

2012

VCE Further Mathematics Trial Examination 2

Suggested Solutions

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Kilbaha Multimedia Publishing ABN 47 065 111 373
PO Box 2227
Kew Vic 3101
Australia
Tel: (03) 9018 5376
Fax: (03) 9817 4334
kilbaha@gmail.com
<http://kilbaha.com.au>

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Core**Question 1****a.**

Using TI-nspire CX CAS calculator, go to spread sheet, label list female, enter data, go to menu – statistics – stat calculations – one variable statistics – number of lists 1 OK – X1 list female – frequency list 1 OK.

This gives $\bar{x} = 20.7$
 $s_x = 2.1$

(2 marks)

1 mark for mean and one mark for standard deviation.

b.

Mean swim time for males = 19.8 minutes. 5 females swam faster than this.

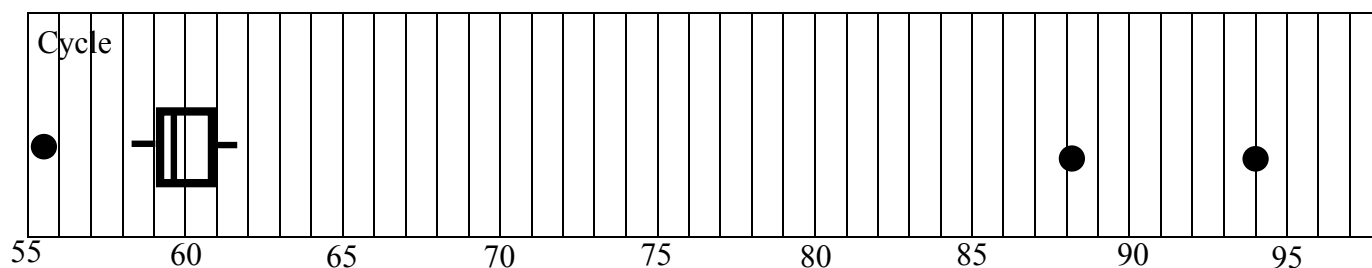
$$\text{Percentage} = \frac{5}{12} \times \frac{100}{1} = 41.7\%$$

(1 mark)

c.

Standard deviation is a measure of spread. Standard deviation for males is 4.9 and for females is 2.1. Hence, the males have a bigger spread for swim times than the females.

(1 mark)

Question 2**a. i.**

Go to spreadsheet and type cycle at the top of the list and enter data. Go to home – graphs – Type cycle on X axis

Menu – plot type – box plot. This gives

$$Q_1 = 59.1, M = 59.4, Q_3 = 60.8$$

Left hand whisker starts at 58.3 and right hand whisker ends at 61.5.

Outliers are 55.3, 88.2 and 94

1 mark for the three outliers, 1 mark for correct box and whiskers, 1 mark for correct median

(3 marks)

Core**Question 2 (continued)****a. ii.**59.1 is Q_1 . 75% of values are greater than Q_1

(1 mark)

b.

Entering data as in part (a), we get Lower Quartile = 33.6 and upper quartile = 35.1

$$IQR = 35.1 - 33.6 = 1.5$$

$$1.5 \times IQR = 1.5 \times 1.5 = 2.25$$

$$\text{Lower Quartile} - 2.25 = 33.6 - 2.25 = 31.35$$

$$\text{Upper Quartile} + 2.25 = 35.1 + 2.25 = 37.35$$

All running times lie between these two values, so no outliers.

1 mark for no outliers, 1 mark for the calculation.

(2 marks)

c.Range of cycling times = longest time – shortest time = $94 - 55.3 = 38.7$ minutes.

(1 mark)

