January 2018

Question	Scheme	Marks
3. (a)	$[\mathrm{f}(d) =]\begin{cases} \frac{1}{5} & -2.5 \le d \le 2.5 \\ 0 & \text{otherwise} \end{cases}$	B1 B1 (2)
(b)	$\sqrt{\dfrac{(2.5-(-2.5))^2}{12}} = 1.4433...$ **awrt <u>1.44</u>**	M1 A1 (2)
(c)	0	B1 (1)
(d)	$\left[\dfrac{1-(-1)}{5}\right] = \dfrac{2}{5}$	B1 (1)
(e)	X~B(10, '0.4') $[\mathrm{P}(X \ge 6) =]1 - \mathrm{P}(X \le 5) = 1 - 0.8338 = 0.1662$ **awrt <u>0.166</u>**	M1 M1 A1 (3) **Total 9**

June 2018

Question Number	Scheme	Marks
3.(a)	$(102-100)p = \dfrac{1}{3}$ <u>or</u> $\dfrac{102-100}{k-100} = \dfrac{1}{3}$ <u>or</u> $\dfrac{k-102}{k-100} = \dfrac{2}{3}$ <u>or</u> $(k-100)p = 1$ (o.e.)	M1
	$p = \dfrac{1}{6}$ so $(k-100)\dfrac{1}{6} = 1$	dM1
	$k-100 = 6$ therefore $k = 106$ *	A1cso (3)
(b)(i)	$\dfrac{5}{6}$ (or exact equivalent)	B1
(ii)	0	B1 (2)
(c)	103	B1 (1)
(d)	$\dfrac{r-100}{6} = 0.15$	M1
	= **<u>100.9</u>**	A1 (2)
(e)	$3\mathrm{P}(X \leqslant x-1.5) = \mathrm{P}(X \geqslant x+1.5)$ so $\dfrac{3}{6}(x-1.5-100) = \dfrac{1}{6}(106-x-1.5)$	M1
	$[3(x-1.5-100) = (106-x-1.5)]$ implies $4x - 304.5 = 104.5$ (o.e.)	dM1
	$x =$ **<u>102.25</u>** (o.e.)	A1 (3)

October 2018

Question	Scheme	Marks
6.(a)	$a = 4 \times(-0.5)$ and $b = 4 \times 0.5$	B1 (1)
(b)(i)	$\sqrt{\dfrac{(2-(-2))^2}{12}} = \dfrac{2\sqrt{3}}{3} = 1.1547...$ awrt $\underline{\mathbf{1.15}}$	M1 A1
(ii)	$[\text{P}(-\tfrac{2\sqrt{3}}{3} < W < \tfrac{2\sqrt{3}}{3}) =] \dfrac{\tfrac{2\sqrt{3}}{3} - (-\tfrac{2\sqrt{3}}{3})}{2-(-2)} = \dfrac{\sqrt{3}}{3} = 0.57735...$ awrt $\underline{\mathbf{0.577}}$	M1 A1 (4)
(c)	$\text{P}(W > 1.9) = \frac{2-1.9}{2-(-2)}$ $[=0.025]$ $X \sim \text{B}(100, 0.025)$ $\rightarrow \text{Po}(2.5)$ $\text{P}(X \geq 5) = 1 - \text{P}(X \leq 4) = 1 - 0.8912 = 0.1088$ awrt $\underline{\mathbf{0.109}}$	M1 M1 M1 A1 (4) **Total 9**

