1 An online shopping company takes orders through its website. On average 80% of orders from the website are delivered within 24 hours. The quality controller selects 10 orders at random to check when they are delivered.

(i) Find the probability that

(*A*) exactly 8 of these orders are delivered within 24 hours, **[3]**

(*B*) at least 8 of these orders are delivered within 24 hours. **[2]**

The company changes its delivery method. The quality controller suspects that the changes will mean that fewer than 80% of orders will be delivered within 24 hours. A random sample of 18 orders is checked and it is found that 12 of them arrive within 24 hours.

(ii) Write down suitable hypotheses and carry out a test at the 5% significance level to determine whether there is any evidence to support the quality controller's suspicion. **[7]**

(iii) A statistician argues that it is possible that the new method could result in either better or worse delivery times. Therefore it would be better to carry out a 2-tail test at the 5% significance level. State the alternative hypothesis for this test. Assuming that the sample size is still 18, find the critical region for this test, showing all of your calculations. **[7]**

2 In a game of darts, a player throws three darts. Let X represent the number of darts which hit the bull's-eye. The probability distribution of X is shown in the table.

r	0	1	2	3
$P(X = r)$	0.5	0.35	p	q

(i) (*A*) Show that $p + q = 0.15$. [1]

(*B*) Given that the expectation of X is 0.67, show that $2p + 3q = 0.32$. [1]

(*C*) Find the values of p and q. [2]

(ii) Find the variance of X. [3]

3 A psychology student is investigating memory. In an experiment, volunteers are given 30 seconds to try to memorise a number of items. The items are then removed and the volunteers have to try to name all of them. It has been found that the probability that a volunteer names all of the items is 0.35. The student believes that this probability may be increased if the volunteers listen to the same piece of music while memorising the items and while trying to name them.

The student selects 15 volunteers at random to do the experiment while listening to music. Of these volunteers, 8 name all of the items.

(i) Write down suitable hypotheses for a test to determine whether there is any evidence to support the student's belief, giving a reason for your choice of alternative hypothesis. [4]

(ii) Carry out the test at the 5% significance level. [4]

4 A particular product is made from human blood given by donors. The product is stored in bags. The production process is such that, on average, 5% of bags are faulty. Each bag is carefully tested before use.

(i) 12 bags are selected at random.

(*A*) Find the probability that exactly one bag is faulty. [3]

(*B*) Find the probability that at least two bags are faulty. [2]

(*C*) Find the expected number of faulty bags in the sample. [2]

(ii) A random sample of n bags is selected. The production manager wishes there to be a probability of one third or less of finding any faulty bags in the sample. Find the maximum possible value of n, showing your working clearly. [3]

(iii) A scientist believes that a new production process will reduce the proportion of faulty bags. A random sample of 60 bags made using the new process is checked and one bag is found to be faulty. Write down suitable hypotheses and carry out a hypothesis test at the 10% level to determine whether there is evidence to suggest that the scientist is correct. [8]