1a) 0.000129

1b) 0.0322

1c) 0.402

1d) 0 and 1 equally likely

(4)

Question			Answer	Marks	Guidance
2	(a)		$P(X = 0) = 0.4 \times 0.5^4 = 0.025$ **NB ANSWER GIVEN**	M1 A1 **[2]**	For 0.5^4
	(b)		$P(X = 1) = (0.6 \times 0.5^4) + (4 \times 0.4 \times 0.5 \times 0.5^3)$ $= 0.0375 + 0.1 = 0.1375$ **NB ANSWER GIVEN**	M1* M1* M1* dep A1 **[4]**	For 0.6×0.5^4 seen as a single term (not multiplied or divided by anything) For $4 \times 0.4 \times 0.5^4$ Allow 4×0.025 Watch out for incorrect methods such as (0.4/4) 0.1 **MUST** be justified For sum of both , dep on both M1's
	(c)		P(Total of 3) = $(3 \times 0.325 \times 0.025^2) + (6 \times 0.3 \times 0.1375 \times 0.025) + 0.1375^3 = 3 \times 0.000203 + 6 \times 0.001031 + 0.002600 =$ $0.000609 + 0.006188 + 0.002600 = 0.00940$ $(= 3 \times 13/64000 + 6 \times 33/32000 + 1331/512000)$	M1 M1 M1 A1 **[4]**	For decimal part of first term 0.325×0.025^2 For decimal part of second term $0.3 \times 0.1375 \times 0.025$ For third term – ignore extra coefficient All M marks above depend on triple probability products CAO: AWRT 0.0094. Allow 0.009 with working.

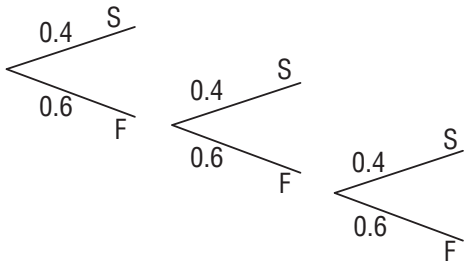
3	**(a)**		<table><tr><td>r</td><td>2</td><td></td><td></td><td></td></tr><tr><td>P($X = r$)</td><td>k</td><td>$8k$</td><td>$15k$</td><td>$24k$</td></tr></table> $3k + 8k + 15k + 24k = 1$ $k = 0.02$	B1 M1 A1 **[3]**	For correct table (ito k or correct probabilities 0.06, 0.16, 0.30, 0.48) or $k = 1/50$ (with or without working)	For their four multiples of k added and =1. Allow M1A1 even if done in part **(ii)** – link part **(ii)** to part **(i)**

4 **(i)**	$\mathrm{P}(X=2)=\binom{3}{2}\times 0.87^2\times 0.13=0.2952$	M1 0.87^2 x 0.13 M1 $\binom{3}{2}$ x p^2q **with p+q=1** A1 CAO	**3**
(ii)	In 50 throws expect 50 (0.2952) = 14.76 times	B1 FT	**1**
(iii)	P (two 20's twice) = $\binom{4}{2}\times 0.2952^2\times 0.7048^2=0.2597$	M1 $0.2952^2\times 0.7048^2$ A1 FT their 0.2952	**2**
		TOTAL	**6**

4 (i)	$X \sim B(20, 0.1)$ $(\boldsymbol{A})\quad P(\boldsymbol{X} = 1) = \binom{20}{1} \times 0.1 \times 0.9^{19} = 0.2702$ OR from tables $\quad 0.3917 - 0.1216 = 0.2701$ $(\boldsymbol{B})\quad P(\boldsymbol{X} \geq 1) = 1 - 0.1216 = 0.8784$	M1 0.1×0.9^{19} M1 $\binom{20}{1} \times pq^{19}$ A1 CAO OR: M2 for 0.3917 – 0.1216 A1 CAO M1 P(X=0) *provided that P(X≥1)=1–P(X≤1) not seen* M1 1-P(X=0) A1 CAO	**3** **3**
(ii)	EITHER: $1 - 0.9^n \geq 0.8$ $0.9^n \leq 0.2$ Minimum $n = 16$ OR (using trial and improvement): Trial with 0.9^{15} or 0.9^{16} or 0.9^{17} $1 - 0.9^{15} = 0.7941 < 0.8$ and $1 - 0.9^{16} = 0.8147 > 0.8$ Minimum $n = 16$ NOTE: $n = 16$ unsupported scores SC1 only	M1 for 0.9^n M1 for inequality A1 CAO M1 M1 A1 CAO	**3**

