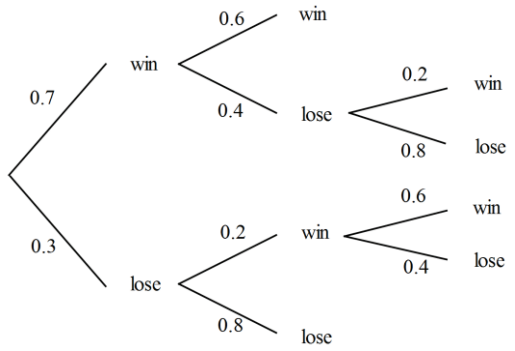
Question Number	Scheme	Marks
1 (a)		B1 B1 B1
		(3)
(b)	$0.7\times0.6=0.42$ oe	M1 A1
		(2)
(c)	$'0.42'+(0.7\times'0.4'\times'0.2')+('0.3'\times'0.2'\times'0.6')=0.512$ oe	M1 A1
		(2)
(d)	$\frac{'0.42'}{'0.512'}=0.8203...$ oe awrt 0.820	M1 A1ft
		(2)
(e)	$\frac{'0.42'+(0.7\times'0.4'\times'0.2')}{0.7}=0.68$ oe or $0.6+'0.4'\times'0.2'=0.68$ oe	M1 A1
		(2)

	Notes	Total 11
(a)	**B1**	For 0.3 in the correct place on the first branch and 0.4 in the correct place on the second branch
	B1	For 0.2 and 0.8 in the correct place in the second branch
	B1	For 0.2, 0.8, 0.6 and 0.4 in the correct place in the third branch
		NB ISW any extra branches drawn on the tree diagram
(b)	**M1**	For 0.7×0.6
	A1	Cao
(c)	**M1**	For $'0.42'+(0.7\times'0.4'\times'0.2')+('0.3'\times'0.2'\times'0.6')$ Follow through part (b) and their tree diagram
	A1	Cao
(d)	**M1**	For $\frac{\text{part (b)}}{\text{part (c)}}$ provided the answer is a probability or ft their tree diagram
	A1ft	awrt 0.820 or ft part (b) and part (c) provided the answer is a probability or ft their tree diagram. Allow 0.82 If ft and a decimal answer is given then this must be at least 3sf
(e)	**M1**	For a correct ratio of probabilities. Follow through their part (b) and their tree diagram or $0.6+'0.4'\times'0.2'$ ft their tree diagram
	A1	Cao Allow 0.680

Question Number	Scheme	Marks
2 (a)(i)	$Q_2 = 57$	B1
(ii)	$Q_1 = 45$ $Q_3 = 63$	B1 B1
		(3)
(b)	'63'+1.5('63'−'45')[=90] or '45'−1.5('63'−'45')[=18]	M1
	= 90 or = 18	A1ft
	16 and 94 [are outliers]*	A1*
		(3)
(c)	A boxplot drawn with 2 whiskers	M1
	Q_1, Q_2 and Q_3 plotted correctly	A1ft
	Whiskers drawn correctly	A1ft
	Outliers marked at 16 and 94	A1
		(4)
(d)	The **median/Q_2** for February is less/lower than the **median/Q_2** for December oe	B1ft
	The **IQR/range** for February is less/lower than December (allow similar) oe	B1ft
	For a correct interpretation of either average or spread e.g. • on average February weigh less than December oe • the weights of February are less varied/little change in variability than the weights of December oe • They weighed more later in the year oe • Most of the distribution has shifted right, implying that most kangaroos have gained weight but some appear to have lost weight.	B1ft
		(3)