Question 3**a.**

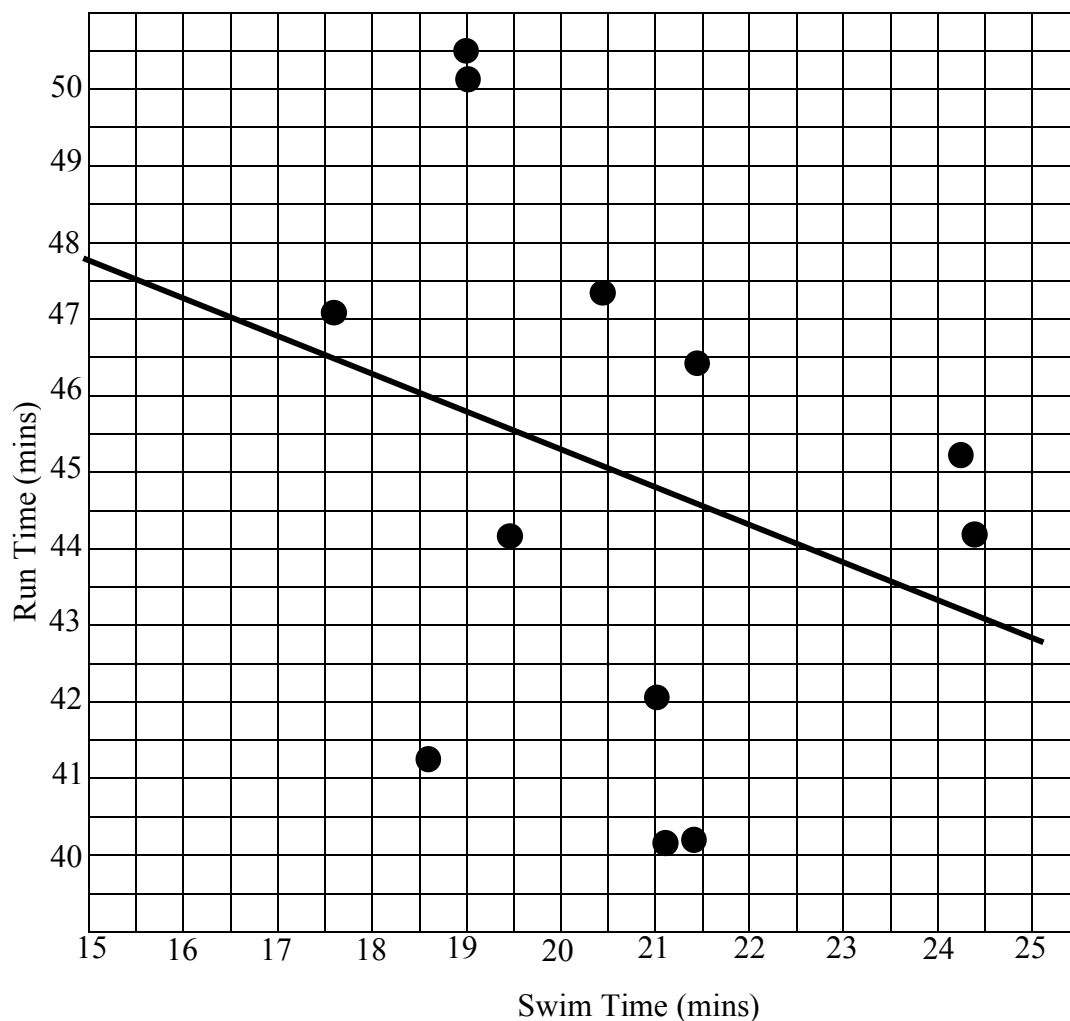
Make data headings swim and run and enter data.

Home – graph – enter swim on X axis and run on Y axis.

Menu – statistics – linear regression . this gives

$$\text{Run time} = -0.5 \times \text{swim time} + 55.2$$

(1 mark)

Core**Question 3 (continued)****b.****b.**

On calculator press menu – analyze – regression – show linear regression line and the line, and the line will be drawn on the scatter graph. You can get 2 points that lie on the line and then reproduce these on your graph, then draw the line through the two points.

e.g. (15, 47.7) and (25, 42.7)

(1 mark)

c.

$r = -0.3$

With your lists showing in the spread sheet, click in a free column, then go to menu, linear regression. Fill in the titles of your X and Y axes – menu – statistics – linear regression. Scroll down to find r .

(1 mark)

d.

There is a weak negative correlation between the swim times and the run times, but since we do not know the length of the swim and the length of the run, it is hard to come to any real conclusion about the speed of the athletes in these two events.

(1 mark)

