24 (*a*) $P(X = 0) + P(X = 1) + P(X = 2) + P(X = 3) = 1$

$P(X = 0) + a + b + P(X = 3) = 1$

$P(X = 0) + P(X = 3) = 1 - a - b$

$P(X = 0) + P(X > 2) = 1 - a - b$

(*b*) $P(X = 0) = \frac{27}{343}$

$^3C_0\,(p^0)\,(1 - p)^3 = \frac{27}{343}$

$1 \times 1 \times (1 - p)^3 = \left(\frac{3}{7}\right)^3$

$1 - p = \frac{3}{7}$

$p = \frac{4}{7}$

25 (*a*) $P(X < h) = 0.5 - 0.2881$

$P(X < h) = 0.2119$

$P(X < -0.8) = 0.2119$

$h = -0.8$

(*b*) $X = 58.8$

$\frac{X - \mu}{\sigma} = \frac{58.8 - \mu}{\sigma}$

$Z = \frac{58.8 - \mu}{4}$

$h = \frac{58.8 - \mu}{4}$

$-0.8 = \frac{58.8 - \mu}{4}$

$-3.2 = 58.8 - \mu$

$\mu = 58.8 + 3.2 = 62$

PAPER 2

Section A

1 $x - 3y = 1$ .... ①

$x^2 + 3xy + 9y^2 = 7$ .... ②

From ①: $x = 3y + 1$ .... ③

Substitute ③ into ②:

$(3y + 1)^2 + 3(3y + 1)y + 9y^2 = 7$

$9y^2 + 6y + 1 + 9y^2 + 3y + 9y^2 - 7 = 0$

$27y^2 + 9y - 6 = 0$

$9y^2 + 3y - 2 = 0$

$(3y - 1)(3y + 2) = 0$

$y = \frac{1}{3}$ or $-\frac{2}{3}$

When $y = \frac{1}{3}$, $x = 3\left(\frac{1}{3}\right) + 1 = 2$

When $y = -\frac{2}{3}$, $x = 3\left(-\frac{2}{3}\right) + 1 = -1$

Hence, the solutions are $x = 2$, $y = \frac{1}{3}$ or $x = -1$, $y = -\frac{2}{3}$.

2 (*a*) $y = \frac{5}{x^2} = 5x^{-2}$

$\frac{dy}{dx} = -10x^{-3}$

$= -\frac{10}{x^3}$

$= -\frac{10}{3^3}$

$= -\frac{10}{27}$

(*b*) $\delta x = 2.98 - 3 = -0.02$

$\delta y = \frac{dy}{dx} \cdot \delta x$

$= -\frac{10}{27} \times (-0.02) = 0.007407$

Values of $\frac{5}{(2.98)^2} = y + \delta y$

$= \frac{5}{x^2} + (0.007407)$

$= \frac{5}{3^2} + (0.007407)$

$= 0.56296$

3 (*a*) Length of arc $AB = 2$ cm

$r\theta = 2$ .... ①

Length of arc $CD = 7$ cm

$(r + 10)\theta = 7$ .... ②

Substitute ① into ②: $2 + 10\theta = 7$

$10\theta = 5$

$\theta = \frac{5}{10}$

$= 0.5$ rad

From ①: When $\theta = 0.5$ rad,

$r \times 0.5 = 2$

$r = 4$

(*b*) Area of shaded region

= area of ΔOCD − area of sector OAB

$= \left(\frac{1}{2} \times 14^2 \times \sin 0.5 \text{ rad}\right) - \left(\frac{1}{2} \times 4^2 \times 0.5\right)$

$= 42.978$ cm²

4 (*a*) 5, 8, 11, …

$a = 5$, $d = 3$

(i) $T_{54} = a + (54 - 1)d$

$= 5 + 53(3)$

$= 164$ cm

(ii) $S_n = \frac{n}{2}(a + l)$

$S_{54} = \frac{54}{2}(5 + 164)$

$= 4\,563$ cm

(b) 1 000, 1 600, 2 200, …

$a = 1\,000$, $d = 600$

$$T_n = 28\,000$$
$$a + (n - 1)d = 28\,000$$
$$1\,000 + (n - 1)600 = 28\,000$$
$$600(n - 1) = 27\,000$$
$$n - 1 = 45$$
$$n = 46$$

The colour of that particular rectangle is red.

