	Solution/ Mark Scheme
1	**(a)** $\frac{2x+7}{2}-\frac{7-x}{5}=0$ $\frac{2x+7}{2}=\frac{7-x}{5}$ $5(2x+7)=2(7-x)$ --- [M1] $10x+35=14-2x$ $12x=-21$ $x=-1\frac{3}{4}$ (also accept $-\frac{7}{4}$) --- [A1] Alternative $\frac{2x+7}{2}-\frac{7-x}{5}=0$ $5(2x+7)-2(7-x)=0$ --- [M1] $10x+35-14+2x=0$ $12x=-21$ $x=-1\frac{3}{4}$ (also accept $-\frac{7}{4}$) --- [A1]
	(b) $(2x-3)(x-4)=2$ $2x^2-11x+12=2$ $2x^2-11x+10=0$ ---[M1] $x=\frac{-(-11)\pm\sqrt{(-11)^2-4(2)(10)}}{2(2)}$ ---[M1] $x=\frac{11\pm\sqrt{41}}{4}$ $x=1.15$ or 4.35 --- [A1, A1]
	(c) $\frac{15x^2}{2y}\div\frac{3x^2y}{8}$ $=\frac{15x^2}{2y}\times\frac{8}{3x^2y}$ $=\frac{20}{y^2}$ --- [B1]

	(d) $\frac{ax+3bx-2a-6b}{a^2+ab-6b^2}$ $=\frac{x(a+3b)-2(a+3b)}{a^2+ab-6b^2}$ $=\frac{(a+3b)(x-2)}{(a+3b)(a-2b)}$ --- [M1 for numerator; M1 for denominator] $=\frac{x-2}{a-2b}$ --- [A1]

	Solution/ Mark Scheme
2	**(a)** Each compound increases the principal amount, which in turn leads to greater interest being generated. Cody should invest in account A as it provides more frequent compounding than account B, hence, generating greater interest. OR Cody should invest in account A because the interest is calculated 12 times each year as compared to only once a year for Account B. Each time, the interest is calculated on a larger amount of money. Therefore, account A will generate greater interest. *Do not accept if students provide a calculated example and arrive at a conclusion just based on calculation. Key idea of more frequent compounding in account A, which will lead to more interest generated, should be featured in students' explanation.
	(b) $20000\left(1+\frac{x}{100}\right)^3 = 22823.32$ --- [M1] $\left(1+\frac{x}{100}\right)^3 = \frac{22823.32}{20000}$ $1+\frac{x}{100} = \sqrt[3]{\frac{22823.32}{20000}}$ --- [M1] $\frac{x}{100} = \sqrt[3]{\frac{22823.32}{20000}} - 1$ $x = 4.4999$ (5 s.f.) ≈ 4.5 (1 d.p.) --- [A1]
	(c)(i) $\frac{40}{100} \times \$156000 + 36 \times \$2800$ --- [M1] $= \$163200$ --- [A1]

(c)(ii)

$\$156000(0.92)^3$ --- [M1]

$= \$121475.328$ (3 d.p.)

Method 1

$\frac{\$121475.328}{\$163200} \times 100\% = 74.433\%$ --- [M1]

$100\% - 74.433\% = 25.6\%$ (3 s.f.) --- [A1]

Method 2

loss incurred: $\$163200 - \$121475.328 = \$41724.672$

% loss: $\frac{\$41724.672}{\$163200} \times 100\%$ --- [M1]

$= 25.566\%$

$= 25.6\%$ (3 s.f.) ---[A1]

(d)

Amount of S$ spent in America: $\$368 \times 2 \times 1.35 = \$993.60$

[M1 for finding cost of hotel in US in SGD]

Amount of S$ spent in Canada: $\$250 \times 3 \times \frac{1}{1.02} = \$735.2941$ (4 d.p.)