(c) P(3 orange | at least 2 O) = $\frac{P(3O)}{P(at\ least\ 2O)}$			
P(3 orange) = P(OOO)	M1		Atttempt at P(OOO) one three-factor option, not added
$= \frac{5}{7} \times \frac{4}{6} \times \frac{3}{5} = \frac{2}{7}$	A1		Correct unsimplified num of a fraction
P(at least 2O) = P(YOO) + P(OYO) + P(OOY) + $\frac{2}{7}$			
$= \frac{2}{7} \times \frac{5}{6} \times \frac{4}{5} + \frac{5}{7} \times \frac{2}{6} \times \frac{4}{5} + \frac{5}{7} \times \frac{4}{6} \times \frac{2}{5} + \frac{2}{7}$	M1		Attempt at P(at least 2O) sum 3 or 4 three-factor options
$= \frac{6}{7}$	A1		Correct unsimplified answer seen anywhere
P(30 | at least 2O) = $\frac{2}{7} \div \frac{6}{7} = \frac{1}{3} (0.333)$	A1	**5**	Correct answer evaluated
Alternative 1			
3 Orange = $^5C_3$	M1		Attempt at combinations for 3 orange oe, not added
	A1		Correct unsimplified num of a fraction
At least 2 Orange = $^5C_2 \times {}^2C_1 + {}^5C_3$	M1		Attempt at combinations for at least 2 orange condone omission of $+{}^5C_3$
	A1		Correct unsimplified answer seen anywhere
P(3O | at least 2O) = $\frac{{}^5C_3}{{}^5C_2 \times {}^2C_1 + {}^5C_3} = \frac{1}{3}$	A1	**5**	Correct answer evaluated
Alternative 2			
No Yellow = $^2C_0$	M1		Attempt at combinations for 0 yellow oe, not added
	A1		Correct unsimplified num of a fraction
No more than 1 Yellow = $^2C_1 + {}^2C_0$	M1		Attempt at combinations for no more than 1 yellow. Condone omission of +2C0
	A1		Correct unsimplified answer seen anywhere
P(3O | at least 2O) = $\frac{{}^2C_0}{{}^2C_1 + {}^2C_0} = \frac{1}{3}$	A1	**5**	Correct answer evaluated
Misread – with replacement			
MR–1 applied to first Accuracy Mark earned	M1		Attempt at P(OOO) one three factor option oe not added
P(3O) = $\frac{5}{7} \times \frac{5}{7} \times \frac{5}{7} = \frac{125}{343}$	A1		Correct unsimplified num of a fraction
P(at least 2O) = $\frac{5}{7} \times \frac{5}{7} \times \frac{2}{7} \times {}^3C_2 + \left(\frac{5}{7}\right)^3$	M1		Attempt at P(at least 2O) sum of 3 or 4 three factor options
	A1		Correct unsimplified seen anywhere
P(3O | at least 2O) = $\frac{5}{11}$	A1	**4 max**	Answer evaluated

<table>
<tr><th>Q</th><th>Scheme</th><th>Marks</th><th>AOs</th><th>Pearson Progression Step and Progress descriptor</th></tr>
<tr><td rowspan="2">6a</td><td>$4k$</td><td>B1</td><td>1.1a</td><td>1st
Calculate probabilities for single events</td></tr>
<tr><td></td><td>(1)</td><td></td><td></td></tr>
<tr><td rowspan="2">6b</td><td>Find k: $k + 4k + 9k + 16k = 1$
$k = \frac{1}{30}$</td><td>M1
A1</td><td>3.1a
1.1a</td><td>4th
Model simple discrete random variables as probability distributions</td></tr>
<tr><td></td><td>(2)</td><td></td><td></td></tr>
<tr><td rowspan="2">6C</td><td>$\frac{38}{300} \left(= \frac{19}{150}\right)$ $(= 0.1266\ldots)$</td><td>B1</td><td>1.1a</td><td>2nd
Calculate probabilities from relative frequency tables and real data</td></tr>
<tr><td></td><td>(1)</td><td></td><td></td></tr>
<tr><td rowspan="2">6d</td><td><table><tr><td>Score</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>Relative frequency</td><td>0.033</td><td>0.127</td><td>0.4</td><td>0.44</td></tr><tr><td>Model probability</td><td>0.033</td><td>0.133</td><td>0.3</td><td>0.533</td></tr></table>Model is close to the theoretical probabilities for 1 and 2 but not close for 3 and 4…
…so model is not suitable</td><td>M1
A1</td><td>3.2b
3.2b</td><td>7th
Comment on the appropriateness of binomial and other models in describing real-world situations</td></tr>
<tr><td></td><td>(2)</td><td></td><td></td></tr>
<tr><td colspan="5">(6 marks)</td></tr>
<tr><td colspan="5">Notes
7d M1: Comparing at least two probabilities with corresponding relative frequencies.
A1: (Must make reference to the full range of experimental probabilities, not just 2, or 1 and 2) and state correct conclusion.</td></tr>
</table>

Question	Answer	Marks	Partial Marks	Guidance
7(a)		1	**M1**	3 pairs S (bank, log in, success oe) and F oe seen no extra bits.
		1	**A1**	Exactly 3 pairs, must be labelled
		1	**A1**	Correct diagram with all probs correct
		3		
7(b)	<table><tr><td>*x*</td><td>0</td><td>1</td><td>2</td><td>3</td></tr><tr><td>Prob</td><td>0.4</td><td></td><td>0.144</td><td>0.216</td></tr></table>	1	**B1**	P(0) correct
		1	**M1**	Multiplying two of more factors of 0.4 and 0.6
		1	**A1**	One more correct prob
		1	**B1**	One more correct prob
		4		

8 (a) $r = 3$ (b) $k = 12$ (c) $r = 11$ (d) $k = 21$

9. (a)	Let W represent the number of white plants. W ~ B(12,0.45) use of P(W = 5) = P($W \leq 5$) – P($W \leq 4$) $^{12}C_5 0.45^5 0.55^7$ or equivalent award B1M1 = 0.5269 – 0.3044 values from correct table implies B = 0.2225 awrt 0.222(5)	**B1** **M1** **A1** **(3)**
(b)	P($W \geq 7$) = 1 – P($W \leq 6$) or =1-P($W<7$) = 1 – 0.7393 implies method = 0.2607 awrt 0.261	**M1** **A1** **(2)**
(c)	P(3 contain more white than coloured)= $\frac{10!}{3!7!}(0.2607)^3(1-0.2607)^7$ use of B,n=10 = 0.256654… awrt 0.257	**M1A1**$\int$ **A1** **(3)**