5 (a) $T(x, y)$ is a point on PQ.

$$TA = TB$$
$$\sqrt{[x - (-4)]^2 + [y - (-1)]^2} = \sqrt{(x - 2)^2 + (y - 1)^2}$$
$$\sqrt{(x + 4)^2 + (y + 1)^2} = \sqrt{(x - 2)^2 + (y - 1)^2}$$
$$(x + 4)^2 + (y + 1)^2 = (x - 2)^2 + (y - 1)^2$$
$$x^2 + 8x + 16 + y^2 + 2y + 1$$
$$= x^2 - 4x + 4 + y^2 - 2y + 1$$
$$8x + 2y + 17 + 4x + 2y - 5 = 0$$
$$12x + 4y + 12 = 0$$
$$3x + y + 3 = 0$$

(b) (i) $y = 2x + 7$ .... ①

$3x + y + 3 = 0$ .... ②

Substitute ① into ②:

$$3x + 2x + 7 + 3 = 0$$
$$5x = -10$$
$$x = -2$$

When $x = -2$, $y = 2(-2) + 7 = 3$

Coordinate of traffic light = $(-2, 3)$.

(ii) $C\left(-\frac{4}{3}, 1\right)$: $x = -\frac{4}{3}$, $y = 1$

The equation of ST : $y = 2x + 7$

Left-hand side: $y = 1$

Right-hand side: $2\left(-\frac{4}{3}\right) + 7 = 4\frac{1}{3}$

Thus, the road $y = 2x + 7$ does not pass through C.

The equation of PQ: $3x + y + 3 = 0$

Left-hand side:

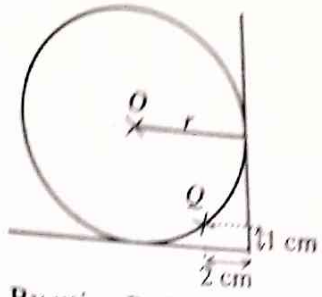
$$3x + y + 3 = 3\left(-\frac{4}{3}\right) + 1 + 3$$
$$= -4 + 4 = 0$$

Right-hand side = 0

Left-hand side = Right-hand side

Thus, the road $3x + y + 3 = 0$ passes through C.

6



By using Pythagoras' Theorem,

$$r^2 = (r - 1)^2 + (r - 2)^2$$
$$r^2 = (r^2 - 2r + 1) + (r^2 - 4r + 4)$$
$$r^2 - 6r + 5 = 0$$
$$(r - 5)(r - 1) = 0$$

$r = 5$ only, $r > 1$.

Diameter = 2 (5) = 10 cm

Diameter > 7 cm.

Container cannot be kept in that box.

Section B

7 (a) $\mu = 0.8$ kg, $\sigma = 0.25$ kg

(i) $P(\text{grade } A) = P(X > 1.2)$

$$= P\left(Z > \frac{1.2 - 0.8}{0.25}\right)$$
$$= P(Z > 1.6) = 0.0548$$

(ii) $P(\text{grade } C) = 0.2$

$$P(X < m) = 0.2$$
$$P\left(Z < \frac{m - 0.8}{0.25}\right) = 0.2$$
$$P(Z < -0.842) = 0.2$$
$$\frac{m - 0.8}{0.25} = -0.842$$
$$m - 0.8 = -0.2105$$
$$m = 0.5895$$

Minimum mass of grade B honeydew is the same as the maximum mass of grade C honeydew.

