

1. The probability distribution of the random variable  $X$  is given by the formula  $P(X = r) = k(r^2 - 1)$  for  $r = 2, 3, 4, 5$ .

i. Show the probability distribution in a table, and find the value of  $k$ .

[3]

2. The probability distribution for the discrete random variable  $X$  is shown in Fig. 3.

$x$	0	1	2	3	4
$P(X = x)$	$0.4a$	$0.5a$	$0.3a$	$0.2a$	$0.1a$

Fig. 3

(a) Calculate the value of the constant  $a$ .

[2]

(b) Calculate  $P(X \geq 2)$ .

[2]

[1]

3. The probability distribution of the discrete random variable  $X$  is given in Fig. 4.

$r$	0	1	2	3	4
$P(X = r)$	0.2	0.15	0.3	$k$	0.25

Fig. 4

(a) Find the value of  $k$ .

[2]

$X_1$  and  $X_2$  are two independent values of  $X$ .

(b) Find  $P(X_1 + X_2 = 6)$ .

[3]

4. The discrete random variable  $X$  takes the values  $r = 0, 1, 2, 3, 4$  with probabilities

$$P(X = r) = k(r + 1)(r + 2).$$

(a) Calculate the value of the constant  $k$ . [2]

(b) Calculate  $P(X < 3)$ , giving your answer as a fraction in its lowest terms. [2]

5. Roxanne is employed by an employment agency called Supertemps. In any given week she may be required to work up to a maximum of 5 days.

Both Roxanne and her partner, Alex, suggest ways in which the number of days,  $X$ , Roxanne is required to work in a week may be modelled.

- Roxanne thinks that  $X$  may be modelled using the discrete uniform distribution.
- Alex suggests the following formula to model the probability distribution of  $X$ .

$$P(X = x) = k(2x - 5)^2 \text{ for } x = 0, 1, 2, 3, 4, 5.$$

(a) Calculate the value of  $k$  for Alex's model. [2]

Alex and Roxanne record the number of days Roxanne is required to work in each of the first 42 weeks of her employment. The results are summarised in Fig. 9.

Number of days	0	1	2	3	4	5
Frequency	13	7	1	0	7	14

Fig. 9


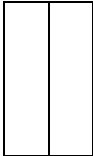
[6]

(b) Investigate how well each model fits the data.

END OF QUESTION paper

# Mark scheme

Question		Answer/Indicative content	Marks	Part marks and guidance										
1	i	<table border="1"> <tr> <td><math>r</math></td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> <tr> <td><math>P(X=r)</math></td> <td><math>3k</math></td> <td><math>8k</math></td> <td><math>15k</math></td> <td><math>24k</math></td> </tr> </table>	$r$	2	3	4	5	$P(X=r)$	$3k$	$8k$	$15k$	$24k$	B1	For correct table (to $k$ or correct probabilities 0.06, 0.16, 0.30, 0.48)
	$r$	2	3	4	5									
	$P(X=r)$	$3k$	$8k$	$15k$	$24k$									
i	$3k + 8k + 15k + 24k = 1$	M1	For their four multiples of $k$ added and = 1.  or $k = 1/50$ (with or without working)											
i	$k = 0.02$	A1	<b>Examiner's Comments</b>  Nearly all candidates were able to calculate the correct coefficients of $k$ and sum the terms to get $50k$ . Work was generally neatly presented and well structured. Only a very few candidates failed to get the correct answer of $1/50$ . A small number of candidates did not show the probabilities in a table, thus losing 1 mark.											
Total			3											
2	a	$0.4a + 0.5a + 0.3a + 0.2a + 0.1a = 1$ soi	M1(AO1.1b)											
		$a = \frac{2}{3}$	A1(AO1.1b)	<table border="1"><tr><td></td><td></td></tr></table>										
	b	$\frac{2}{3}(0.3 + 0.2 + 0.1)$	M1(AO1.1b)	<table border="1"><tr><td><i>their</i> <math>\frac{2}{3}</math></td><td></td></tr></table>	<i>their</i> $\frac{2}{3}$									
<i>their</i> $\frac{2}{3}$														

