Solutions

1(a)	$-\frac{2x+1}{3} \le \frac{3x-1}{-5}$ $-\frac{2x+1}{3} \le -\frac{3x-1}{5}$ $5(2x+1) \ge 3(3x-1)$ $10x+5 \ge 9x-3$ $x \ge -8$	 M1 A1
1(b)	$-\frac{x}{1-3x}+\frac{7}{(3x-1)^2}$ $=\frac{x}{3x-1}+\frac{7}{(3x-1)^2}$ $=\frac{x(3x-1)}{(3x-1)^2}+\frac{7}{(3x-1)^2}$ $=\frac{x(3x-1)+7}{(3x-1)^2}$ $=\frac{3x^2-x+7}{(3x-1)^2}$ **Alt method** $-\frac{x}{1-3x}+\frac{7}{(3x-1)^2}$ $=-\frac{x}{1-3x}+\frac{7}{(1-3x)^2}$ $=\frac{7}{(1-3x)^2}-\frac{x(1-3x)}{(1-3x)^2}$ $=\frac{7-x+3x^2}{(3x-1)^2}$ $=\frac{3x^2-x+7}{(3x-1)^2}$	 M1 M1 A1 M1 M1 A1

1(c)	$5x = 49 - 4y ----------(1)$ $4x - 5y = -10 ---------(2)$ From (1) : $5x + 4y = 49 ------(3)$ $(3)\times 4 : 5x + 4y = 49 ---------(4)$ $(2)\times 5 : 20x - 25y = -50 ------(5)$ $(4)-(5):$ $16 - (-25y) = 196 - (-50)$ $41y = 246$ $y = 6$ Subt $y = 6$ into (1) $5x = 49 - 4(6)$ $5x = 25$ $x = 5$ **Ans $x = 5$, $y = 6$**	M1 A1 A1
1(d)	$\left(\frac{h^{15}}{64f^{12}}\right)^{-\frac{2}{3}} = \left(\frac{64f^{12}}{h^{15}}\right)^{\frac{2}{3}}$ $= \left(\frac{64f^{12}}{h^{15}}\right)^{\frac{2}{3}}$ $= \frac{16f^{8}}{h^{10}}$	M1 A1
2(a)	$\begin{pmatrix} 164 & 144 & 50 \\ 128 & 90 & 40 \end{pmatrix}$	B1
2(b)	$\begin{pmatrix} 30 \\ 25 \\ 20 \end{pmatrix}$	B1
2(c)	**AP** $= \begin{pmatrix} 164 & 144 & 50 \\ 128 & 90 & 40 \end{pmatrix}\begin{pmatrix} 30 \\ 25 \\ 20 \end{pmatrix}$ $= \begin{pmatrix} 9520 \\ 6890 \end{pmatrix}$ $(1\ 1)$**AP** $= (1\ \ 1)\begin{pmatrix} 9520 \\ 6890 \end{pmatrix}$ $= (16\ 410)$	M1 A1

	The element 16410 represents the total amount collected from the sales of tickets for Saturday and Sunday for the 1st weekend.	**B1**
2(d)(i)	$\begin{pmatrix} 1.25 & 0 & 0 \\ 0 & 1.5 & 0 \\ 0 & 0 & 0.8 \end{pmatrix}$	**B1**
2(d)(ii)	Each element in matrix **FP** represents **the total amount collected from the sales of tickets for Saturday and Sunday respectively** for the 2nd weekend.	**B1**
3(a)	By sine rule, $\frac{BD}{\sin 85°} = \frac{9}{\sin 30°}$ $BD = 17.9315$ (6s.f) BD = 17.9 m (3 s.f)	**M1** **A1**
3(b)	$\cos \measuredangle BDA = \frac{6^2 + 17.9315^2 - 14.5^2}{2(6)(17.9315)}$ $= 46.8039°$ (4 d.p) Bearing = 180° + 46.8039° = 226.804° = 226.8°	**M1** **M1** **A1**
3(c)	Note : Greatest angle of elevation/depression occurs at shortest distance *CX*. In triangle DCX, $\sin 65° = \frac{CX}{9}$ $CX = 9 \sin 65°$ Let θ be the greatest angle of elevation $\tan \theta = \frac{12}{9 \sin 65°}$ $\theta = 55.7948°$ (4 d.p) $\theta = 55.8°$ (1 d.p) Students may use area of triangle to find *CX*.	 **M1** **M1** **A1**
4(a)	Vol. of container = $\pi(1.5)^2(10) + \frac{1}{2}\pi(1.5)^2(2)$ $= 75.3982$ cm^3 (4 s.f) $= 75.4$ cm^3 (3 s.f)	**M1, M1 for each working** **A1**