Minimum mass of grade B = 0.5895 kg

(b) $p = 0.25$, $X = B(n, 0.25)$

$P(X = r) = {}^nC_r\,(0.25)^r\,(0.75)^{n-r}$

(i) $P(X = 1) = 10\,P(X = 0)$

$${}^nC_r(0.25)^1(0.75)^{n-r} = 10 \times {}^nC_0(0.25)^0(0.75)^n$$
$$n \times 0.25 \times (0.75)^{n-r} = 10 \times 1 \times 1 \times (0.75)^n$$
$$0.25n\,\frac{(0.75)^{n-1}}{0.75^n} = 10$$
$$0.25n(0.75)^{-1} = 10$$
$$\frac{1}{4}n\left(\frac{4}{3}\right) = 10$$
$$\frac{1}{3}n = 10$$
$$n = 30$$

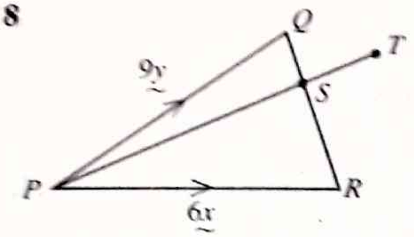
(ii) $n = 30, p = 0.25$

Standard deviation $= \sqrt{np(1-p)}$

$= \sqrt{30 \times 0.25 \times 0.75}$

$= 2.372$

8



(*a*) (i) $\overrightarrow{QR} = \overrightarrow{QP} + \overrightarrow{PR}$

$= -9\underset{\sim}{y} + 6\underset{\sim}{x}$

$= 6\underset{\sim}{x} - 9\underset{\sim}{y}$

(ii) $\overrightarrow{PS} = \overrightarrow{PQ} + \overrightarrow{QS}$

$= 9\underset{\sim}{y} + \frac{1}{3}\overrightarrow{QR}$

$= 9\underset{\sim}{y} + \frac{1}{3}(6\underset{\sim}{x} - 9\underset{\sim}{y})$

$= 9\underset{\sim}{y} + 2\underset{\sim}{x} - 3\underset{\sim}{y}$

$= 2\underset{\sim}{x} + 6\underset{\sim}{y}$

(*b*) $\overrightarrow{PV} = m\overrightarrow{PS}$

$= m(2\underset{\sim}{x} + 6\underset{\sim}{y})$

$= 2m\underset{\sim}{x} + 6m\underset{\sim}{y}$

$\overrightarrow{PQ} + \overrightarrow{QV} = \overrightarrow{PV}$

$9\underset{\sim}{y} + n(\underset{\sim}{x} - 9\underset{\sim}{y}) = 2m\underset{\sim}{x} + 6m\underset{\sim}{y}$

$9\underset{\sim}{y} + n\underset{\sim}{x} - 9n\underset{\sim}{y} = 2m\underset{\sim}{x} + 6m\underset{\sim}{y}$

$n\underset{\sim}{x} + (9 - 9n)\underset{\sim}{y} = 2m\underset{\sim}{x} + 6m\underset{\sim}{y}$

By equating the coefficients of $\underset{\sim}{x}$ and $\underset{\sim}{y}$, we have:

$n = 2m$ .... ①

$9 - 9n = 6m$ .... ②

From ②: $9 - 9n = 6m$

Substitute ① into ②:

$9 - 9(2m) = 6m$

$9 = 6m + 18m$

$24m = 9$

$m = \frac{9}{24} = \frac{3}{8}$

From ①: $n = 2\left(\frac{3}{8}\right) = \frac{3}{4}$

(*c*) *P*, *S* and *T* are collinear.

