence, the horizontal distance of the concrete rod from P is 60 m.

5 (a)

t	0	1	2	3	4
P	2	3	5	9	15

(b)



(c) 13 panda bears

6 (a) $P(t) = ab^t$

$P(0) = ab^0 = 20$

$a = 20$

The number of monkeys increases 20% a year, i.e. $\dfrac{100+20}{100} \times 20 = 24$.

$P(1) = ab^1 = 24$

$20b = 24$

$b = 1.2$

(b) $P(t) = ab^t$

$P(10) = 20(1.2)^{10} = 124$ monkeys

Summative Practice 8

Multiple-Choice Questions

1 $s = mt + c$

For the point (10, 11),
$11 = 10t + c$ … (1)

For the point (15, 8),
$8 = 15t + c$ … (2)

(1) – (2) : $3 = -5t$

$t = -\dfrac{3}{5}$

From (1) : $11 = 10\left(-\dfrac{3}{5}\right) + c$

$11 = -6 + c$

$c = 17$

Hence, $s = -\dfrac{3}{5}t + 17$

Answer: D

2 The s-intercept of a distance-time graph represents the distance between the stadium and Sidek's house.
Answer: D

3 The t-intercept of a distance-time graph represents the time taken by Sidek to drive from the stadium to his house
Answer: A

4 The gradient of a linear distance-time graph represents the speed of the car.
Answer: B

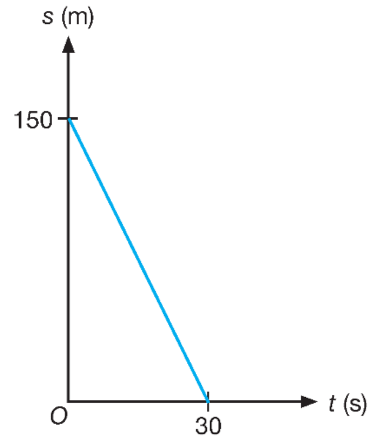
Structured Questions

1 (a) s-intercept = Distance between the bus and the school
t-intercept = Time taken by the bus to reach the school

Gradient = $s = -\dfrac{150}{30}$ m s^{-1}

$s = -5t + 150$

(b)



2 (a) x represents the number of photographs printed and y represents the payment, is RM.
(b) $y = 0.70x - 5$

3 (a) $h(x) = ax^2 + bx + c$

When $x = 0$, $h(0) = a(0)^2 + b(0) + c$
Thus, $c = 0$

When $x = 120$, $h(120) = 0$

$$a(120)^2 + b(120) = 0$$
$$120a + b = 0 \ \dots (1)$$

At the middle of the bridge,

$$h(60) = 70$$
$$a(60)^2 + b(60) = 70$$
$$3\ 600a + 60b = 70$$
$$360a + 6b = 7 \ \dots (2)$$

$$720a + 6b = 0 \ \dots (1) \times 6$$
$$(-) \quad \underline{360a + 6b = 7} \ \dots (2)$$

$$360a = -7$$
$$a = -\frac{7}{360}$$

From (2) : $360\left(-\frac{7}{360}\right) + 6b = 7$

$$-7 + 6b = 7$$
$$b = \frac{14}{6}$$
$$b = \frac{7}{3}$$

Hence, $a = -\frac{7}{360}$, $b = \frac{7}{3}$, $c = 0$

(b) $h(x) = -\frac{7}{360}x^2 + \frac{7}{3}x$

When $h(x) = 58\frac{4}{5}$,

$$-\frac{7}{360}x^2 + \frac{7}{3}x = \frac{294}{5}$$
$$-7x^2 + 840x - 21\ 168 = 0$$
$$x^2 - 120x + 3\ 024 = 0$$
$$(x-36)(x-84) = 0$$
$$x = 36 \text{ or } x = 84$$

Hence, the horizontal distance from P is 36 m or 84 m.

4 (a) The object hits the surface of the sea.

(b) When $y = -64$,

$$24t - 4t^2 = -64$$
$$4t^2 - 24t - 64 = 0$$
$$t^2 - 6t - 16 = 0$$
$$(t-8)(t+2) = 0$$
$$t = 8 \text{ or } t = -2$$

$t = -2$ is not accepted.
$\therefore t = 8$

5 (a) $y = -\frac{3}{100}(x-50)^2 + 75$

When $x = 0$, $y = -\frac{3}{100}(0-50)^2 + 75$

$$y = 75 - 75$$
$$y = 0$$

(b) When $y = 0$, x is the distance of QE.