January 2019

Question Number	Scheme	Marks
5. (a)(i)	$\dfrac{(b-2a)-a}{b-a} = \dfrac{1}{3}$ $3(b-3a) = (b-a)$ $b = 4a$ $\text{E}(X) = \dfrac{a+4a}{2} = \dfrac{5a}{2}*$ or $\dfrac{b-(b-2a)}{b-a} = \dfrac{2}{3}$ $6a = 2(b-a)$ $b = 4a$ $\text{E}(X) = \dfrac{a+4a}{2} = \dfrac{5a}{2}*$ oe	M1 M1A1cso (3)
(ii)	$[[\text{P}(X > b-4a) = \text{P}(X > 0) =]$ 1	B1 (1)
(b)(i)	$\dfrac{(c-3)^2}{12} = 3c - 9$ $c^2 - 42c + 117 = 0 \rightarrow (c-3)(c-39) = 0$ $\underline{\mathbf{c = 39}}$	M1 M1 A1 (3)
(ii)	$\text{P}(2Y - 7 < 20 - Y) = \text{P}(Y < 9)$ $\dfrac{9-3}{'39'-3} = \dfrac{1}{6}$ **awrt 0.167**	M1 A1ft A1 (3)
(iii)	$\text{E}(Y^2) = \text{Var}(Y) + [\text{E}(Y)]^2 = (3('39') - 9) + \left(\dfrac{'39'+3}{2}\right)^2$ $\text{E}(Y^2) = \underline{\mathbf{549}}$	M1 A1ft A1 (3) **[13 marks]**

June 2019

Question Number	Scheme	Marks
3(a)	$\frac{a+b}{2}=6$ $\qquad \frac{1}{12}(b-a)^2=3$	B1
	$a+b=12$ and $b-a=\pm 6$ **or** $a^2-12a+27=0$ **or** $b^2-12b+27=0$	dM1
	$a=3,\ b=9$	A1
		(3)
(b)	[P($Y > 6+\sqrt{3}$) =] $\frac{"9"-\left(6+\sqrt{3}\right)}{"9"-"3"}$	M1
	$=\frac{3-\sqrt{3}}{6}$ or 0.211(32…) $\qquad$ awrt 0.211	A1
		(2)
(c)	$\left[\mathrm{F}(y)=\right]\begin{cases}0 & y<3\\ \frac{y-3}{6} & 3\leqslant y\leqslant 9\\ 1 & y>9\end{cases}$	B1 B1
		(2)

October 2019

Question	Scheme	Marks
2(a)	$\frac{x-(-3)}{12-(-3)}=0.75$	M1
	$x=8.25$ $\qquad$ **<u>8.25</u>** oe	A1
		(2)
(b)	$\mathrm{P}(5\le X<14)=\mathrm{P}(5\le X<12)=\frac{12-(5)}{12-(-3)}=\frac{7}{15}$	M1 A1
		(2)
(c)	$\mathrm{E}(X)=4.5\rightarrow \mathrm{E}(Y)=7.5$	B1
	$\mathrm{Var}(X)=\frac{(12-(-3))^2}{12}$ $[=\frac{75}{4}$ or $18.75]$ or $\mathrm{Var}(Y)=\frac{(12-(-3))^2}{48}$ $[=\frac{75}{16}$ or $4.6875]$	B1
	$\frac{a+b}{2}='7.5'$ and $\frac{(b-a)^2}{12}='4.6875'$ or $(b-a)^2=\frac{225}{4}$	M1
	$(b-(15-b))^2=56.25$ oe	dM1
	<u>a = 3.75</u> $\quad$ ***<u>b = 11.25</u>***	A1
		(5)
		Total [9]

October 2019

Question	Scheme	Marks
6(a)	0.95	B1
		(1)
(b)	$X \sim B(10, \text{'0.95'})$	B1
	$P(X \geq 9) = P(X = 9) + P(X = 10) = 10(0.95)^9(0.05) + 0.95^{10}$	M1
	0.91386... awrt **0.914**	A1
		(3)
(c)	Y = Number of bolts that cannot be used	
	$Y \sim B(120, 0.05)$ can be approximated by Po(6)	M1A1
	P(more than 117 bolts can be used) $= P(Y \leq 2)$	dM1
	$P(Y \leq 2) = 0.06196...$ awrt **0.062**	A1
		(4)
		Total [8]

January 2020

Question Number	Scheme	Marks
3(a)	$\frac{3}{4}$	B1
		(1)
(b)	$E(T) = \frac{50+2k}{2} [= 25 + k]$	B1
	$\text{Var}(T) = \frac{(4k)^2}{12} \left[= \frac{4k^2}{3} \right]$	B1
	$E(T^2) = \frac{4k^2}{3} + (25+k)^2$	M1
	$\frac{7k^2}{3} + 625 + 50k = 918.76$	
	$7k^2 + 150k - 881.28 = 0$	dM1
	$k = \frac{-150 \pm \sqrt{150^2 + 4 \times 7 \times 881.28}}{14}$	dM1
	$k = 4.8$ oe only	A1
		(6)
(c)	$P(T < 25) = \frac{1}{4}$	B1
	B(50, 0.25)	
	$P(X \geq 20) = 1 - P(X \leq 19)$	M1
	$= 1 - 0.9861$	
	$= 0.0139$ awrt 0.0139	A1
		(3)