Module 1 Number patterns and applications**Question 1**

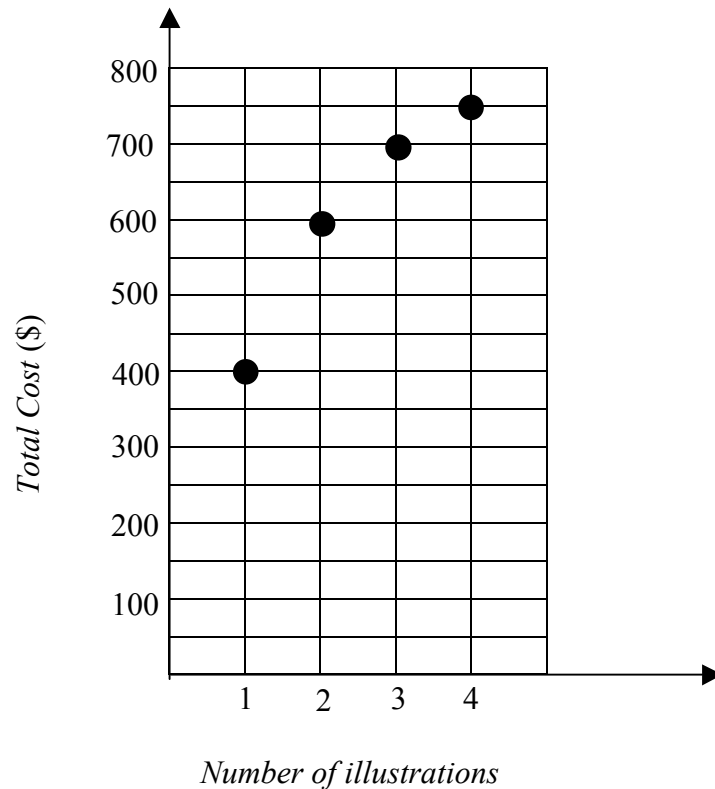
a. The pattern is 3, 5, 7 This is an arithmetic sequence with the common difference equal to 2. The fourth term is $7 + 2 = 9$. (1 mark)	b. This is an arithmetic sequence with $a = 3$ and $d = 2$ $t_n = a + (n - 1)d$ $t_{25} = 3 + (25 - 1)2$ $t_7 = 3 + 48$ $t_7 = 51$ (1 mark)
c. $S_n = \frac{n}{2}[2a + (n - 1)d]$ $S_{30} = \frac{30}{2}[2 \times 3 + (30 - 1) \times 2] = 960 \text{ words}$ (1 mark)	d. Use the TI nspire CX CAS calculator and just keep adding the terms of the arithmetic sequence until you get the first answer larger than 300, which is 323. Count the number of sums up to here to get 16. Or, use the rule $S_n = \frac{n}{2}[2a + (n - 1)d]$ $300 = \frac{n}{2}[6 + (n - 1) \times 2]$ $600 = n(6 + 2n - 2)$ $2n^2 + 4n - 600 = 0$ $n^2 + 2n - 300 = 0$ Use the calculator, - calculate, menu, algebra, solve and enter the equation and solve to get $n = 16.35$ This means 16 pages would be the maximum. (1 mark)

Module 1 Number patterns and applications**Question 2**

a. $B_{n+1} = 1.2 B_n + 50$ where $B_1 = 3000$ (1 mark)	b. $B_2 = 1.2 \times 3000 + 50 = 3650$ $B_3 = 1.2 \times 3650 + 50 = 4430$ (1 mark)
c. Use the calculator to multiply each answer in turn by 1.2 and then add 50 to get the answers 3000, 3650, 4430, 5366, 6489.2, 7837.04, 9454.4, 11395.3. The eighth year is the first year that the number of copies exceeds 10,000 (1 mark)	

Module 1 Number patterns and applications**Question 3**

a. Cost of printing 100 copies = $75 \times 100 = \\$7500$ Price decrease by \$10 = $75 - 10 = 65$ Hence, 500 books cost $65 \times 500 = \\$32,500$ (1 mark)	b. Pattern for books is 100, 300, 500 Pattern of cost per book is 75, 70, 65 For books, $t_n = a + (n - 1) \times d$ $2100 = 100 + (n - 1) \times 200$ $2100 = 100 + (n - 1) \times 200$ $n = 11$ Cost for 11th in book pattern $t_n = a + (n - 1) \times d$ $t_{11} = 75 + (11 - 1) \times (-5) = 25$ Cost for 2100 books at \$25 a book = $2100 \times 25 = \\$52500$ (1 mark)
c. From cost pattern $t_n = a + (n - 1)d$ $5 = 75 + (n - 1)(-5)$ $5 = 75 - 5n + 5$ $5n = 75$ $n = 15$ When $n = 15$ for number of books $t_{15} = 100 + (15 - 1) \times 200$ $= 100 + 14 \times 200$ $= 2900$ books (1 mark)	

Module 1 Number patterns and applications**Question 4****a.**

(1 mark)

b.

This is a geometric sequence.

The pattern is 400, 200, 100

$$\frac{200}{400} = \frac{100}{200} = \frac{1}{2}$$

Hence there is a common ratio.

1 mark for type of sequence, and 1 mark for reason.

(2 marks)

c.

$$400 + 200 + 100 + \dots$$

$$S_n = \frac{a(1 - r^n)}{1 - r}$$

$$S_7 = \frac{400(1 - (\frac{1}{2})^7)}{1 - \frac{1}{2}} = \$793.75$$

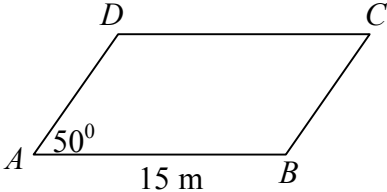
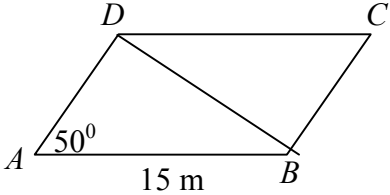
(1 mark)

d.