	Notes	**Total 13**
(a)(i)	**B1**	Cao
(ii)	**B1**	Cao
	B1	Cao
(b)	**M1**	For use of either $Q_3 + 1.5(Q_3 - Q_1)$ or $Q_1 - 1.5(Q_3 - Q_1)$ ft part (a)
	A1ft	For either 90 or 18 ft part (a)
	A1*	For identifying both outliers with no incorrect/missing working (This can ft part (a))
(c)	**M1**	A boxplot drawn with 2 whiskers
	A1ft	For Q_1, Q_2 and Q_3 plotted correctly ft part (a)
	A1ft	Whiskers drawn at 18 and 90 ft part (b) **or** 23 and 86
	A1	Outliers marked at 16 and 94
(d)	**B1ft**	A correct comparison of medians ft their boxplot drawn or part (a) (No figures are required but if quoted then they need to be correct ft) Must mention the word median/Q_2
	B1ft	A correct comparison of range/IQR ft their boxplot drawn or part (a) (No figures are required but if quoted then they need to be correct ft) Must mention either IQR or range
	B1ft	A correct interpretation of either the average or the spread ft their boxplot drawn or part (a)
		NB Ignore any reference to skew or outliers

Question Number	Scheme	Marks
3 (i) (a)	$w = 0.15$	B1
	$x = 0.7 - 0.15 = 0.55$	B1
	$y = 0.65 - 0.55 = 0.1$	B1
	$z = 1 - 0.15 - 0.55 - 0.1 = 0.2$	B1
		(4)
(b)	$'0.15' + '0.1' = '0.25'$	B1ft
		(1)
(c)	$[\mathrm{P}(C) \times \mathrm{P}(O)] = '0.65' \times '0.7' \neq '0.55' [= \mathrm{P}(C \cap O)]$ or $[\mathrm{P}(C \mid O) =] \dfrac{'0.55'}{'0.7'} \neq '0.65' [= \mathrm{P}(C)]$ oe	M1
	$'0.455' \neq '0.55'$ or $'0.7857'... \neq '0.65'$ [So not independent]*	A1*
		(2)
3 (ii) (a)		
	$\left[P(F \cup H) = \dfrac{2}{7} + \dfrac{1}{4} = \right] \dfrac{15}{28}$	B1
		(1)
(b)	$\dfrac{5}{8} = \dfrac{2}{7} + \mathrm{P}(G) - \dfrac{2}{7}\mathrm{P}(G)$	M1
	$\mathrm{P}(G) = \dfrac{\frac{5}{8} - \frac{2}{7}}{1 - \frac{2}{7}} = \dfrac{19}{56} \div \dfrac{5}{7}$	dM1
	$\mathrm{P}(G) = \dfrac{19}{40}$	A1
		(3)
(c)	$\left[P(F \cap G) = \dfrac{2}{7} \times '\dfrac{19}{40}' = \right] \dfrac{19}{140}$	B1ft
		(1)

	Notes		**Total 12**
(i)(a)	**B1**	$w = 0.15$ If answer is given in the script and the Venn diagram, then mark the script	
	B1	$x = 0.55$ If answer is given in the script and the Venn diagram, then mark the script	
	B1	$y = 0.1$ If answer is given in the script and the Venn diagram, then mark the script	
	B1	$z = 0.2$ If answer is given in the script and the Venn diagram, then mark the script	
(b)	**B1ft**	For $w + y = '0.25'$ follow through their w and their y (You will need to check for their values) provided this is a probability	
(c)	**M1**	For $'(x+y)' \times '(w+x)' \neq 'x'$ or $\dfrac{'x'}{'w+x'} \neq 'x+y'$ ft their w, x and y	
	A1*	A fully correct solution with values evaluated and no errors ft their w, x and y	
(ii) (a)	**B1**	For $\dfrac{15}{28}$ oe Allow awrt 0.536	
(b)	**M1**	For use of $\mathrm{P}(F \cup G) = \mathrm{P}(F) + \mathrm{P}(G) - \mathrm{P}(F) \times \mathrm{P}(G)$	
	dM1	Dependent on M1. For a correct rearrangement to find $\mathrm{P}(G)$ e.g. $\left(\dfrac{5}{8} - \dfrac{2}{7}\right) \div \left(1 - \dfrac{2}{7}\right)$ Allow $\dfrac{19}{56} = \dfrac{5}{7}\mathrm{P}(G)$ May be implied by $\dfrac{19}{40}$	
	A1	For $\dfrac{19}{40}$ oe	
(c)	**B1ft**	For $\dfrac{19}{140}$ oe or $\dfrac{2}{7} \times \mathrm{P}(G)$ evaluated correctly and where $\mathrm{P}(G)$ is a probability	