June 2020

Question Number	Scheme		Marks
2(a)	$f(w)=\begin{cases}\frac{1}{8} & -1.4<w<6.6\\ 0 & \text{otherwise}\end{cases}$		M1 A1
			(2)
(b)	$E(W)=2.6$ oe		B1
			(1)
(c)	$(1.6-\alpha)\times"\frac{1}{8}"=0.35$		M1
	$\alpha=-1.2$ oe		A1cso
			(2)
(d)	$P(1.2<W<2.4)=(2.4-1.2)\times"\frac{1}{8}"$		M1
	$=\frac{3}{20}$ or 0.15 oe		A1ft
			(2)
(e)	$P(W>2 \mid 1.2<W<2.4)=\frac{0.4\times"\frac{1}{8}"}{"0.15"}$		M1
	$=\frac{1}{3}$	awrt 0.333	A1
			(2)
(f)	The random variable Y is the number of days the train is between 1.2 minutes and 2.4 minutes late $Y\sim B(40,\ "0.15")$		M1
	$P(Y\geq 10)=1-P(Y\leq 9)$ or $1-0.9328$		M1
	$=0.0672$	awrt 0.0672	A1 (3)

January 2021

Question Number	Scheme	Marks
5(a)	U[0, 3]	M1
	$\frac{3-1.8}{3}=0.4$	A1
		(2)
(b)	$X^2=W^2+(3-W)^2$	M1
	$X^2=W^2+9+W^2-6W \quad\Rightarrow\quad X^2=2W^2-6W+9$	A1
		(2)
(c)	$E(W)=1.5$	B1
	$\text{Var}(W)=\frac{9}{12}=\frac{3}{4}$	B1
	$E(W^2)="\frac{3}{4}"+"1.5"^2$	M1
	$E(W^2)=3$	A1
	So $E(X^2)=2\times"3"-6\times"1.5"+9=6$	M1A1
		(6)
(d)	$P(X^2>5)=P(2W^2-6W+4>0)$	M1
	$=P((2W-2)(W-2)>0)$	M1
	$=P(W>2)+P(W<1)$	dM1
	$=\frac{2}{3}$ oe	A1
		(4)

Question Number	Scheme	Marks
2(i)(a)	$\text{P}(X > 14) = \frac{2}{5}$ oe	B1
		(1)
(b)	$a = 8 - 2(14-8)[= -4]$	M1
	$b = 14 + 2(14-8)[= 26]$	M1
	$\text{P}(6X > a\ +\ b) = \left(\dfrac{26 - \dfrac{26-4}{6}}{26+4}\right)$ oe	M1
	$= \frac{67}{90}$ oe awrt 0.744	A1
		(4)
(ii)(a)	$S \sim \text{U}[0, 22.5]$ or $\text{f}(s) = \begin{cases} \frac{2}{45} & 0 \leqslant s \leqslant 22.5 \\ 0 & \text{otherwise} \end{cases}$	B1
		(1)
(b)	$\text{P}(S < 12) = \frac{12}{\text{"}22.5\text{"}}$	M1
	$= \frac{8}{15}$ awrt 0.533	A1
		(2)
(c)	$\text{P}(T = 6) = {}^{20}\text{C}_6 \left(\text{"}\frac{8}{15}\text{"}\right)^6 \left(1 - \text{"}\frac{8}{15}\text{"}\right)^{14}$	M1M1
	$= 0.02072\ldots$ awrt 0.0207	A1
		(3)