$$S_{\infty} = \frac{a}{1 - r} = \frac{400}{1 - \frac{1}{2}} = \$800$$

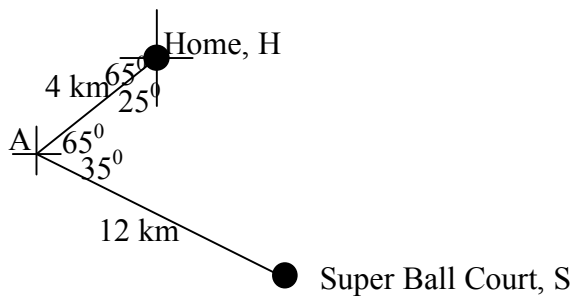
(1 mark)

Module 2 Geometry and trigonometry**Question 1**

a. Balls are 6.8 cm in diameter. The container is 3 balls high = $3 \times 6.8 = 20.4$ cm (1 mark)	b. Volume of cylinder = $\pi \times r^2 \times h$ $= \pi \times 3.4^2 \times 20.4 = 740.86 \text{ cm}^2$ Volume of 3 spheres = $3 \times \frac{4}{3} \times \pi \times r^3$ $= 3 \times \frac{4}{3} \times \pi \times 3.4^3 = 493.91$ Volume of air = $740.86 - 493.91 = 246.95 \text{ cm}^2$ (1 mark)
Question 2 a. $\angle CBA = 130^\circ$ (cointerior angles are supplementary)  (1 mark)	b.  $\angle BDA = 70^\circ$ (alternate angles) Using the sine rule in triangle ADB, $\angle DBA = 130 - 70 = 60^\circ$ $\frac{DA}{\sin 60^\circ} = \frac{15}{\sin 70^\circ}$ $DA = 13.82 \text{ m}$ (1 mark)
c. In triangle ABC, using cosine rule $AC = \sqrt{15^2 + 13.82^2 - 2 \times 15 \times 13.82 \times \cos 130^\circ}$ $= 26 \text{ m}$ (1 mark)	d. The two triangles are congruent. So, Area of court = $2 \times$ Area of triangle DAB. $= 2 \times \frac{1}{2} \times 15 \times 13.82 \times \sin 50^\circ = 158.8 \text{ m}^2$ (1 mark)

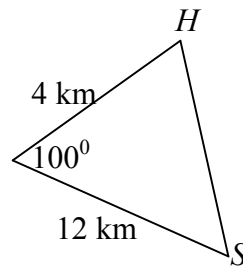
Module 2 Geometry and trigonometry**Question 3**

a. The width of the door = the diameter of the semi circle = $2r$ (1 mark)	b. $2r + 4r + 4r + \frac{1}{2} \times 2\pi r = 10$ $10r + \pi r = 10$ $r = 0.761$ $h = r + 4r = 5r$ $h = 3.8 \text{ m}$ (1 mark)
c. area of door = area of rectangle + area of semi-circle $= L \times W + \frac{1}{2} \pi r^2$ $= 4r \times 2r + \frac{1}{2} \pi r^2$ $= 8r^2 + \frac{1}{2} \pi (0.761)^2$ $= 8 \times (0.761)^2 + \frac{1}{2} \pi (0.761)^2$ $= 5.5 \text{ m}^2$ (1 mark)	

Module 2 Geometry and trigonometry**Question 4****a.**

$$\angle HAS = 65 + 35 = 100^\circ$$

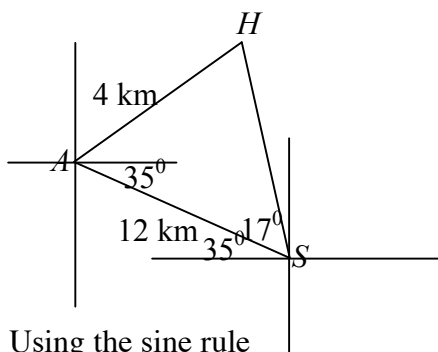
(1 mark)

b.

Using the cosine rule

$$HS = \sqrt{12^2 + 4^2 - 2 \times 12 \times 4 \times \cos 100^\circ} = 13.3 \text{ km}$$

(1 mark)

c.

Using the sine rule

$$\frac{4}{\sin S} = \frac{13.29}{\sin 100^\circ}$$

$$S = \sin^{-1} \left(\frac{4 \times \sin 100^\circ}{13.29} \right) = 17^\circ$$

$$\text{Bearing} = 270 + 35 + 17 = 322^\circ \text{T}$$

(1 mark)

Module 2 Geometry and trigonometry**Question 5****a.**

PQ = Radius of large ball + radius of small ball
 $= 3.4 + 0.85 = 4.25$ cm

(1 mark)

b.

Let $PV = x$.

Triangles PVY and QVX are similar AAA.