[M1 for finding cost of hotel in Canada in SGD]

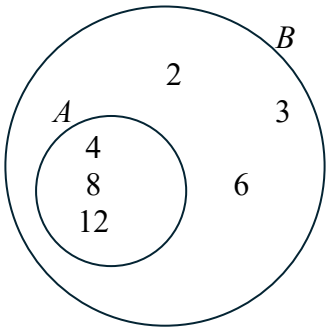
Total amount spent: $\$993.60 + \$735.2941 + \frac{1.5}{100} \times (\$993.60 + \$735.2941) = \$1754.82$

OR

$(\$993.60 + \$735.2941) \times \frac{101.5}{100} = \$1754.82$

[A1] for either

	Solution/ Mark Scheme
3	**(a)(i)** Median mark = 35
	(a)(ii) $38-30$ --- [M1] $=8$ --- [A1]
	(a)(iii) 60^{th} percentile: $\frac{60}{100}\times 80=48$ From graph, 60^{th} percentile: 36 --- [B1]
	(b) $\frac{85}{100}\times 80=68$ --- [M1] $80-68=12$ 12 students scored less than x marks. From graph: $x=25$ ---[A1]
	(c)(i) Chemistry Test: Median mark: 32; IQR: $40-25=15$ Physics Test: Median mark: 35; IQR: 8 1. The students perform better for the Physics test due to a higher median mark of 35, as compared to the Chemistry test, with a lower median mark of 32. --- [B1] 2. The performance of the students were more consistent for the Physics test due to a lower interquartile range of 8, as compared to the Chemistry test, which has a higher interquartile range of 15. --- [B1] *Note: Students need to draw reference to the values of median/ IQR in their explanation to be awarded the mark.
	(c)(ii) The entire box-and-whisker plot would shift to the right by one unit/ one mark. --- [B1]

	Solution/ Mark Scheme
4	$\xi = \{2, 3, 4, ...15\}$ $A = \{4, 8, 12\}$ $B = \{2, 3, 4, 6, 8, 12\}$ **(a)(i)** Elements in B': 5,7,9,10, 11,13,14,15 --- [B1] [Accept if students write: $\{5, 7, 9, 10, 11, 13, 14, 15\}$]
	(a)(ii) *Note: A is a proper subset of B. Answer: 2,3,6 --- [B1] 
	(a)(iii) Answer: 0 --- [B1]

(b)(i)

	Physics	Not Physics
Literature	*13* } [A1] for both correct	*5* ---[B1]
Not Literature	7 }	15

Let x represent number of students who took both Physics and Lit.

$\frac{x}{40} \times \frac{x-1}{39} = \frac{1}{10}$ --- [M1]

$10x(x-1) = 40 \times 39$

$x^2 - x - 156 = 0$

$(x-13)(x+12) = 0$ --- [M1]

$x = 13$ or $x = -12$ (rej)

Note: Award full credit if students managed to obtain the first column correctly by trial and error, with relevant workings provided.
i.e.

$13 + 7 = 20$

By trial and error,

$\frac{13}{40} \times \frac{12}{39} = \frac{1}{10}$

Therefore, there are 13 students taking Physics and Literature.

7 students take Physics but not Literature.

(b)(ii)

$\frac{18}{40} \times \frac{22}{39} \times 2$ --- [M1, allow ecf]

$= \frac{33}{65}$ --- [A1]

	Solution/ Mark Scheme
5	**(a)** $\frac{2}{3}\pi(2r)^3 = \frac{1}{3}\pi(2r)^2 h$ --- [M1, M1] $\frac{2}{3}\pi(8r^3) = \frac{1}{3}\pi(4r^2)h$ $16r^3 = 4r^2 h$ $h = \frac{16r^3}{4r^2}$ $h = 4r$ --- [A1] M1: applying formula to find vol of hemisphere correctly. M1: applying formula to find vol of cone correctly.
	(b) $\frac{2}{3}\pi(2r)^3 = 450$ --- [M1] $\frac{16}{3}\pi r^3 = 450$ $r^3 = \frac{450\times 3}{16\pi}$ $r = \sqrt[3]{\frac{450\times 3}{16\pi}}$ $r = 2.9947$ (5 s.f.) --- [A1] Total surface area: $2\pi(R)^2 + \pi(R)l$, where $R = 2r$ $l = \sqrt{R^2 + h^2}$ $= \sqrt{(2r)^2 + (4r)^2}$ --- [M1] $= \sqrt{20r^2}$ $= \sqrt{20(2.9947)^2}$ $=13.392$ **Alternatively** (radius) $2\times 2.9947 = 5.9894$ (height) $4\times 2.9947 = 11.9788$ $l = \sqrt{5.9894^2 + 11.9788^2}$ --- [M1] $=13.392$ Total Surface area: $2\pi(2\times 2.9947)^2 + \pi(2\times 2.9947)(13.392)$ --- [M1] $= 477.38$ cm^3 (5 s.f.) ≈ 477 cm^3 --- [A1]