$\overrightarrow{PS} = k\overrightarrow{PT}$

$2\underset{\sim}{x} + 6\underset{\sim}{y} = k(h\underset{\sim}{x} + 9\underset{\sim}{y})$

$2\underset{\sim}{x} + 6\underset{\sim}{y} = kh\underset{\sim}{x} + 9k\underset{\sim}{y}$

Equating the coefficients of $\underset{\sim}{y}$: $9k = 6$

$k = \frac{6}{9}$

$= \frac{2}{3}$

Equating the coefficients of $\underset{\sim}{x}$: $kh = 2$

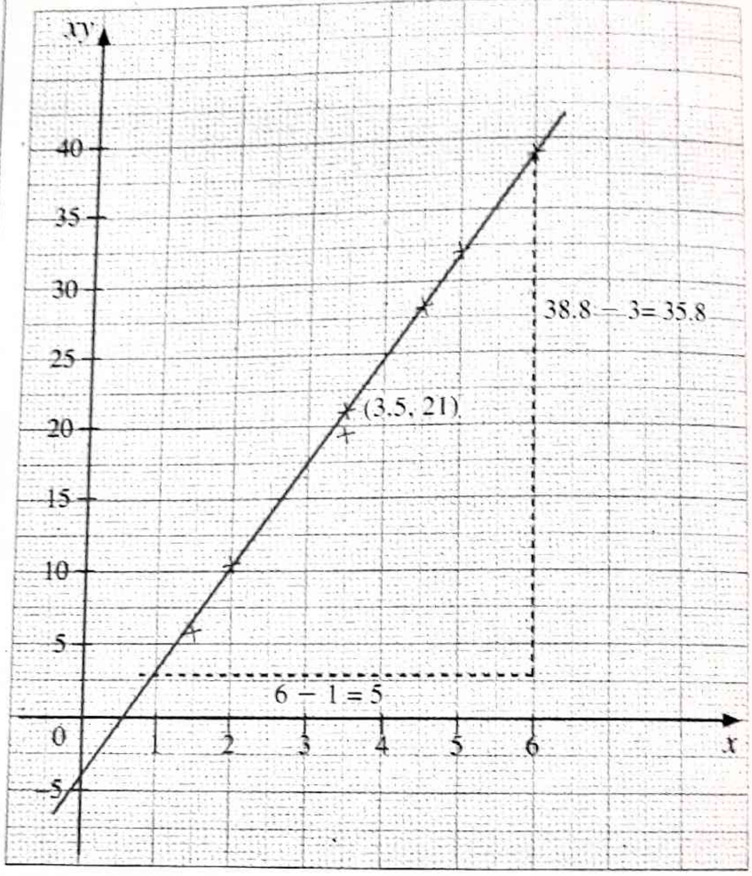
$\frac{2}{3}h = 2$

$h = 2 \times \frac{3}{2}$

$= 3$

9 (*a*)

x	1.5	2.0	3.5	4.5	5.0	6.0
y	4.5	5.25	5.5	6.3	6.34	6.5
xy	6.75	10.50	19.25	28.35	31.70	39.00



(*b*) $y - \sqrt{h} = \frac{hk}{x}$

$xy = \sqrt{h}\,x + hk$

$Y = mX + C$

$m = \sqrt{h}$, $C = hk$

(i) $m = \frac{35.8}{5}$

$\sqrt{h} = \frac{35.8}{5}$

$h = 51.27$

$C = -4$

$hk = -4$

$k = -\frac{4}{h}$

$= -\frac{4}{51.27}$

$= -0.0780$

(ii) $xy = 21$

$3.5y = 21$

$y = \frac{21}{3.5} = 6.0$

Correct value of y is 6.0.

10 (*a*) Left-hand side $= 2 \tan \theta \cos^2 \theta$

$= 2 \times \frac{\sin \theta}{\cos \theta} \times \cos^2 \theta$

$= 2 \sin \theta \cos \theta$

$= \sin 2\theta$

= Right-hand side (∴ Proven)

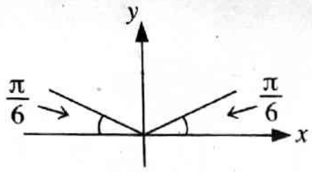
(*b*) $4 \tan \theta \cos^2 \theta = 1, 0 \leqslant \theta \leqslant 2\pi$