4(b)	Vol. of water = $\frac{75}{100}\times 75.3982$ =56.5487 (4 s.f) Height of water = $\frac{56.5487}{\pi(1.5)^2}$ = 8.00 cm d = 10 + 2 – 8.0000 = 4.00 (3 s.f)	**M1** **M1** **A1**
4(c)	Let the height of pyramid be h cm. $\frac{1}{3}\times 4\times 4\times h = 56.5487$ $h = 10.6029$ (6 s.f) $h = 10.6$ cm (3 s.f)	**M1** **A1**
4(d)	Time = $\left[1-\left(\frac{2}{3}\right)^3\right]x$ $= \frac{19}{27}x$ minutes Accept $\frac{1}{27}x$ minutes (as students may see it in another perspective)	**B1**
5(a)	P = – 0.05	**B1**
5(b)	Refer to graph paper	
5(c)	The graph $y=\frac{x^2}{7}+\frac{2}{x}-2$ **cuts the** x**-axis at 2 points.** Hence, $\frac{x^2}{7}+\frac{2}{x}-2=0$ has 2 solutions	**B1**
5(d)	Accurate tangent line drawn Gradient = $\frac{1.8}{1.8}$ = 1 (accepts 1.02 ± 0.05)	**M1** **A1**
5(e)	$x^3+7x^2-28x+14=0$ $x^2+7x-28+\frac{14}{x}=0$ $\frac{x^2}{7}+x-4+\frac{2}{x}=0$ $\frac{x^2}{7}+\frac{2}{x}-2=-x+2$ Line $y = 2 - x$ drawn From graph, $\underline{x=2.35}\pm 0.05$	**M1** **M1** **A1**

6(a)(i)	$\measuredangle OBI = 90°$ (tan perpendicular rad) $\measuredangle OCI = 90°$ (tan perpendicular rad) OI is a common line. $OB = OC$ (radii of the same circle) By **RHS,** triangle *OBI* is congruent to triangle *OCI*.	**M1** **A1**
6(a)(ii)(a)	$\measuredangle DCB = 180 - (62 + 70)$ ($\measuredangle$in opposite segment) $= 48°$	**B1**
6(a)(ii)(b)	$\measuredangle GCE = \measuredangle GAB$ $= 62°$ ($\measuredangle$in the same segment) $OC = OE$ (radii of the same circle) $\measuredangle OCE = \measuredangle OEC = 76°$ (base of isos triangle) $\measuredangle GOC = 76 - 62$ $= 14°$ Accepts other methods (eg. Find angle *OBC* first)	**M1** **A1**
6(a)(ii)(c)	$\measuredangle OCH = 90°$(tan perpendicular rad) $\measuredangle BCH = 90 + 14$ $= 104°$	**B1**
(b)	Major arclength $= (2\pi - 2.18) \times 8$ $= 16\pi - 17.44$ $AD^2 = 8^2 + (8+3.6)^2 - 2(8)(8+3.6)\cos 2.18$ $AD =$ 17.4575 (6s.f) Perimeter = $16\pi - 17.44 + 3.6 +$ 17.4575 = 53.9 cm (3 s.f)	**M1** **M1** **M1** **A1**
(c)	$\dfrac{\text{area of sector ABCO}}{\text{area of triangle AOD}} = \dfrac{\frac{1}{2} \times (8)^2 \times (2\pi - 2.18)}{\frac{1}{2} \times (8) \times (8+3.6)\sin 2.18}$ = 3.45052 (5 d.p) = 3.45 (2 d.p)	**M1 for denominator** **M1 for numberator** **A1**
7(a)	Mean $= \dfrac{22(8) + 26(10) + 30(21) + 34(7) + 38(4)}{50}$ =29.12 minutes $\dfrac{\sum fx^2}{N} = \dfrac{8(22)^2 + 10(26)^2 + 21(30)^2 + 7(34)^2 + 4(38)^2}{50}$ $= 868$ Standard deviation = $\sqrt{868 - 29.12^2}$ = 4.474997	**M1** **M1** **A1**
7(b)	The **mean waiting time for hospital A** and hospital **are the same (29.12 min).** Hence, the average waiting time is generally the same for both hospital.	**B1**