January 2022

Question Number	Scheme		Marks
7 (a)	$\mathrm{P}(L \geqslant 4.5) \Rightarrow \mathrm{P}(A \geqslant 20.25)$		
	$\mathrm{P}(A \geqslant 20.25) = (30 - 20.25) \times \frac{1}{20}$		M1
	$= 0.4875$		A1
			(2)
(b)	$\mathrm{Var}(L) = \mathrm{E}(L^2) - \mathrm{E}(L)^2$		
	$[\mathrm{E}(L^2) = \mathrm{E}(A)] = 20$		B1
		$\mathrm{g}(L) = \begin{cases} \frac{L}{10} & \sqrt{10} \leqslant L \leqslant \sqrt{30} \\ 0 & \text{otherwise} \end{cases}$	
	$\mathrm{E}(L) = \mathrm{E}(\sqrt{A}) = \frac{1}{20}\int_{10}^{30} \sqrt{a}\ \mathrm{d}A$	$\mathrm{E}(L) = \frac{1}{10}\int_{\sqrt{10}}^{\sqrt{30}} L^2\ \mathrm{d}L$	M1
	$= \frac{1}{20}\left[\frac{2}{3}a^{\frac{3}{2}}\right]_{10}^{30}$	$\frac{1}{10}\left[\frac{l^3}{3}\right]_{\sqrt{10}}^{\sqrt{30}}$	A1
	$= 4.4231\ldots$		A1
	$\mathrm{Var}(L) = "20" - ("4.4231...")^2$		M1
	$= 0.4358\ldots$ awrt 0.436		A1
			(6)

June 2022

Question	Scheme	Marks
3. (a)	$\frac{19}{24}$	B1
		(1)
(b)	$\mathrm{P}(\lvert R\rvert > 3.5) = \frac{-3.5-(-5)}{19-(-5)} + \frac{19-3.5}{19-(-5)}, = \frac{17}{24}$	M1, A1
		(2)
(c)		M1 A1
		(2)
(d)(i)	$\mathrm{P}(R_1 > 10) = \frac{19-10}{19-(-5)}\left[= \frac{9}{24} = 0.375\right]$	M1
	$[\mathrm{P}(R > 10)]^3 = \left(\frac{9}{24}\right)^3 = \frac{27}{512}$	M1 A1
		(3)
(ii)	$1 - [\mathrm{P}(R < 10)]^3 = \frac{387}{512}$	M1 A1
		(2)