$2(2 \tan \theta \cos^2 \theta) = 1$

$2 \sin 2\theta = 1$

$\sin 2\theta = \frac{1}{2}$

Basic angle $= \frac{\pi}{6}$

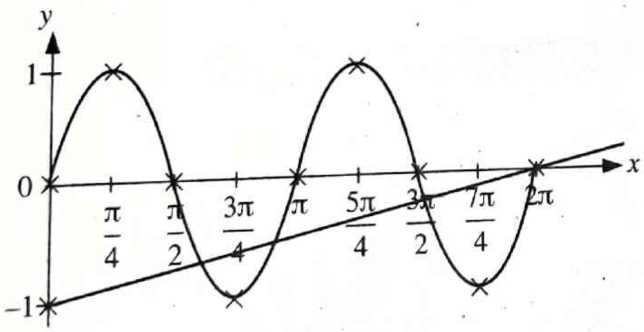


$2\theta = \frac{\pi}{6}, \frac{5\pi}{6}, \frac{13\pi}{6}, \frac{17\pi}{6}$

$\theta = \frac{\pi}{12}, \frac{5\pi}{12}, \frac{13\pi}{12}, \frac{17\pi}{12}$

(*c*) (i) $y = \sin 2\theta, 0 \leqslant \theta \leqslant 2\pi$

x	0	$\frac{\pi}{4}$	$\frac{\pi}{2}$	$\frac{3\pi}{4}$	π	$\frac{5\pi}{4}$	$\frac{3\pi}{2}$	$\frac{7\pi}{4}$	2π
y	0	1	0	−1	0	1	0	−1	0



(ii) $4\pi \tan \theta \cos^2 \theta = x - 2\pi$

$2\pi(2\tan \theta \cos^2 \theta) = x - 2\pi$

$2\pi \sin 2\theta = x - 2\pi$

$\sin 2\theta = \frac{x}{2\pi} - \frac{2\pi}{2\pi}$

$y = \frac{x}{2\pi} - 1$

x	0	2π
y	−1	0

Number of solutions = 4

11 (*a*) $y = 2x^2 - 18$

$\frac{dy}{dx} = 4x$

Gradient of straight line $AB = 4$

Thus, $4x = 4$

$x = 1$

When $x = 1$, $y = 2(1)^2 - 18 = -16$

Coordinates of $Q = (1, -16)$

(*b*) When $y = 0$, $2x^2 - 18 = 0$

$2x^2 = 18$

$x^2 = 9$

$x = \pm 3$

The curve cuts the x-axis at $(-3, 0)$ and $(3, 0)$.

Area of shaded region

$= \text{Area of } \Delta - \int_1^3 y\,dx$

$= \left(\frac{1}{2} \times 4 \times 16\right) - \int_1^3 2x^2 - 18\,dx$

$= 32 - \left|\left[\frac{2x^3}{3} - 18x\right]_1^3\right|$

$= 32 - \left|\left[18 - 54 - \left(\frac{2}{3} - 18\right)\right]\right|$

$= 32 - \left|-18\frac{2}{3}\right|$

$= 32 - 18\frac{2}{3} = 13\frac{1}{3}$ unit²

(*c*) Volume generated $= 65\pi$

$\pi\int_h^0 x^2\,dy = 65\pi$

$\pi\int_h^0 \frac{1}{2}y + 9\,dy = 65\pi$

$\left[\frac{1}{2}\frac{y^2}{2} + 9y\right]_h^0 = 65$

$0 - \left(\frac{1}{4}h^2 + 9h\right) = 65$

$-\frac{1}{4}h^2 - 9h = 65$

$\frac{1}{4}h^2 + 9h + 65 = 0$

$h^2 + 36h + 260 = 0$

$(h + 10)(h + 26) = 0$

$h = -10$ or $h = -26$ (rejected)