Question Number	Scheme	Marks
4 (a)	$\mathrm{E}\left(\frac{1}{X}\right)=1\times\frac{1}{10}+\frac{1}{2}\times\frac{1}{5}+\frac{1}{3}\times\frac{3}{10}+\frac{1}{4}\times\frac{2}{5}=\frac{2}{5}$ *	B1*
		(1)
(b)	$\mathrm{E}\left(\left(\frac{1}{X}\right)^2\right)=1^2\times\frac{1}{10}+\left(\frac{1}{2}\right)^2\times\frac{1}{5}+\left(\frac{1}{3}\right)^2\times\frac{3}{10}+\left(\frac{1}{4}\right)^2\times\frac{2}{5}\left[=\frac{5}{24}\right]$	M1
	$\mathrm{Var}\left(\frac{1}{X}\right)=\frac{5}{24}-\left(\frac{2}{5}\right)^2=\frac{29}{600}$	M1 A1
		(3)
(c) (i)	$[\mathrm{E}(Y)=]12$	B1
(ii)	$[\mathrm{Var}(Y)=]30^2\,'\mathrm{Var}\left(\frac{1}{X}\right)'=\frac{87}{2}$ or If y : 30 15 10 7.5 then $[\mathrm{Var}(Y)=]\frac{375}{2}-12^2=\frac{87}{2}$	M1 A1
		(3)
(d)	$[Y<20\Rightarrow]\frac{30}{X}<20\Rightarrow X>1.5$ or y : 30 15 10 7.5	M1
	$\mathrm{P}(Y<20)=\mathrm{P}(X>1.5)=\frac{9}{10}$	A1
	$[\mathrm{P}(X<3\,\vert\,Y<20)=]\frac{\mathrm{P}(X=2)}{\mathrm{P}(X>1.5)}=\frac{\frac{1}{5}}{'\left(\frac{9}{10}\right)'}=\frac{2}{9}$ or $[\mathrm{P}(X<3\,\vert\,Y<20)=]\frac{\mathrm{P}(Y=15)}{\mathrm{P}(Y<20)}=\frac{\frac{1}{5}}{'\left(\frac{9}{10}\right)'}=\frac{2}{9}$	dM1 A1 A1
		(5)

	Notes	Total 12
(a)	**B1***	Value given, so must see sight of a correct expression, with no incorrect working seen. (Allow equivalent expressions.)
(b)	**M1**	For attempt at an expression for $\mathrm{E}\left(\left(\frac{1}{X}\right)^2\right)$ with at least 3 correct terms (Allow equivalent expressions.) May be embedded in a correct expression for Var (X)
	M1	For a correct expression for $\mathrm{Var}\left(\frac{1}{X}\right)$ (Need not be simplified) ft a stated value of $\mathrm{E}\left(\left(\frac{1}{X}\right)^2\right)$
	A1	Cao Allow awrt 0.0483
(c) (i)	**B1**	For [E(Y)] = 12
(ii)	**M1**	For correct use of $30^2\,\mathrm{Var}\left(\frac{1}{X}\right)$ ft their $\mathrm{Var}\left(\frac{1}{X}\right)$ or $\frac{375}{2}-12^2$ (May be implied by $\frac{87}{2}$ oe)
	A1	For $[\mathrm{Var}(Y)=]\frac{87}{2}$ oe
(d)	**M1**	For a correct inequality for $Y<20$ or all 4 values of Y found (these may be seen in part (c))
	A1	For $\mathrm{P}(Y<20)=\frac{9}{10}$ (May be seen as the denominator (e.g 0.2 + 0.3 + 0.4 oe) in a ratio of probabilities and scores M1A1)
	dM1	Dependant on 1st M1 For $\frac{\mathrm{P}(X=2)}{\mathrm{P}(X>1.5)}$ or $\frac{\mathrm{P}(Y=15)}{\mathrm{P}(Y<20)}$ Allow $\frac{\mathrm{P}(1.5<X<3)}{\mathrm{P}(X>1.5)}$ or a correct ratio of probabilities ft $\mathrm{P}(Y<20)$
	A1	For a correct numerator
	A1	For $\frac{2}{9}$ oe (Allow a decimal answer that is 3sf or better e.g. 0.222)