October 2022

Question Number	Scheme	Marks
7(i)	$\frac{a+b}{2}=9$ and $\frac{13-5}{b-a}=\frac{1}{5}$ or $a=-11$ and $b=29$	M1
	$\mathrm{P}\left(X>\frac{"29"-"11"}{3}\right)\left[=\mathrm{P}(X>6)\right]$ or $\mathrm{P}\left(X>\frac{9\times 2}{3}\right)\left[=\mathrm{P}(X>6)\right]=\frac{23}{40}$	M1A1
		(3)
(ii)	$\frac{1}{12}(c-1)^2=0.48 \Rightarrow c=3.4$	M1
	$\mathrm{E}(Y)=\frac{1+"3.4"}{2}$	M1
	$\mathrm{E}(Y^2)=0.48+"\left(\frac{1+3.4}{2}\right)"^2=5.32$	M1A1
		(4)
(iii)	$W\sim \mathrm{U}[0,20]$ $X\sim \mathrm{U}[10,20]$ $Y\sim \mathrm{U}[0,10]$	
	$W<6$ or $W>14$ or $X<12$ or $Y>8$ any letter, ignore distribution	M1
	$2\times\mathrm{P}(W<6)=2\times\frac{(6-0)}{20}$ or $2\times\mathrm{P}(W>14)=2\times\frac{(20-14)}{20}$ or $\mathrm{P}(W<6)=\frac{6-0}{20}$ **and** $\mathrm{P}(W>14)=\frac{20-14}{20}$ or $\mathrm{P}(X>14)=\frac{20-14}{10}$ or $\mathrm{P}(Y<6)=\frac{6-0}{10}$	M1
	$\mathrm{P}(8<W<12)=\frac{12-8}{20}$ or $\mathrm{P}(X<12)=\frac{12-10}{10}$ or $\mathrm{P}(Y>8)=\frac{10-8}{10}$	M1
	$\mathrm{P}(\text{ shortest side}<6\text{ })="\frac{3}{10}"+"\frac{3}{10}"+"\frac{1}{5}"$ or $"\frac{1}{5}"+"\frac{3}{5}"=\frac{4}{5}$	dM1A1
		(5)
	Alternative 1	
	$6<W<8$ or $12<W<14$ any letter, ignore distribution	M1
	$\mathrm{P}(6<W<8)=\frac{8-6}{20}$ or $\mathrm{P}(12<W<14)=\frac{14-12}{20}$ — M2 for $\mathrm{P}(12<X<14)=\frac{14-12}{10}$ or $\mathrm{P}(6<Y<8)=\frac{8-6}{10}$	M1
	$\mathrm{P}(6<W<8)=\frac{1}{10}$ and $\mathrm{P}(12<W<14)=\frac{1}{10}$ or $2\times\mathrm{P}(6<W<8)=2\times\frac{1}{10}$ or $2\times\mathrm{P}(12<W<14)=2\times\frac{1}{10}$	M1
	$\mathrm{P}(\text{shortest side}<6)=1-"\frac{1}{10}"-"\frac{1}{10}"$ or $1-"\frac{2}{10}"=\frac{4}{5}$	dM1A1
	Alternative 2	(5)
	$W>10$ or $12<W<14$ or $6<W<8$ or $W<10$ any letter, ignore distribution	M1
	$\mathrm{P}(12<W<14)=\frac{14-12}{20}$ and $\mathrm{P}(W>10)=\frac{20-10}{20}$ or $\mathrm{P}(6<W<8)=\frac{8-6}{20}$ and $\mathrm{P}(W<10)=\frac{10-0}{20}$	M1
	$\mathrm{P}(12<W<14\mid W>10)=\frac{"1/10"}{"1/2"}\left[=\frac{1}{5}\right]$ or $\mathrm{P}(6<W<8\mid W<10)=\frac{"1/10"}{"1/2"}\left[=\frac{1}{5}\right]$	M1
	$\mathrm{P}(\text{ shortest side}<6\text{ })=1-"\frac{1}{5}"=\frac{4}{5}$	dM1A1
		(5)
	NB Any answer of $\frac{4}{5}$ scores 5/5 provided it has not come from incorrect working	

January 2023

Question Number	Scheme		Marks
4 (a)	$\frac{9}{20}$		B1
			(1)
(b)	$(21k-k)\times\frac{\pi}{20}=1$		M1
	$k=\frac{1}{\pi}$ *		A1*
			(2)
(c) (i)	$\left[\mathrm{E}(X)=\frac{1}{2}(k+21k)\right]=\frac{11}{\pi}$		B1
(ii)	$\mathrm{Var}(X)=\frac{1}{12}(21k-k)^2$	or $\mathrm{Var}(X)=\int_{\frac{1}{\pi}}^{\frac{21}{\pi}}\frac{\pi}{20}x^2\,\mathrm{d}x-\left(\frac{11}{\pi}\right)^2$	M1
	$=\frac{100}{3\pi^2}$		A1
			(3)
(d)	$\mathrm{E}(A)=\pi\mathrm{E}(X^2)+4\mathrm{E}(X)+\frac{4}{\pi}$	$\mathrm{E}(A)=\int_k^{21k}\mathrm{f}(x)(A)\,\mathrm{d}x=\int_k^{21k}\frac{\pi}{20}(\pi)\left(x^2+\frac{4}{\pi}x+\frac{4}{\pi^2}\right)\mathrm{d}x$	M1
	$\mathrm{E}(X^2)=\frac{100}{3\pi^2}+\left(\frac{11}{\pi}\right)^2=\frac{463}{3\pi^2}$	$\mathrm{E}(A)=\frac{\pi}{20}(\pi)\left(\frac{x^3}{3}+(\frac{4}{\pi})\frac{x^2}{2}+\frac{4}{\pi^2}x\right)$	M1
	$\mathrm{E}(A)=\frac{463}{3\pi}+\frac{44}{\pi}+\frac{4}{\pi}$	sub limits $\frac{21}{\pi}$ and $\frac{1}{\pi}$	M1
	$=\frac{607}{3\pi}$	$=$ awrt 64.4	A1
			(4)