	Solution/ Mark Scheme
6	**(a)** $\angle PQS = \angle SRP$ (angles in the same segment) $\angle OSP = \angle OPS$ (base angles, isos. triangle) $\angle QSP = \angle QSO + \angle OSP$ $= \angle RPO + \angle OPS$ $= \angle RPS$ PS is the common side. M1 for any two correct; M2 for all three correct By AAS test, triangles SQP and PRS are congruent. --- [A1] *max 1 mark is deduced directly from the question for any wrong reason given.
	(b) $\angle POS = 64° \times 2$ ($\angle$ at centre = 2$\angle$ at circumference) $= 128°$ $\angle OPT = \angle OST = 90°$ (tangent perpendicular to radius) $\angle PTS = 360° - 90° - 90° - 128°$ --- [M1] $= 52°$ $\angle PTS + \angle PRS = 64° + 52° = 116°$ ($\neq 180°$) By property of angles in opposite segment, since $\angle PTS + \angle PRS \neq 180°$, we cannot draw a circle passing through P, R, S and T. [A1]

(c)(i)

$\angle OPS = \dfrac{180° - 128°}{2}$ (base angle, isos. triangle)

$= 26°$

$\dfrac{r}{\sin 26°} = \dfrac{13.5}{\sin 128°}$ --- [M1]

$r = \dfrac{13.5}{\sin 128°} \times \sin 26°$

$= 7.5100$ (5 s.f.)

≈ 7.51 (3.s.f) [shown] --- [A1]

Alternative #1

$13.5^2 = r^2 + r^2 - 2r^2 \cos 128°$ --- [M1]

$13.5^2 = 2r^2 - 2r^2 \cos 128°$

$13.5^2 = r^2(2 - 2\cos 128°)$

$r^2 = \dfrac{13.5^2}{(2 - 2\cos 128°)}$

$r = 7.5100$

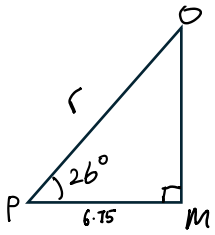
≈ 7.51 (3 s.f.) (shown) } [A1]

Alternative #2

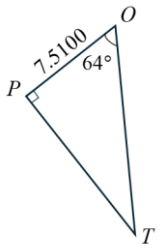
$\cos 26° = \dfrac{6.75}{r}$ --- [M1]

$r = \dfrac{6.75}{\cos 26°}$

≈ 7.51 (3 s.f.) (shown) } [A1]



(c)(ii)



$\tan 64° = \dfrac{PT}{7.5100}$ --- [M1]

$PT = 7.5100 \tan 64°$

$PT = 15.397$

Method 1

Area of $OPTS$: $\dfrac{1}{2} \times 15.397 \times 7.5100 \times 2$ --- [M1, allow ecf]

$= 115.63 \text{ cm}^2$

Area of major sector $OPQRS$: $\dfrac{232}{360} \times \pi \times 7.5100^2$ --- [M1]

$= 114.18 \text{ cm}^2$

Total area: $115.63 \text{ cm}^2 + 114.18 \text{ cm}^2 = 229.81 \text{ cm}^2$

$\approx 230 \text{ cm}^2$ (3 s.f.) --- [A1]

Method 2

Area of $OPTS$: Area of triangle POS + Area of triangle PTS

$= \dfrac{1}{2} \times 7.5100^2 \times \sin 128° + \dfrac{1}{2} \times 15.397^2 \times \sin 52°$ --- [M1, allow ecf]

$= 115.627 \text{ cm}^2$

Area of major sector $OPQRS$: $\dfrac{232}{360} \times \pi \times 7.5100^2$ --- [M1]

$= 114.18 \text{ cm}^2$

Total area: $115.627 \text{ cm}^2 + 114.18 \text{ cm}^2 = 229.807 \text{ cm}^2$

$\approx 230 \text{ cm}^2$ (3 s.f.) --- [A1]

Method 3

[M1]: refer to method 1 or 2 on how to find Area of OPTS

Area of PST  :