Question Number	Scheme	Marks
5 (a)	$X \sim N(210, 25^2)$	
	$P(X < 240) = P\left(Z < \frac{240-210}{25}\right)\left[= P(Z < 1.2)\right]$	M1
	$= 0.8849$*	A1*
		(2)
(b)	$P(190 < X < 240) = 0.8849 - P\left(Z < \frac{190-210}{25}\right)\left[= 0.8849 - P(Z < -0.8)\right]$	M1
	$0.8849 - 0.2119 = 0.673$ awrt 0.673	A1
		(2)
(c)	$\frac{210+k-210}{25} = 1.96$ or $\frac{210-k-210}{25} = -1.96$	M1 B1
	$k = 49$ awrt 49	A1
		(3)
(d)	$P(X < S) = 0.15 \Rightarrow \frac{S-210}{25} = -1.0364$	M1 B1
	$S = 184.09$ awrt 184	A1
		(3)
(e)	$Y \sim N(\mu, \sigma^2)$	
	$P(Y < 152) = 0.05 \Rightarrow \frac{152-\mu}{\sigma} = -1.6449$	M1 A1
	$P(Y > 180) = 0.40 \Rightarrow \frac{180-\mu}{\sigma} = 0.2533$	A1
	$28 = 1.8982\sigma$	dM1
	$\sigma = 14.75...$ and $\mu = 176.26...$	A1
		(5)
	Notes	**Total 15**

(a)	**M1**	For standardising using 240, 210 and 25
	A1*	Cao As the answer is given then no incorrect working should be seen
(b)	**M1**	For standardising using 190/230, 210 and 25 and subtracting from 0.8849 May be implied by $\Phi(1.2) + \Phi(0.8) - 1$ or 0.8849 + 0.7881 – 1
	A1	awrt 0.673
(c)	**M1**	For standardising and setting equal to a z value, where $1.9 < \lvert z \rvert < 2$
	B1	For $\lvert z \rvert = 1.96$ or better
	A1	awrt 49
(d)	**M1**	For standardising using S (allow any letter) and setting equal to a z value, where $1 < \lvert z \rvert < 1.1$
	B1	For z = -1.0364
	A1	awrt 184
(e)	**M1**	For a correct method to form an equation in μ and σ set equal to a z value, where $-1.6 < z < -1.7$ or $0.2 < z < 0.3$ (Signs must be compatible)
	A1	For a correct equation for $P(Y < 152)$
	A1	For a correct equation for $P(Y > 180)$
	dM1	Dependent on previous M mark. For solving the 2 equations simultaneously. If answers are incorrect then working must be shown. May be implied by $\sigma =$ awrt 14.8 and $\mu =$ awrt 176
	A1	For $\sigma =$ awrt 14.8 and $\mu =$ awrt 176