June 2023

Question Number	Scheme	Marks
6. (a)	$\mathrm{P}(17 < W < k) = \mathrm{P}(W < k) - \mathrm{P}(W < 17) = \frac{53}{60} - \left(1 - \frac{1}{5}\right) = \frac{1}{12}$	M1 A1 (2)
(b)(i)	$\frac{(b-a)^2}{12} = 75$, $\frac{b-17}{b-a} = \frac{1}{5}$ or $\frac{17-a}{b-a} = \frac{4}{5}$	B1, B1
	$\frac{(b-a)^2}{12} = 75 \rightarrow (b-a) = 30$ $\frac{b-17}{30} = \frac{1}{5}$	M1
	$b = 23$ and $a = -7$	A1 (4)
(ii)	$\mathrm{P}(W < k) = \frac{k - ("-7")}{"23" - ("-7")} = \frac{53}{60}$ or $\mathrm{P}(17 < W < k) = \frac{k-17}{30} = \frac{1}{12}$ or $\mathrm{P}(W > k) = \frac{"23" - k}{"23" - ("-7")} = \frac{7}{60}$	M1
	$k = 19.5$	A1 (2)
(c)	$\mathrm{P}(-5 < W < 5) = \frac{5-(-5)}{"23" - ("-7")} = \frac{1}{3}$	M1A1ft (2)
(d)	$\mathrm{E}(W^2) = \mathrm{Var}(W) + \mathrm{E}(W)^2 = 75 + \left(\frac{"23" + "-7"}{2}\right)^2 = 139$	M1 A1 (2)
		[Total 12]

October 2023

Question Number	Scheme	Marks
3 (a)(i)	3 + [0] + 29 = 32*	B1*
(ii)	3 + 15 + 29 = 47*	B1*
		(2)
(b)	$\mathrm{f}(t) = \begin{cases} \frac{1}{15} & 32 \leqslant t \leqslant 47 \\ 0 & \text{otherwise} \end{cases}$	M1 A1
		(2)
(c) (i)	$[\mathrm{E}(T) =]$ 39.5 oe	B1
(ii)	$[\mathrm{Var}(T) =] \frac{(47-32)^2}{12}$	M1
	$\frac{75}{4} = 18.75$	A1
		(3)
(d)	$(40 - 32) \times \frac{1}{15}$	M1
	$= \frac{8}{15}$	A1
		(2)

Question Number	Scheme		Marks
5(a)	$\dfrac{(a+6)^2}{12}=27$		M1
	$a=\sqrt{27\times12}-6\Rightarrow 12^*$ or $a^2+12a-288=0\Rightarrow a=12^*$		A1*
			(2)
(b)(i)	$\dfrac{12-b}{18}=\dfrac{3}{5}$ or $\dfrac{b+6}{18}=\dfrac{2}{5}$		M1
	$b=1.2$		A1
			(2)
(ii)	$\text{P}(-6<W<\text{"}0.6\text{"})=\dfrac{\text{"}0.6\text{"}+6}{18}$		M1
	$=\dfrac{11}{30}$ or $0.3666\ldots$		A1ft
			(2)
(c)	Let C be the point where the wood is cut and x is the distance AC		
	$\dfrac{x}{2}$ and $\left(\dfrac{160-x}{2}\right)$	$L+W=80$ and $LW=975$	M1
	$\dfrac{x}{2}\times\left(\dfrac{160-x}{2}\right)=975 \quad\Rightarrow x=30$ or 130	$L(80-L)=975\Rightarrow L=15$ or 65	M1
	$\text{P}(\text{"}30\text{"}<x<\text{"}130\text{"})=\dfrac{\text{"}130\text{"}-\text{"}30\text{"}}{160}\left[=\dfrac{5}{8}\right]$ oe	$\text{P}(\text{"}15\text{"}<x<\text{"}65\text{"})=\dfrac{\text{"}65\text{"}-\text{"}15\text{"}}{80}\left[=\dfrac{5}{8}\right]$ oe	dM1
	$=\dfrac{5}{8}$ oe		A1
			(4)