Thus, $h = -10$

Section C

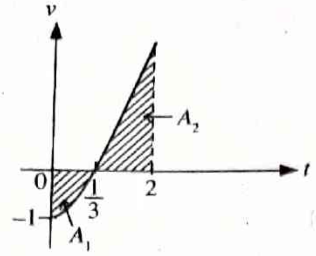
12 (*a*) $s_Q = 3t^3 - t$

$v_Q = 9t^2 - 1$

$t = 0, v_Q = 0 - 1$

$= -1 \text{ m s}^{-1}$

(b)



$A_1 = \int_0^{\frac{1}{3}} v_Q \, dt$

$= \int_0^{\frac{1}{3}} 9t^2 - 1 \, dt$

$= \left[\frac{9t^3}{3} - t\right]_0^{\frac{1}{3}} = 3\left(\frac{1}{27}\right) - \frac{1}{3} - 0 = -\frac{2}{9}$ m

$A_1 = \frac{2}{9}$ m

$A_2 = \int_{\frac{1}{3}}^{2} v_Q \, dt$

$= [3t^3 - t]_{\frac{1}{3}}^{2}$

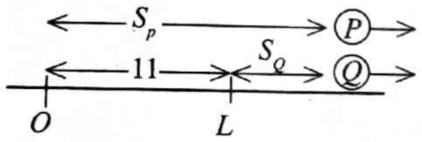
$= 3(8) - 2 - \left(\frac{1}{9} - \frac{1}{3}\right)$

$= 24 - 2 - \frac{1}{9} + \frac{1}{3} = 22\frac{2}{9}$ m

Total distance travelled $= A_1 + A_2$

$= \frac{2}{9} + 22\frac{2}{9} = 22\frac{4}{9}$ m

(c)



When particle P meets particle Q,

$s_P = 11 + S_Q$

$3t^3 + 10t = 11 + 3t^3 - t$

$11t = 11$

$t = 1$

When $t = 1$, $s_P = 3(1) + 10(1) = 13$ m

$s_Q = 3(1) - 1 = 2$ m

Distance of P from $L = 13 - 11 = 2$ m

Distance of Q from $L = 13 - 11 = 2$ m

Note:

Particles Q moves to the left for $\frac{1}{3}$ second only. Then, it changes its direction and moves to the right.

13 (a) (i) $x = 120$

(ii) $\frac{3}{y} \times 100 = 120$

$y = \frac{3 \times 100}{120} = 2.50$

(b) Composite index

$= \frac{132.8(50) + 120(20) + 190(1)}{50 + 20 + 1}$

$= \frac{9\,230}{71} = 130$

(c) $\frac{P_{16}}{P_{12}} \times 100 = 140$, $\frac{P_{16}}{P_{14}} \times 100 = 130$