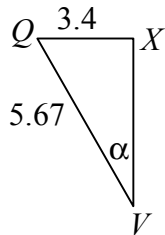
$\therefore$ the sides are in the same ratio.

$$\therefore \frac{PY}{QX} = \frac{PV}{QV}$$

$$\frac{0.85}{3.4} = \frac{x}{x + 4.25}$$

$$x = 1.42 \text{ cm}$$

(1 mark)

c.

$$QV = 4.25 + 1.42 = 5.67$$

$$\sin \alpha = \frac{3.4}{5.67}$$

$$\alpha = \sin^{-1} \left(\frac{3.4}{5.67} \right) = 36.8$$

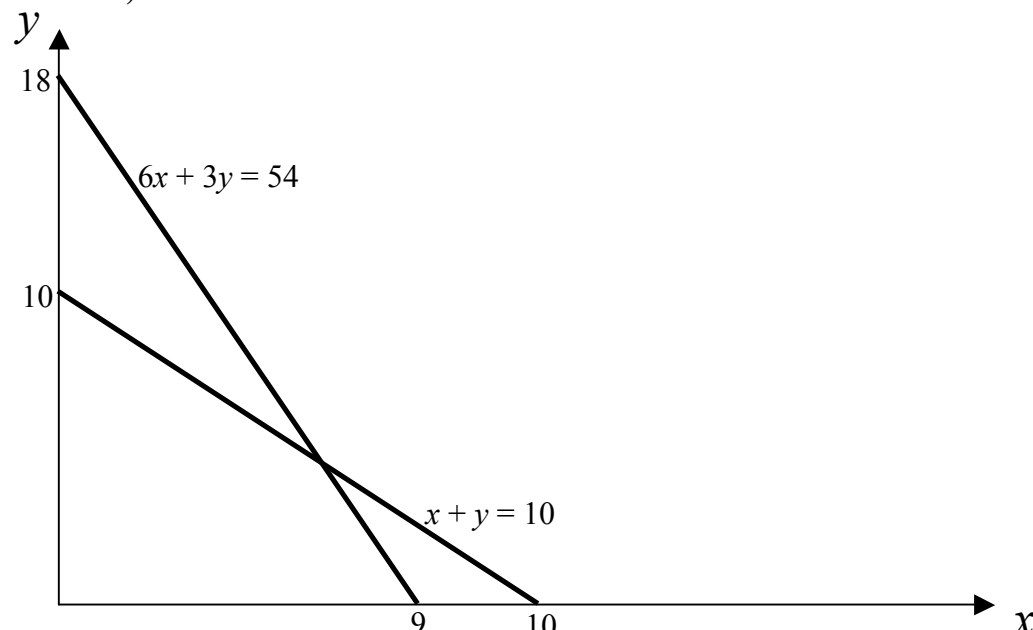
$$\angle ZVX = 2\alpha = 2 \times 36.8 = 74^\circ$$

(1 mark)

Module 3 Graphs and relations**Question 1**

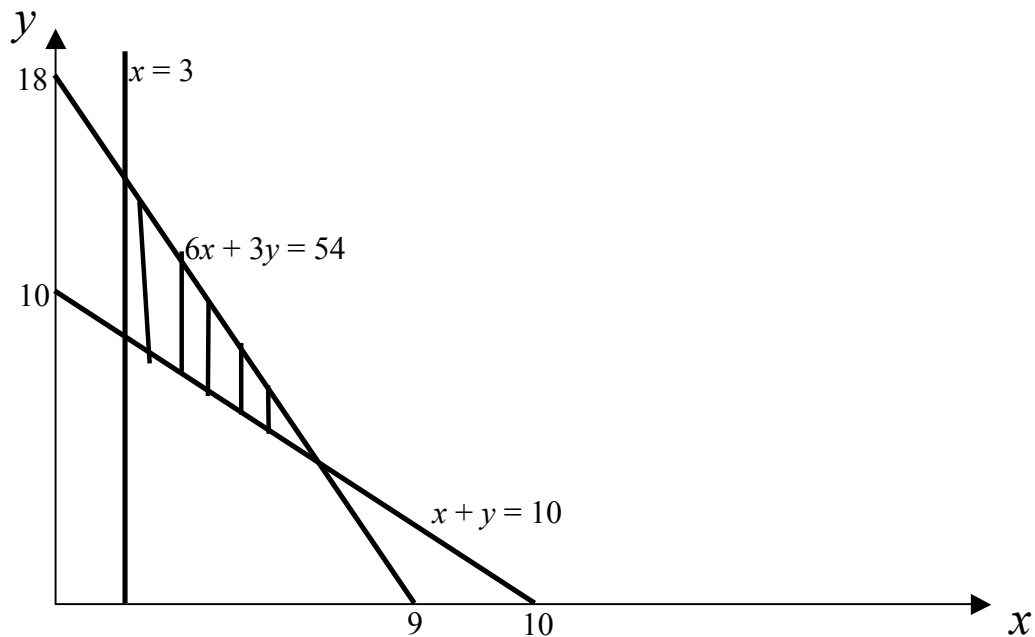
a. When Martha gets into the bath the water will rise. She gets in at point C. From the graph the depth is 45 cm. (1 mark)	b. At point B, Martha turns the tap so that the water coming into the bath is reduced. (1 mark)
c. The horizontal line shows when Martha is in the bath. This stretches from $t = 8$ to $t = 23$. This is a total of 15 minutes. (1 mark)	d. When $t = 2$, $2h = 66$ $h = 33$ cm. (1 mark)
e. $h = mt + c$ $m = \frac{45 - 33}{8 - 2} = 2$ $h = 2t + c$ When $t = 2$, $h = 33$ $33 = 4 + c$ $c = 29$ $h = 2t + 29$ (1 mark)	f. Rate of change = $\frac{0 - 45}{30 - 23} = -6.4$ cm/min This means that the water empties from the bath at a rate of 6.4 cm/min. (1 mark)
g. If water emptied at 9 litres per minute the equation would be $h = -9t + c$ When $h = 45$, $t = 23$ $45 = -9 \times 23 + c$ $c = 252$ $h = -9t + 252$ $0 = -9t + 252$ $t = 28$ $28 - 23 = 5$ minutes. (1 mark)	