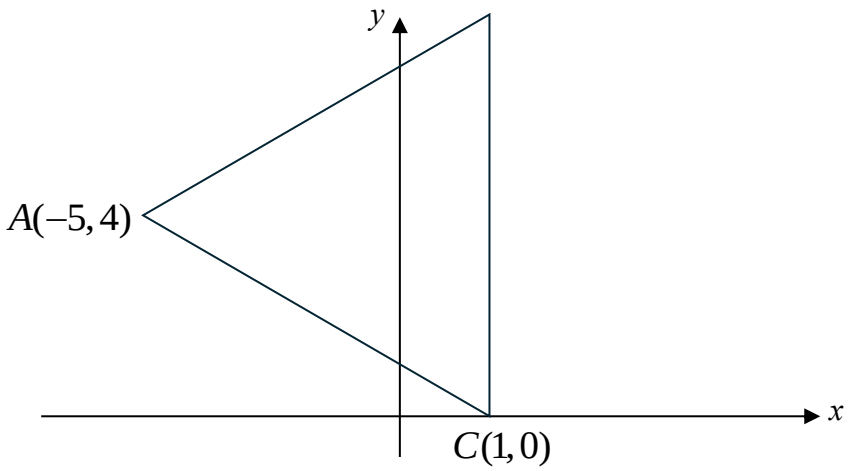
$$115.63 - \underbrace{\left(\frac{128^\circ}{360^\circ} \times \pi \times 7.5100^2\right)}_{[M1]}$$
$$= 52.631$$

Shaded Area: Area of Circle + Area of PST

$$= \pi \times 7.5100^2 + 52.631$$
$$= 229.817 \text{ cm}^2 \approx 230 \text{ cm}^2 \text{ (3 s.f.)} \text{ --- [A1]}$$

Solution/ Mark Scheme

7 **(a)**



Method 1:

$-5+3k=1$ --- [M1]

$3k=6$

$k=2$

$\therefore B(1,12)$ --- [M1]

$C(1,0)$

Method 2:

$\overrightarrow{OA}=\begin{pmatrix}-5\\4\end{pmatrix}$

Let coordinates of B be $(1,b)$

$\overrightarrow{OB}=\begin{pmatrix}1\\b\end{pmatrix}$

$\overrightarrow{AB}=\overrightarrow{OB}-\overrightarrow{OA}$

$\begin{pmatrix}3k\\4k\end{pmatrix}=\begin{pmatrix}1\\b\end{pmatrix}-\begin{pmatrix}-5\\4\end{pmatrix}$

$\begin{pmatrix}3k\\4k\end{pmatrix}=\begin{pmatrix}6\\b-4\end{pmatrix}$

$3k=6$ --- [M1]

$k=2$

$b-4=4(2)$

$b=12$

$B(1,12)$ --- [M1]

Area of triangle $ABC: \frac{1}{2}\times 6\times 12$ --- [M1]

$=36$ units^2 --- [A1]

(b)(i)(a)

Method 1	**Method 2**
$\overrightarrow{BA} = \overrightarrow{OA} - \overrightarrow{OB}$ $= \mathbf{a} - \mathbf{b}$ $\overrightarrow{BX} = \frac{1}{2}(\mathbf{a} - \mathbf{b})$ --- [M1] $\overrightarrow{OX} = \overrightarrow{OB} + \overrightarrow{BX}$ $= \mathbf{b} + \frac{1}{2}(\mathbf{a} - \mathbf{b})$ $= \frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}$ --- [A1]	$\overrightarrow{BA} = \overrightarrow{OA} - \overrightarrow{OB}$ $= \mathbf{a} - \mathbf{b}$ $\overrightarrow{AX} = -\frac{1}{2}(-\mathbf{b} + \mathbf{a})$ --- [M1] $= \frac{1}{2}\mathbf{b} - \frac{1}{2}\mathbf{a}$ $\overrightarrow{OX} = \overrightarrow{OA} + \overrightarrow{AX}$ $= \mathbf{a} - \mathbf{b} + \frac{1}{2}\mathbf{b} - \frac{1}{2}\mathbf{a}$ $= \frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}$ --- [A1]

(b)(i)(b)

$\overrightarrow{OD} = 3 \times \overrightarrow{OA}$
$= 3\mathbf{a}$ --- [M1]