		0.4	A1(AO1.1b)		
			[2]		
	c	positive skew	B1(AO1.2)		
			[1]		
		<b>Total</b>	<b>2</b>		
3	a	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>0.2 + 0.15 + 0.3 + k + 0.25 = 1</math> </div> <span style="border: 1px solid black; padding: 2px 5px;">oe</span>	M1(AO1.1)		
		$k = 0.1$	A1(AO1.1)		
			[2]	<u>Examiner's Comments</u> Candidates generally did this correctly, with many showing exactly the working given in the mark scheme.	
	b	$k^2$ seen $0.3 \times 0.25 \times 2 + k^2$  0.16	M1(AO3.1a)	Or $0.3 \times 0.25 \times 2$ seen  Allow slip eg omission of 2; or insertion of 2  Ft $k$ from (a) for M1M1	
			M1(AO1.1)		
			A1(AO1.1)		
			[3]		

				<p><u>Examiner's Comments</u></p> <p>This part caused considerable difficulty, with some candidates omitting it, others drawing a possibility space with equally likely outcomes, and others copying information from the table given in the question.</p> <p>Candidates who realised that a total of 6 could be made either from 3 and 3 or else from 2 and 4 sometimes did not realise that 4 and 2 is also possible; others thought the probability of 3 and 3 had to be counted twice.</p>																	
		<b>Total</b>	<b>5</b>																		
4	a	$k(1 \times 2 + 2 \times 3 + 3 \times 4 + 4 \times 5 + 5 \times 6) = 1$ $k = \frac{1}{70}$	M1 (AO1.1) A1 (AO1.1) [2]	<table border="1"> <tr> <td></td> <td></td> </tr> </table>																	
	b	$\frac{2+6+12}{70}$ $= \frac{2}{7}$	M1 (AO1.1) A1 (AO1.1) [2]	<table border="1"> <tr> <td>FT their <math>k</math></td> <td>Allow 1. <math>P(X \leq 3)</math> method</td> </tr> </table>	FT their $k$	Allow 1. $P(X \leq 3)$ method															
FT their $k$	Allow 1. $P(X \leq 3)$ method																				
		<b>Total</b>	<b>4</b>																		
5	a	$k(25 + 9 + 1 + 1 + 9 + 25) = 1$ $k = \frac{1}{70}$	M1 (AO 3.3) A1(AO 1.1) [2]																		
	b	Roxannes model <table border="1"> <tr> <td>day</td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> <tr> <td>s</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	day	0	1	2	3	4	5	s								<table border="1"> <tr> <td></td> <td></td> </tr> </table>			
day	0	1	2	3	4	5															
s																					

	<table border="1" data-bbox="219 76 913 124"> <tr> <td><math>f_e</math></td> <td>7</td> <td>7</td> <td>7</td> <td>7</td> <td>7</td> <td>7</td> </tr> </table> <p data-bbox="219 180 640 236">Correct for 1 and 4 days, but otherwise a poor fit Alexs model</p> <table border="1" data-bbox="219 268 896 406"> <tr> <td>day s</td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> <tr> <td><math>f_e</math></td> <td>15</td> <td>5.4</td> <td>0.6</td> <td>0.6</td> <td>5.4</td> <td>15</td> </tr> </table> <p data-bbox="219 566 1059 627">The expected frequencies are all within 2 of the observed frequencies, so Alex's model appears to be a good fit.</p>	$f_e$	7	7	7	7	7	7	day s	0	1	2	3	4	5	$f_e$	15	5.4	0.6	0.6	5.4	15	<p data-bbox="1104 87 1209 113">B1 (AO 3.4)</p> <p data-bbox="1126 161 1187 220">B1(AO 3.5a)</p> <p data-bbox="1104 304 1209 330">M1(AO 3.4)</p> <p data-bbox="1104 378 1209 403">A1(AO 1.1)</p> <p data-bbox="1104 451 1209 477">B1(AO 2.4)</p> <p data-bbox="1126 525 1187 584">B1(AO 3.5a)</p> <p data-bbox="1144 632 1169 657">[6]</p>	<table border="1" data-bbox="1236 76 1664 746"> <tr> <td data-bbox="1236 76 1451 746"> <p data-bbox="1236 552 1442 740">A0 if expected frequencies are rounded to nearest integer</p> </td> <td data-bbox="1451 76 1664 746"></td> </tr> </table>	<p data-bbox="1236 552 1442 740">A0 if expected frequencies are rounded to nearest integer</p>		
$f_e$	7	7	7	7	7	7																					
day s	0	1	2	3	4	5																					
$f_e$	15	5.4	0.6	0.6	5.4	15																					
<p data-bbox="1236 552 1442 740">A0 if expected frequencies are rounded to nearest integer</p>																											
	<p data-bbox="219 799 264 825">Total</p>	<p data-bbox="1144 799 1169 825">8</p>																									