1 A gardener plants beetroot seeds. The probability of a seed not germinating is 0.35, independently for each seed.

Find the probability that, in a row of 40 seeds, the number not germinating is:

(a) 9 or fewer; *(3 marks)*

(b) 7 or more; *(2 marks)*

(c) equal to the number germinating. *(3 marks)*

Question Number and part	Solution	Marks	Total	Comments
1(a)	Binomial $n = 40$ $p = 0.35$	B1 B1		Binomial $n = 40$, $p = 0.35$
	P(9 or fewer) = 0.0644	B1	3	0.0644 (0.064 – 0.065)
(b)	P(7 or more) = 1– 0.0044	M1		P(7 or more) = 1 – P(6 or fewer) generous, or correct formula Allow 1– P(7 or fewer) = 1– 0.0124
	= 0.9956	A1	2	0.9956 (0.995 – 0.996)
(c)	P(20) = 0.9827 – 0.9637 = 0.0190	B1 M1		P(20) required P(20) = P(20 or fewer) – P(19 or fewer) or correct formula – can be earned for P(r) $r \neq 20$
		A1	3	0.0190 (0.0189 – 0.0191)
	Total		**8**	

2 A specialist bicycle shop builds made-to-measure bicycle frames. The shop has 40 orders for frames. Past experience shows that the probability of a customer, who has ordered a frame, failing to complete the purchase is 0.04 and is independent for each customer.

(a) Find the probability that, of the 40 orders, the number of purchases not completed is:

(i) 4 or fewer;

(ii) exactly 2. *(6 marks)*

(b) Find the probability that the purchase is completed for all 40 orders. *(2 marks)*

2(a)(i)	Binomial	B1		
	$n=40\ \ p=0.04$	B1		
	$P(4 \text{ or fewer})=0.979$	B1		$0.979(0.9785-0.9795)$
(ii)	$P(2)=0.7855-0.5210=0.2645$	M1		$P(2)=P(2 \text{ or fewer})-P(1 \text{ or fewer})$
		m1		Completely correct method
		A1	6	$0.2645(0.264-0.265)$
(b)	40 completed $\rightarrow$ 0 not completed	M1		0 not completed
	$P(0)=0.195$	A1		$0.195(0.195-0.196)$
	Total		**8**	

3 Dwight, a clerical worker, is employed by a benefits agency to calculate the weekly payments due to unemployed adults claiming benefit. These payments vary according to personal circumstances. During the first week of his employment, the probability that he calculates a payment incorrectly is 0.25 for each payment.

(a) Given that Dwight calculates 40 payments during his first week of employment, find the probability that

(i) five or fewer are incorrect, *(2 marks)*

(ii) more than 30 are **correct**. *(3 marks)*

(b) The random variable, R, represents the number of payments he calculates until a total of 10 have been carried out correctly. State, giving a reason, whether the binomial distribution is an appropriate model for R. *(2 marks)*

(c) A random sample of 40 payments is taken from those calculated by Dwight during his first **year** of employment. Give a reason why a binomial distribution may not provide a suitable model for the number of incorrect payments in the sample. *(2 marks)*

Question Number	Solution	Marks	Total Marks	Comments
3 (a)(i)	Binomial $n = 40$ $p = 0.25$	B1		
	P(5 or fewer) = 0.0433	B1	(2)	
(ii)	> 30 contains no error	M1		
	→ 9 or fewer contain error	M1		
	P(9 or fewer) = 0.4395	A1	(3)	
(b)	Not binomial, n not constant	B1 B1	(2)	
(c)	p may decrease as clerical worker gains experience	B1 B1	(2)	
		TOTAL	(9)	

6 Eight friends take a picnic to a cricket match. As her contribution to the picnic, Hilda buys eight sandwiches at a supermarket. She selects the sandwiches at random from those on display. The probability that a sandwich is suitable for vegetarians is independently 0.3 for each sandwich.

(a) Find the probability that, of the eight sandwiches, the number suitable for vegetarians is:

(i) 2 or fewer;

(ii) exactly 2;

(iii) more than 3. *(7 marks)*

(b) Two of the eight friends are vegetarians. Hilda decides to ensure that the eight sandwiches she takes to the match will include at least two suitable for vegetarians. If, having selected eight sandwiches at random, she finds they include fewer than two suitable for vegetarians she will replace one, or if necessary two, of the sandwiches unsuitable for vegetarians with the appropriate number of sandwiches suitable for vegetarians.

State whether or not the binomial distribution provides an appropriate model for the number of sandwiches suitable for vegetarians which Hilda takes to the match. Explain your answer. *(2 marks)*

(c) In fact the eight sandwiches which Hilda took to the match contained four suitable for vegetarians. The first four friends to eat a sandwich were not vegetarians. Each selected one of the available sandwiches at random and ate it.

State whether or not the binomial distribution provides an appropriate model for the number of sandwiches suitable for vegetarians eaten by these four friends. Explain your answer. *(2 marks)*

Question Number and part	**Solution**	**Marks**	**Total**	**Comments**
6(a)(i)	Binomial $n = 8$ $p = 0.3$	B1 B1		Binomial 8, 0.3
	P (2 or fewer) = 0.552	B1		0.552 (0.551 , 0.5525)
(ii)	P(2) = 0.5518 – 0.2553 = 0.2965	M1		P(2 or fewer) – P(1 or fewer) or use of correct formula
		A1		0.2965 (0.296 , 0.297)
(iii)	P(>3) = 1 – 0.8059 = 0.194	M1		P(>3) = 1 – P(3 or fewer) or use of correct formula
		A1	7	0.194 (0.193 , 0.195) **sc** B1 0.448 (0.448 , 0.449)
(b)	No, n not constant/probabilities not random/not independent/0,1 not possible outcomes	M1 A1	2	No Reason
(c)	No, p not constant/ not independent	M1 A1	2	No Reason
	Total		**11**	