$\overrightarrow{OY} = \overrightarrow{OD} + \overrightarrow{DY}$
$= 3\mathbf{a} - (2\mathbf{a} - \mathbf{b})$
$= \mathbf{a} + \mathbf{b}$ --- [A1]

(b)(ii)

1. O, X and Y are collinear. --- [B1]

2. $OX = \frac{1}{2}OY$ or X is the midpoint of OY. --- [B1]

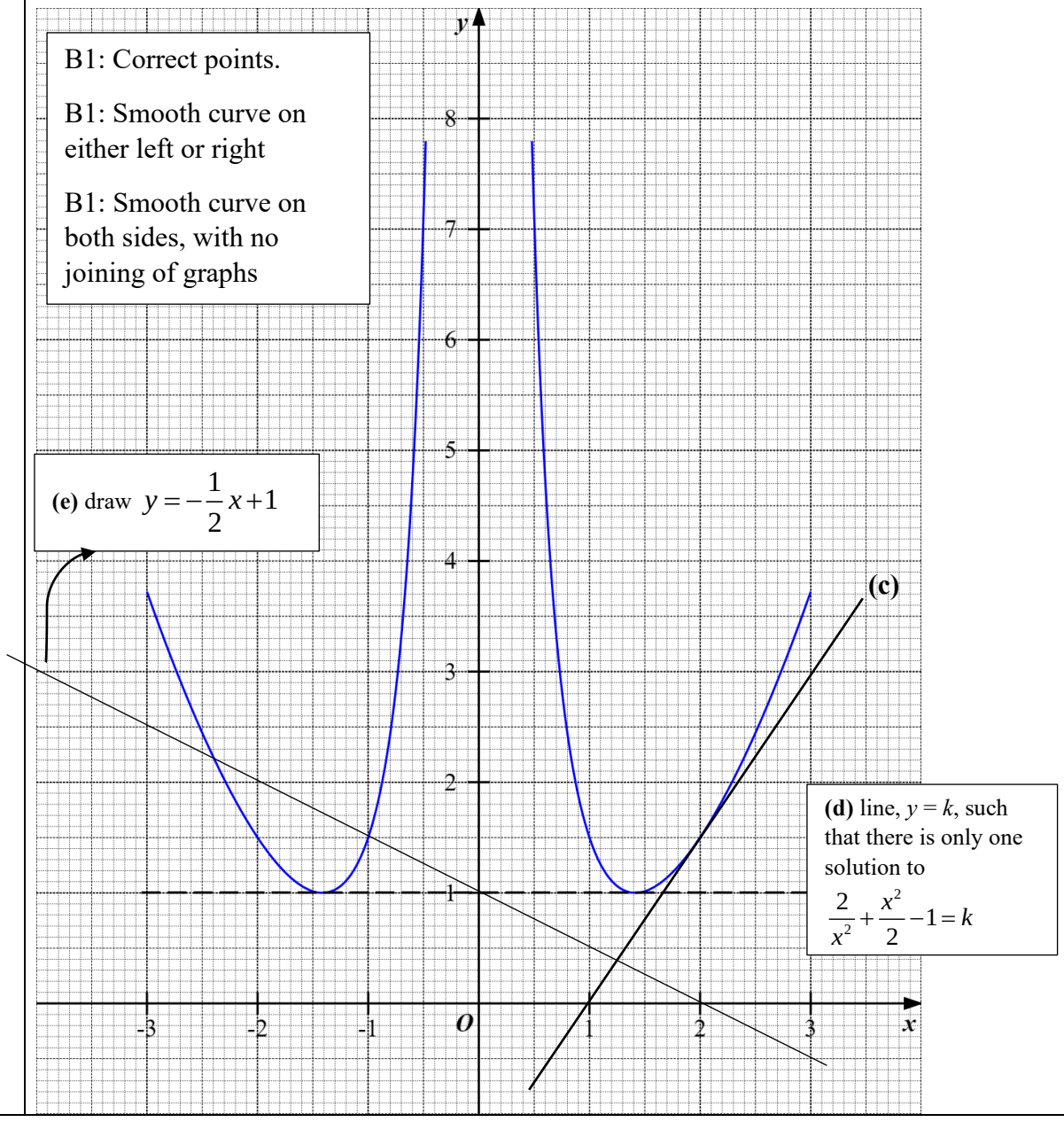
Note: Students are awarded the above only if both answers in (b)(i) are correct. Otherwise, no mark is awarded even if they somehow, were able to make the correct claims.

