

- 1** A manufacturer produces tiles. On average 10% of the tiles produced are faulty. Faulty tiles occur randomly and independently.

A random sample of 18 tiles is selected.

- (i) (A) Find the probability that there are exactly 2 faulty tiles in the sample. [3]
- (B) Find the probability that there are more than 2 faulty tiles in the sample. [3]
- (C) Find the expected number of faulty tiles in the sample. [2]

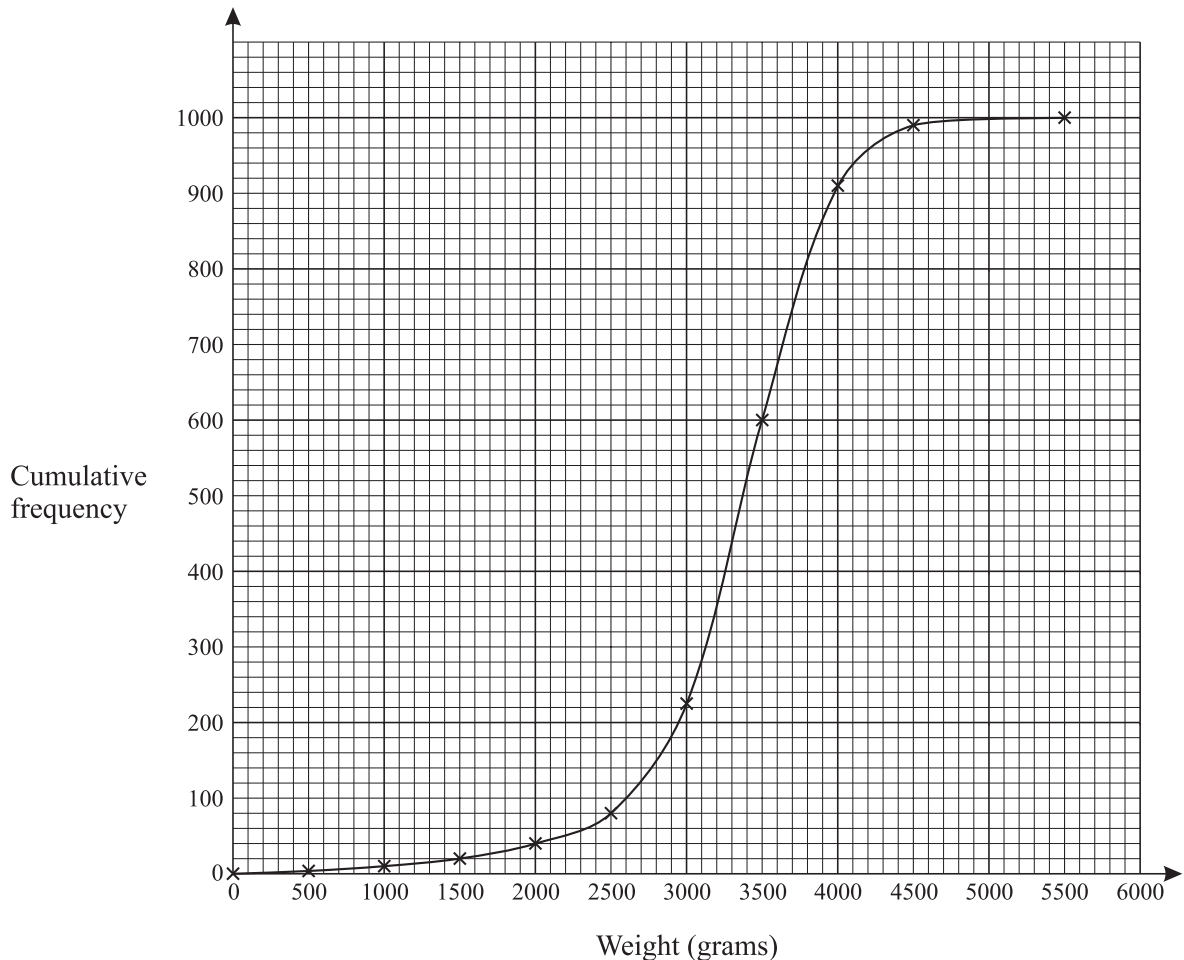
A cheaper way of producing the tiles is introduced. The manufacturer believes that this may increase the proportion of faulty tiles. In order to check this, a random sample of 18 tiles produced using the cheaper process is selected and a hypothesis test is carried out.

- (ii) (A) Write down suitable null and alternative hypotheses for the test.
- (B) Explain why the alternative hypothesis has the form that it does. [4]
- (iii) Find the critical region for the test at the 5% level, showing all of your calculations. [4]
- (iv) In fact there are 4 faulty tiles in the sample. Complete the test, stating your conclusion clearly. [2]

- 2** In a multiple-choice test there are 30 questions. For each question, there is a 60% chance that a randomly selected student answers correctly, independently of all other questions.

- (i) Find the probability that a randomly selected student gets a total of exactly 20 questions correct. [3]
- (ii) If 100 randomly selected students take the test, find the expected number of students who get exactly 20 questions correct. [2]

- 3 The birth weights in grams of a random sample of 1000 babies are displayed in the cumulative frequency diagram below.



- (i) Use the diagram to estimate the median and interquartile range of the data. [3]
- (ii) Use your answers to part (i) to estimate the number of outliers in the sample. [4]
- (iii) Should these outliers be excluded from any further analysis? Briefly explain your answer. [2]
- (iv) Any baby whose weight is below the 10th percentile is selected for careful monitoring. Use the diagram to determine the range of weights of the babies who are selected. [2]

12% of new-born babies require some form of special care. A maternity unit has 17 new-born babies. You may assume that these 17 babies form an independent random sample.

- (v) Find the probability that
- (A) exactly 2 of these 17 babies require special care, [3]
- (B) more than 2 of the 17 babies require special care. [3]
- (vi) On 100 independent occasions the unit has 17 babies. Find the expected number of occasions on which there would be more than 2 babies who require special care. [1]

4 When onion seeds are sown outdoors, on average two-thirds of them germinate. A gardener sows seeds in pairs, in the hope that at least one will germinate.

(i) Assuming that germination of one of the seeds in a pair is independent of germination of the other seed, find the probability that, if a pair of seeds is selected at random,

(A) both seeds germinate,

(B) just one seed germinates,

(C) neither seed germinates. [3]

(ii) Explain why the assumption of independence is necessary in order to calculate the above probabilities. Comment on whether the assumption is likely to be valid. [2]

(iii) A pair of seeds is sown. Find the expectation and variance of the number of seeds in the pair which germinate. [3]

(iv) The gardener plants 200 pairs of seeds. If both seeds in a pair germinate, the gardener destroys one of the two plants so that only one is left to grow. Of the plants that remain after this, only 85% successfully grow to form an onion. Find the expected number of onions grown from the 200 pairs of seeds. [3]

If the seeds are sown in a greenhouse, the germination rate is higher. The seed manufacturing company claims that the germination rate is 90%. The gardener suspects that the rate will not be as high as this, and carries out a trial to investigate. 18 randomly selected seeds are sown in the greenhouse and it is found that 14 germinate.

(v) Write down suitable hypotheses and carry out a test at the 5% level to determine whether there is any evidence to support the gardener's suspicions. [7]