Module 3 Graphs and relations**Question 2**

a. i. $6x + 3y \leq 54$ (1 mark) ii. $x + y \geq 10$ (1 mark)	b. $6x + 3y = 54$ When $x = 0, 3y = 54 \Rightarrow y = 18$ When $y = 0, 6x = 54 \Rightarrow x = 9$ $x + y = 10$ When $x = 0, y = 10$ When $y = 0, x = 10$ (1 mark)
b. (continued)  (1 mark)	

Module 3 Graphs and relations**Question 2 (continued)****c.**

$x \geq 3$



(1 mark)

d.

$P = 300x + 120y$

(1 mark)

e.

Find the point of intersection of the lines,
 $6x + 3y = 54$ and $x + y = 10$

Using CAS calculator gives $x = 8, y = 2$

The corner points of the shaded region are
 $(3, 7)$, $(3, 12)$ and $(8, 2)$

At $(3, 7)$, $P = 900 + 840 = \$1740$

At $(3, 12)$, $P = 900 + 1440 = \$2340$

At $(8, 2)$, $P = 2400 + 240 = \$2640$

Hence, for maximum profit, the company should
 make 8 spa baths and 2 claw foot baths per
 week.

(1 mark)

f.

From part **e.** the maximum profit is \$2640

(1 mark)

Module 4 Business-related mathematics**Question 1**

a. i. Total depreciation = $5 \times 6845 = 34225$ Original value of the cars = $55775 + 34225$ = \$90000 (1 mark)	a. ii. Depreciation = 6845 % depreciation = $\frac{6845}{90000} \times 100 = 7.6\%$ (1 mark)
a. iii. $90000 - 6845 \times n < 30000$ Put the expression $90000 - 6845 \times n$ into a spreadsheet or table on your calculator and scroll down to where the answer is 300000 The first value less than 300000 is 28395 when $n = 9$ He will have the cars 9 years before he sells them. (1 mark)	

Question 2

a. $A = P \left(1 - \frac{r}{100} \right)^n = 90000 \left(1 - \frac{12}{100} \right)^5 = 47495.87$ = \$47496 to the nearest dollar (1 mark)	b. $39934 = 90000 \left(1 - \frac{r}{100} \right)^5$ Solve on the CAS calculator to get $r = 14.9998$ $r = 15\%$ to the nearest whole number (1 mark)
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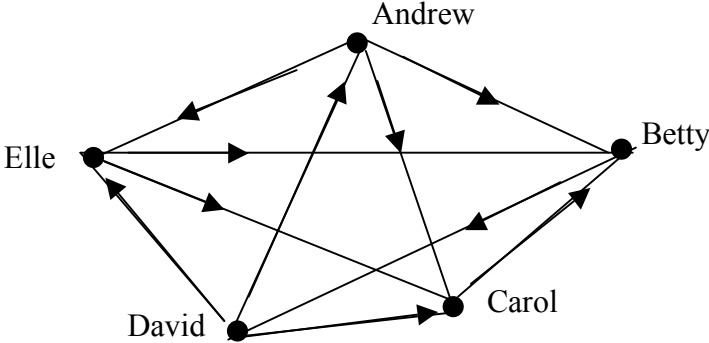
Module 4 Business-related mathematics**Question 3**

a. Increase in price = $115000 - 90000 = 25000$ Inflation rate = $\frac{25000}{90000} \times 100 = 27.8\%$ (1 mark)	b. i. Peter pays back $96 \times 850 = 81600$ He borrows $115000 - 60000 = 55000$ Interest = $81600 - 55000 = \\$26600$ (1 mark)
b. ii. Use TVM solver N = 96 I = PV = 55000 PMT = -850 FV = 0 P/Y = 12 C/Y = 12 This gives I = 10.5% (1 mark)	c. Use TVM solver N = 72 I = 10.52718763 PV = 55000 PMT = -850 FV = P/Y = 12 C/Y = 12 This gives FV = \$18323.46 (1 mark)