	Solution/ Mark Scheme
8	**(a)**

x	–3	–2	–1.5	–1	–0.5	0.5	1	1.5	2	3
y	3.7	1.5	1.0	**1.5**	7.1	7.1	**1.5**	1.0	1.5	3.7

B1 for both correct.

(b)



	(c) M1: Drawing tangent line to the curve at point (2, 1.5) $\frac{3-0}{3-1}=1.5$ Gradient: accept 1.3 to 1.7 --- [A1]
	(d) k = 0.9/ 0.95/ 1 --- [B1: accept either one]
	(e) $x^4+x^3-4x^2+4=0$ Divide throughout by x^2 $x^2+x-4+\frac{4}{x^2}=0$ $x^2-4+\frac{4}{x^2}=-x$ Divide throughout by 2 $\frac{1}{2}x^2-2+\frac{2}{x^2}=-\frac{1}{2}x$ $\frac{2}{x^2}+\frac{x^2}{2}-1=-\frac{1}{2}x+1$ --- [M1 for expression on RHS] [M1: drawing linear graph $y=-\frac{1}{2}x+1$] $x=-1.1/-1.05/-1/-0.95/-0.9$ or --- [A1] $-2.3/-2.35/-2.4/2.45/-2.5$ --- [A1]

	Solution/ Mark Scheme
9	**(a)** $\$[250 + 0.375 \times (1400 - 1000)] \times 1.564$ $= \$625.60$ --- [B1]
	(b) $\$\dfrac{2.3 + 2.7 + 2.7 + ... + 2.5 + 2.7}{12}$ --- [M1] $= \$2.57$ (2 d.p.) --- [A1]

Important note: There are two main approach: students compare prices which involves the calculation of either mean monthly fuel cost **OR** using the most expensive fuel cost of the year. Students need to be consistent in their comparison, i.e. award final A1 mark only if students compare costs using average monthly fuel with average monthly fuel or most exp. cost with most exp. cost.

(c) **Method 1: Using the mean fuel price and annual approach**

Ponda Fleet	**Toyoyo Joah**
Average monthly cost of Petrol: $\$\frac{3.4+3.6+3.5+...+3.8}{12}$ --- [M1] $=\$3.525$	
Annual fuel cost: $\$3.525\times\frac{11000}{25}$ $=\$1551$	Annual fuel cost: $\$2.57\times\frac{11000}{16}$ $=\$1766.875$ --- [M1 for either correct]
Road Tax: $\$[250+0.375\times(1500-1000)]\times1.564$ $=\$684.25$	Road Tax: $\$[475+0.75\times(2000-1600)]\times1.564$ $=\$1212.10$ --- [M1 for either correct]
Total interest: $\frac{4}{100}\times\$172000\times7=\$48160$	Total interest: $\frac{4}{100}\times\$160000\times7=\$44800$ --- [M1 for either correct]
Annual cost for paying car: $\frac{\$172000+\$48160}{7}=\$31451.43$ (2 d.p)	Annual cost for paying car: $\frac{\$160000+\$\$44800}{7}=\$29257.14$ (2 d.p)
Total cost for driving Ponda Fleet: $\$1551+\$684.25+\$31451.43=\$33686.68$ --- [A1]	Total cost for driving Ponda Fleet: $\$\$1766.875+\$1212.10+\$\$29257.14=\$32236.12$ (2.d.p.) --- [A1]

Ean should get the Toyoyo Joah as it can accommodate his whole family. The total annual cost of $32 236.12 is lower, as compared to the other car which can also accommodate the whole family, the Ponda Fleet. The Ponda Fleet would costs Ean $33 686.68 annually. --- [A1]