Question Number	Scheme	Marks
6 (a)(i)	$x = 1.2 + 0.2(1.4x + 1.5)$ o.e or $y = 1.4(1.2 + 0.2y) + 1.5$ o.e	M1
	$x = \frac{25}{12}$ $y = \frac{53}{12}$	A1A1
(ii)	$\left[\sum x = \right] \frac{25}{12} \times 12 \left[= 25\right]$	A1*
		(4)
(b)	$\left[\sum y = \right]' \left(\frac{53}{12}\right)' \times 12 = 53$	M1A1ft
	$S_{xy} = \frac{6961}{60} - \frac{(25 \times '53')}{12} = 5.6$	M1 A1
		(4)
(c)	$\frac{'5.6'}{S_{xx}} = 1.4$ and $\frac{'5.6'}{S_{yy}} = 0.2$ $S_{xx} = 4$ and $S_{yy} = 28$ $r = \frac{'5.6'}{\sqrt{'4' \times '28'}} = 0.5291...$ $\frac{'5.6'}{\sqrt{\frac{'5.6'}{1.4} \times \frac{'5.6'}{0.2}}}$ $\frac{5.6}{\frac{5.6}{\sqrt{1.4 \times 0.2}}}$ $\sqrt{1.4 \times 0.2} = 0.5291$ $\frac{S_{xy}}{S_{xx}} = 1.4$ and $\frac{S_{xy}}{S_{yy}} = 0.2$ $r^2 = 1.4 \times 0.2$	M1 A1 M1 dA1
	awrt 0.529	
		(4)

	Notes	Total 12
(a)(i)	**M1**	For either of the two equations o.e or an attempt to solve the two equations simultaneously. May be implied by $x = \frac{25}{12}$ / 2.08 or better or $y = \frac{53}{12}$ / 4.42 or better
	A1	For either $x = \frac{25}{12}$ / 2.08 or better or $y = \frac{53}{12}$ / 4.42 or better
	A1	For both $x = \frac{25}{12}$ / 2.08 or better and $y = \frac{53}{12}$ / 4.42 or better (May be written as a coordinate) **NB This is M1 on EPEN**
(ii)	**A1***	For $\frac{25}{12} \times 12$ Allow use of $\sum x$ rather than $\bar{x}$ e.g. $\sum x = 14.4 + 0.2\left(1.4\sum x + 18\right)$ oe As the answer is given no incorrect working must be seen. **NB Working must be shown**
(b)	**M1**	For $'\left(\frac{53}{12}\right)' \times 12$ ft their y coordinate. Allow use of $\sum y$ rather than $\bar{y}$ e.g. $\sum y = 1.4\left(14.4 + 0.2\sum y\right) + 18$ oe
	A1ft	For $\sum y = 53$ or ft their y coordinate × 12 (An answer of exactly 5.6 implies M1A1)
	M1	Use of $S_{xy} = \frac{6961}{60} - \frac{25 \times '\sum y'}{12}$ ft their $\sum y$ If $\sum y$ is not stated then M0 is awarded
	A1	5.6 (Allow awrt 5.6)

(c)	**M1**	For use of the gradient to find S_{xx} and S_{yy} ft their S_{xy} or use of $\frac{S_{xy}}{\sqrt{\frac{S_{xy}}{1.4}\times\frac{S_{xy}}{0.2}}}$ or setting both $\frac{S_{xy}}{S_{xx}}$ and $\frac{S_{xy}}{S_{yy}}$ equal to their respective gradients
	A1	$S_{xx}=4$ and $S_{yy}=28$ or $\frac{S_{xy}}{\sqrt{S_{xy}}}$ or $\frac{(S_{xy})^2}{S_{xx}\times S_{yy}}=1.4\times0.2$
	M1	For a correct expression for *r* ft their S_{xy}, S_{xx} and S_{yy} or $\sqrt{1.4\times0.2}$ If answer is incorrect then you must see their stated values substituted into a correct expression for *r*. An answer of $\frac{\sqrt{7}}{5}$ implies M1A1M1 only
	dA1	Dependant on all previous marks being awarded. awrt 0.529