Module 4 Business-related mathematics**Question 4**

a. $I = \frac{PRT}{100} = \frac{12000 \times 5.2 \times 6}{100} = \3744 Total value = 12000 + 3744 = \$15744 (1 mark)	b. $A = 12000 \left(1 + \frac{4.8}{200} \right)^{12} = \15950.74 Interest = 15950.74 – 12000 = \$3950.74 (1 mark)
c. Amount invested = 30000 – 24000 = 6000 Use TVM solver N = 72 I = 5 PV = 6000 PMT = 500 FV = P/Y = 12 C/Y = 12 This gives FV=\$49976.24 (1 mark)	d. Final value of investment = 15744 + 15950.74 + 49976.24 = \$81671 to the nearest dollar. (1 mark)
e. Amount invested = 30000 + 500 × 72 = 66000 Interest = 81671 – 66000 = \$15671 (1 mark)	f. Need this account to be worth 100000 – (15744 + 49976.24) = 34279.76 Use TVM solver N = 72 I = 4.8 PV = 12000 PMT = FV = 34279.76 P/Y = 2 C/Y = 2 This gives PMT = 533.9698 = \$534 to the nearest dollar (1 mark)

Module 5 Networks and decision mathematics**Question 1**

a. A plays B, C, D and E Each player plays the other 4 players. 4. (1 mark)	b. AB BC CD DE AC BD CE AD BE AE A total of 10 sets are played. (1 mark)
c.  (1 mark)	
d. A complete graph (1 mark)	
e. $ \begin{array}{c} A \quad B \quad C \quad D \quad E \\ A \begin{bmatrix} 0 & 1 & 1 & 0 & 1 \end{bmatrix} \\ B \begin{bmatrix} 0 & 0 & 0 & 1 & 0 \end{bmatrix} \\ C \begin{bmatrix} 0 & 1 & 0 & 0 & 0 \end{bmatrix} \\ D \begin{bmatrix} 1 & 0 & 1 & 0 & 1 \end{bmatrix} \\ E \begin{bmatrix} 0 & 1 & 1 & 0 & 0 \end{bmatrix} \end{array} $ (2 marks)	

Module 5 Networks and decision mathematics

Question 1 (continued)

f.

Andrew and David each have 3 points.

(1 mark)

g.

$$\begin{array}{ccccc} & A & B & C & D & E \\ \begin{array}{l} A \\ B \\ C \\ D \\ E \end{array} & \left[\begin{array}{ccccc} 0 & 2 & 1 & 1 & 0 \\ 1 & 0 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 3 & 2 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 \end{array} \right] \end{array}$$

(3 marks)

h.

$$A = 3 + 4 = 7$$

$$B = 1 + 3 = 4$$

$$C = 1 + 1 = 2$$

$$D = 3 + 6 = 9$$

$$E = 2 + 2 = 4$$

David wins the prize

(1 mark)

Question 2

a.

Person	Mark Court	Bag Court	Collect Balls	Put up net
Andrew	$12 - 8 = 4$	$8 - 8 = 0$	$10 - 8 = 2$	$8 - 8 = 0$
Betty	$9 - 8 = 1$	$12 - 8 = 4$	$9 - 8 = 1$	$8 - 8 = 0$
Carol	$12 - 8 = 4$	$10 - 8 = 2$	$8 - 8 = 0$	$8 - 8 = 0$
David	$12 - 12 = 0$	$12 - 12 = 0$	$14 - 12 = 2$	$13 - 12 = 1$

Person	Mark Court	Bag Court	Collect Balls	Put up net
Andrew	4	0	2	0
Betty	1	4	1	0
Carol	4	2	0	0
David	0	0	2	1

(1 mark)