(c) **Method 2: Using the mean fuel price and 7-year approach**

Ponda Fleet	**Toyoyo Joah**	
Average monthly cost of Petrol: $\$\frac{3.4+3.6+3.5+...+3.8}{12}$ --- [M1] $=\$3.525$		
Annual fuel cost: $\$3.525\times\frac{11000}{25}$ $=\$1551$	Annual fuel cost: $\$2.57\times\frac{11000}{16}$ $=\$1766.875$	--- [M1 for either correct]
Road Tax: $\$[250+0.375\times(1500-1000)]\times1.564$ $=\$684.25$	Road Tax: $\$[475+0.75\times(2000-1600)]\times1.564$ $=\$1212.10$	--- [M1 for either correct]
Total interest: $\frac{4}{100}\times\$172000\times7=\$48160$	Total interest: $\frac{4}{100}\times\$160000\times7=\$44800$	--- [M1 for either correct]
Total cost for driving Ponda Fleet: $7(\$1551+\$684.25)+\$48160+\$172000=\$235806.75$ [A1]	Total cost for driving Ponda Fleet: $7(\$1766.875+\$1212.10)+\$16000+\$44800=\$225652.83$ (2.d.p.) [A1]	

Ean should get the Toyoyo Joah as it can accommodate his whole family. The total cost at the end of 7 years, $225 652.83 is lower, as compared to the other car which can also accommodate the whole family, the Ponda Fleet. The Ponda Fleet would costs Ean $235 806.75 at the end of 7 years. --- [A1]

(c) **Method 3: Using the most expensive (worst case) fuel price and annual approach**

Ponda Fleet	**Toyoyo Joah**	
Most expensive cost per month: \$3.80/*l*	Most expensive cost per month: \$2.70/*l*	---[M1 for either correct]
Annual fuel cost: $\$3.80\times\frac{11000}{25}$ $=\$1672$	Annual fuel cost: $\$2.70\times\frac{11000}{16}$ $=\$1856.25$	--- [M1 for either correct]
Road Tax: $\$[250+0.375\times(1500-1000)]\times1.564$ $=\$684.25$	Road Tax: $\$[475+0.75\times(2000-1600)]\times1.564$ $=\$1212.10$	--- [M1 for either correct]
Total interest: $\frac{4}{100}\times\$172000\times7=\$48160$	Total interest: $\frac{4}{100}\times\$160000\times7=\$44800$	--- [M1 for either correct]
Annual cost for paying car: $\frac{\$172000+\$48160}{7}=\$31451.43$ (2 d.p)	Annual cost for paying car: $\frac{\$160000+\$\$44800}{7}=\$29257.14$ (2 d.p)	
Total cost for driving Ponda Fleet: $\$1672+\$684.25+\$31451.43=\$33807.68$ --- [A1]	Total cost for driving Ponda Fleet: $\$1856.25+\$1212.10+\$\$29257.14=\$32325.49$ (2.d.p.) --- [A1]	

Ean should get the Toyoyo Joah as it can accommodate his whole family. The total annual cost of \$32 325.49 is lower, as compared to the other car which can also accommodate the whole family, the Ponda Fleet. The Ponda Fleet would costs Ean \$33 807.68 annually. --- [A1]

(c) **Method 4: Using the most expensive (worst case) fuel price and 7-year approach**

Ponda Fleet	**Toyoyo Joah**	
Most expensive cost per month: \$3.80/*l*	Most expensive cost per month: \$2.70/*l*	---[M1 for either correct]
Annual fuel cost: $\$3.80\times\frac{11000}{25}$ $=\$1672$	Annual fuel cost: $\$2.70\times\frac{11000}{16}$ $=\$1856.25$	--- [M1 for either correct]
Road Tax: $\$[250+0.375\times(1500-1000)]\times1.564$ $=\$684.25$	Road Tax: $\$[475+0.75\times(2000-1600)]\times1.564$ $=\$1212.10$	--- [M1 for either correct]
Total interest: $\frac{4}{100}\times\$172000\times7=\$48160$	Total interest: $\frac{4}{100}\times\$160000\times7=\$44800$	--- [M1 for either correct]
Total cost for driving Ponda Fleet: $7(\$1672+\$684.25)+\$48160+\$172000=\$236653.75$ [A1]	Total cost for driving Ponda Fleet: $7(\$1856.25+\$1212.10)+\$44800+\$160000=\$226278.45$ [A1]	

Ean should get the Toyoyo Joah as it can accommodate his whole family. The total cost of \$226 278.45 at the end of 7 years is lower, as compared to the other car which can also accommodate the whole family, the Ponda Fleet. The Ponda Fleet would costs Ean \$236 653.75 at the end of 7 years. --- [A1]