	However, the **standard deviation for waiting times in hospital B (3.2 min) is lower than the waiting times in hospital A (4.47 min)**. Hence, the waiting times in hospital B are more consistent.	**B1**
7(c)	P(required) $= \frac{8}{50}\times\frac{11}{49}+\frac{11}{50}\times\frac{8}{49}$ $= \frac{88}{1225}$ Accepts other relevant method	**M1** **A1**
8(a)(i)	$-\underset{\sim}{a}+\underset{\sim}{b}$	**B1**
8(a)(ii)	$\overrightarrow{CD}=\overrightarrow{CO}+\overrightarrow{OD}$ $=\frac{2}{3}(-\underset{\sim}{a})+\frac{1}{2}(\underset{\sim}{b})$ $=-\frac{2}{3}\underset{\sim}{a}+\frac{1}{2}\underset{\sim}{b}$ $\overrightarrow{CE}=\frac{1}{2}\left(-\frac{2}{3}\underset{\sim}{a}+\frac{1}{2}\underset{\sim}{b}\right)$ $=-\frac{1}{3}\underset{\sim}{a}+\frac{1}{4}\underset{\sim}{b}$	**M1** **A1**
8(b)(i)	$\overrightarrow{OF}=\overrightarrow{OA}+\overrightarrow{AF}$ $=\underset{\sim}{a}+m(-\underset{\sim}{a}+\underset{\sim}{b})$ $=(1-m)\underset{\sim}{a}+m\underset{\sim}{b}$	**M1** **A1**
8(b)(ii)	$\overrightarrow{OE}=\frac{3}{5}\overrightarrow{OF}$ Since $\overrightarrow{OE}$ is a scalar multiple of $\overrightarrow{OF}$ and there is a common point *O*, *O, E* and *F* lie on a straight line.	**M1** **A1**
8(c)(i)	$\frac{\text{area of triangle AEC}}{\text{area of triangle OEC}}=\frac{\frac{1}{2}\times1\times h}{\frac{1}{2}\times2\times h}$ $=\frac{1}{2}$	**B1**
8(c)(ii)	$\frac{\text{area of triangle OCD}}{\text{area of triangle OAD}}=\frac{\text{area of triangle OCD}}{\text{area of triangle OAD}}\times\frac{\text{area of triangle OAD}}{\text{area of triangle OAB}}$ $=\frac{2}{3}\times\frac{1}{2}$ $=\frac{1}{3}$ **Accepts other methods**	**B1**
9(a)	Time taken by Ali $=\frac{42}{x}$ h Time taken by Robert $=\frac{42}{x-2}$ h	

	$\frac{42}{x-2}-\frac{42}{x}=\frac{1}{2}$ $\frac{42x-42(x-2)}{x(x-2)}=\frac{1}{2}$ $\frac{84}{x(x-2)}=\frac{1}{2}$ $x(x-2)=168$ $x^2-2x-168=0$	**M1** ($\frac{42}{x}$ and $\frac{42}{x-2}$ seen) **M1** **M1** **M1 (able to reduce)**
9(b)	$x^2-2x-168=0$ $(x+12)(x-14)=0$ $x=-12$ *or* $x=14$ Accept by Formula method	**M1** **A1**
9(c)	Since x represents speed, x cannot be negative.	**B1**
9(d)	Time taken = $\frac{42}{14-2}$ $=3.5$ h	**B1**
10(a)	Total time taken = 13 h 50 min + 2 h = 15h 50 min Time = 8.05 am	**B1**
10(b)	Total per day = £25 + £10 + £15 = £50 Total for 6 days = 6×50 = £300 Assuming that he needs to save 10% of the total amount of \$700 Total planned spending = $300(1.65)+\frac{10}{100}\times700$ = \$565 **Sufficient** Alternative Solutions : Assuming that he needs to save 10% of the total amount planned for 6 days : Total planned spending = $300(1.65)+\frac{10}{100}\times(300\times1.65)$ = \$544.50	**M1** **M1** **A1** **M1***

10(c)	Budget = 15×4 =£60 **Option A** Full price = £60 Discount = $\frac{5}{100} \times 90$ = £4.50 Final cost = 60 - 4.50 = £55.50 Exceed budget **Option B** 8 attractions $\times 12.50$ =£100 Exceed budget **Option C** 2 day pass = £35 Remaining 2 days = 4 attractions $\times 6$ =£24 Total cost = £35 + £24 =£59 Cover all attractions with sufficient budget. Money left = £60 – £59 = £1 I would recommend C. It meets all her sightseeing needs at the lowest cost and meeting her budget of \$60.	**M1** **M1** **M1** **M1** **A1**