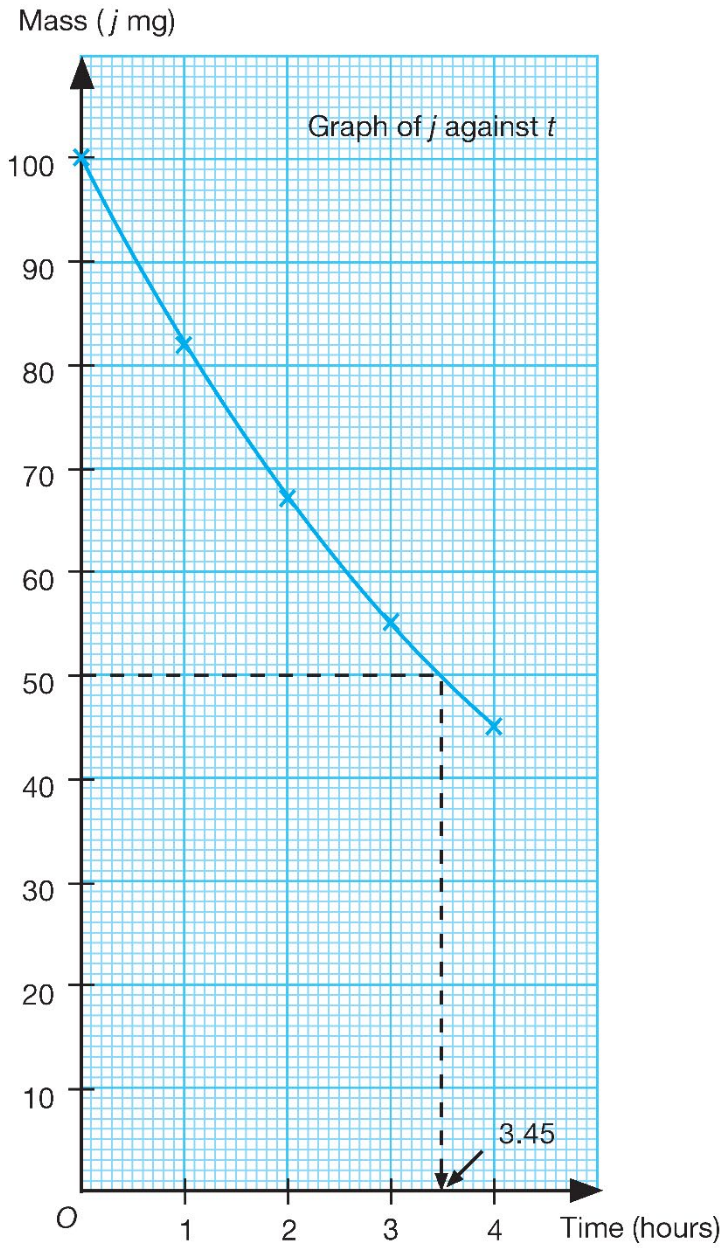
$$-\frac{3}{100}(x-50)^2 + 75 = 0$$
$$-3(x-50)^2 + 7\ 500 = 0$$
$$-3\left(x^2 - 100x + 2\ 500\right) + 7\ 500 = 0$$
$$-3x^2 + 300x - 7\ 500 + 7\ 500 = 0$$
$$-3x^2 + 300x = 0$$
$$x^2 - 100x = 0$$
$$x(x-100) = 0$$
$$x = 100$$

(c) $QE = 100$ cm

6 (a)

Time (*t hours*)	0	1	2	3	4
Mass (*j* mg)	100	81.87	67.03	54.88	44.93

(b)



(c) 3.45 hours

7 (a) $y = a(b)^x$

When $x = 0$, $y = 5\ 000$

$5\ 000 = a(b)^0$

$a = 5\ 000$

When $x = 1$, $y = 5\ 200$

$5\ 200 = a(b)^1$

$ab = 5\ 200$

$5\ 000b = 5\ 200$

$b = 1.04$

(b) $y = 5\ 000\ (1.04)^x$

When $x = 2$,

$y = 5\ 000\ (1.04)^2$

$y = 5\ 408$

Puan Hani's saving is RM5 408.

8 (a) $n = ae^{2t}$

When $t = 0$, $n = 2$.

$2 = a\left[2.718^{2(0)}\right]$

$2 = a(1)$

$a = 2$

(b) $n = 2e^{2t}$

When $t = 4.25$,

$n = 2e^{2(4.25)} = 9\ 821$ bacteria