(i) Composite index $= \frac{P_{14}}{P_{12}} \times 100$

$= \frac{P_{14}}{P_{16}} \times \frac{P_{16}}{P_{12}} \times 100$

$= \frac{100}{130} \times 140 = 107.69$

(ii) $\frac{P_{16}}{P_{12}} \times 100 = 140$

$\frac{P_{16}}{P_{10}} \times 100 = 140$

$P_{16} = \frac{140 \times 10}{100} = 14$ sen

Number of fish balls $= \frac{8\,000.}{14} = 571.4$

Maximum number of fish balls = 571

14 (a) $x + y > 40$

x	0	40
y	40	0

$6x + 5y \leqslant 900$

x	0	150
y	180	0

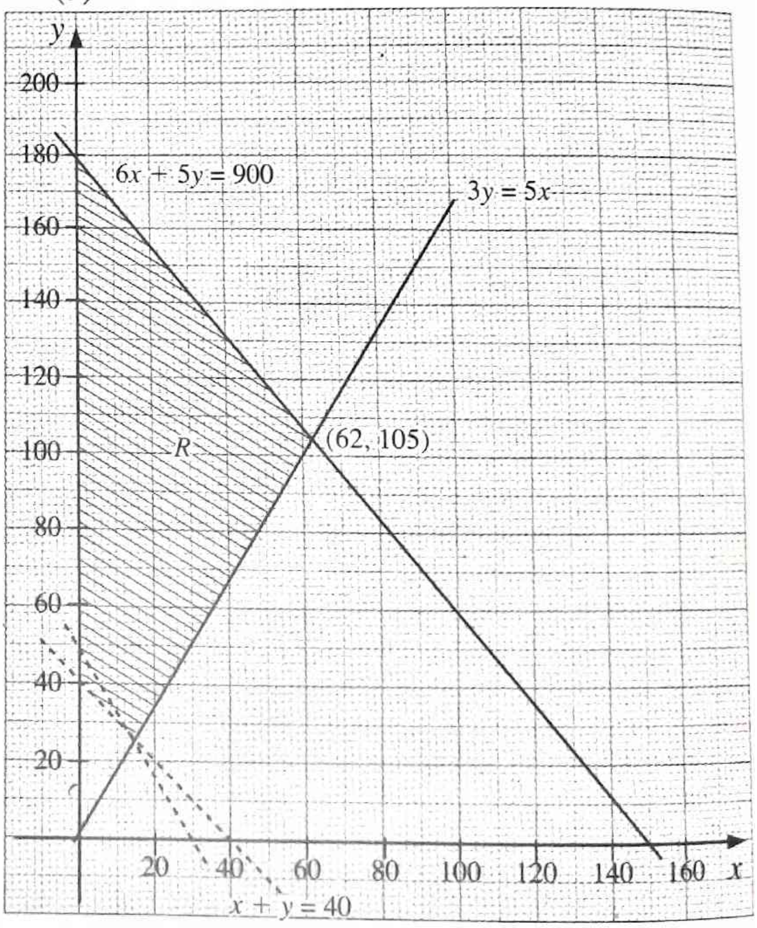
$x : y \leqslant 3 : 5$

$\frac{x}{y} \leqslant \frac{3}{5}$

$3y \geqslant 5x$

x	0	60
y	0	100

(b)



(*c*) Total sales, $P = 5x + 3y$

$$5x + 3y = 150$$

$$\frac{x}{30} + \frac{y}{50} = 1$$

Minimum point = (0, 40)

Minimum total sales = 5(0) + 3(40) = RM120

Maximum point = (62, 105)

Maximum total sales = 5(62) + 3(105)

= RM625

Range of total sales = $120 < P \leqslant 625$

15 (*a*) $\frac{\sin \angle BDC}{20.5} = \frac{\sin 64°}{22}$

$$\sin \angle BDC = \frac{20.5 \times \sin 64°}{22}$$

$$\angle BDC = 56°53'$$

(*b*) $\angle BCD = 180° - 64° - 56°53'$

$= 59°7'$

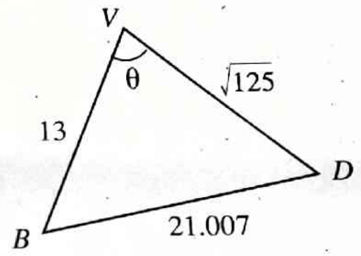
$$\frac{BD}{\sin 59°7'} = \frac{22}{\sin 64°}$$

$$BD = \frac{22 \times \sin 59°7'}{\sin 64°} = 21.007 \text{ m}$$

(*c*) $BV = 13$ m

$DV = \sqrt{5^2 + 10^2} = \sqrt{125}$

$BD = 21.007$



$$21.007^2 = 13^2 + 125 - 2(13)(\sqrt{125}) \cos \theta$$

$$26\sqrt{125} \cos \theta = 13^2 + 125 - 21.007^2$$

$$\cos \theta = \frac{13^2 + 125 - 21.007^2}{26\sqrt{125}}$$

$$\theta = 120° \ 27'$$

Area of $BVD = \frac{1}{2} \times 13 \times \sqrt{125} \times \sin 120° \ 27'$

$= 62.65 \text{ m}^2$