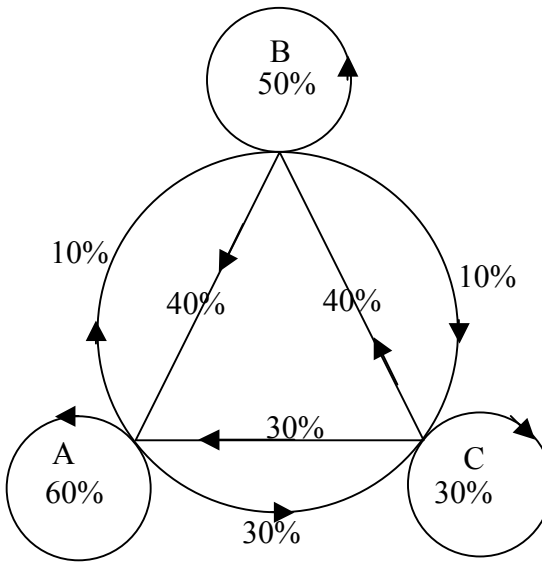
Module 5 Networks and decision mathematics**Question 2 (continued)**

b. David marks the court Andrew bags the court Betty puts up the net Carol collects the balls. (1 mark)	c. Time for David = 12 minutes Time for Andrew = 8 minutes Time for Betty = 8 minutes Time for Carol = 8 minutes. David will be the last to finish and the others will have to wait 4 minutes for him to finish. (2 marks)
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Module 6 Matrices**Question 1**

a. $N = \begin{matrix} & \begin{matrix} Men & Women & Chn. \end{matrix} \\ \begin{matrix} Black \\ Brown \\ White \end{matrix} & \begin{bmatrix} 80 & 100 & 160 \\ 70 & 40 & 60 \\ 10 & 50 & 90 \end{bmatrix} \end{matrix}$ (1 mark)	b. $M = \begin{matrix} & \begin{matrix} 1 & 2 & 3 & 4 \end{matrix} \\ \begin{matrix} Men \\ Women \\ Chn \end{matrix} & \begin{bmatrix} 40 & 60 & 20 & 40 \\ 60 & 55 & 50 & 25 \\ 98 & 70 & 62 & 80 \end{bmatrix} \end{matrix}$ (1 mark)
c. $C = \begin{bmatrix} 240 \\ 120 \\ 80 \end{bmatrix}$ (1 mark)	d. $X = \begin{bmatrix} 44000 \\ 26400 \\ 15600 \end{bmatrix}$ (1 mark)
e. The total cost of all black shoes sold in February is \$44000. The total cost of all brown shoes sold in February is \$26400. The total cost of all white shoes sold in February is \$15600. (1 mark)	f. A 25% reduction means that each shoe will now cost 0.75 times the original cost. $0.75 \begin{bmatrix} 240 \\ 120 \\ 80 \end{bmatrix} = \begin{bmatrix} 180 \\ 90 \\ 60 \end{bmatrix}$ (1 mark)
g. $5 \begin{bmatrix} 40 & 60 & 98 \\ 60 & 55 & 70 \\ 20 & 50 & 62 \\ 40 & 25 & 80 \end{bmatrix} \begin{bmatrix} 180 \\ 90 \\ 60 \end{bmatrix} = \begin{bmatrix} 92400 \\ 99750 \\ 59100 \\ 71250 \end{bmatrix}$ (2 marks)	h. Total income for February $= 44000 + 26400 + 15600 = \\86000 Total income for March $= 92400 + 99750 + 59100 + 71250 = \\322500 March by \$236500 (1 mark)

Module 6 Matrices**Question 2**

a.  (2 marks)	b. 60% of 600 + 50% of 300 + 30% of 400 = 630 cars (1 mark)
c. $\begin{bmatrix} 0.6 & 0.4 & 0.3 \\ 0.1 & 0.5 & 0.4 \\ 0.3 & 0.1 & 0.3 \end{bmatrix} \begin{bmatrix} 600 \\ 300 \\ 400 \end{bmatrix} = \begin{bmatrix} 600 \\ 370 \\ 330 \end{bmatrix}$ 600 at A 370 at B 330 at C (2 marks)	d. Site C. It will have a demand for 400 cars but will only have 330 cars. (1 mark)
e. $\begin{bmatrix} 0.6 & 0.4 & 0.3 \\ 0.1 & 0.5 & 0.4 \\ 0.3 & 0.1 & 0.3 \end{bmatrix}^{30} \begin{bmatrix} 600 \\ 300 \\ 400 \end{bmatrix} = \begin{bmatrix} 611 \\ 374 \\ 315 \end{bmatrix}$ $\begin{bmatrix} 0.6 & 0.4 & 0.3 \\ 0.1 & 0.5 & 0.4 \\ 0.3 & 0.1 & 0.3 \end{bmatrix}^{50} \begin{bmatrix} 600 \\ 300 \\ 400 \end{bmatrix} = \begin{bmatrix} 611 \\ 374 \\ 315 \end{bmatrix}$ 611 cars. (1 mark)	

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Kilbaha Multimedia Publishing
PO Box 2227
Kew Vic 3101
Australia

Tel: (03) 9018 5376
Fax: (03) 9817 4334
kilbaha@gmail.com
<http://kilbaha.com.au>