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7. A fair six-sided die is labelled with the numbers 1, 2, 3, 4, 5 and 6
The die is rolled 40 times and the score, S, for each roll is recorded.

(a) Find the mean and the variance of S.

(2)

(b) Find an approximation for the probability that the mean of the 40 scores is less than 3

(3)

7. The continuous random variable D is uniformly distributed over the interval $[x-1, x+5]$ where x is a constant.

A random sample of n observations of D is taken, where n is large.

(a) Use the Central Limit Theorem to find an approximate distribution for $\overline{D}$
Give your answer in terms of n and x where appropriate.

(3)

The n observations of D have a sample mean of 24.6

Given that the lower bound of the 99% confidence interval for x is 22.101 to 3 decimal places,

(b) find the value of n
Show your working clearly.

(5)

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2. Secondary schools in a region conduct ability testing at the start of Year 7 and the start of Year 8. Each year a regional education officer randomly selects 240 Year 7 students and 240 Year 8 students from across the region. The results for last year are summarised in the table below.

	Mean score	Variance of scores
Year 7	101	38
Year 8	103	42

The regional education officer claims that there is no difference between the mean scores of these two year groups.

(a) Test the regional education officer's claim at the 1% significance level. You should state your hypotheses, test statistic and critical value clearly.

(7)

(b) Explain the significance of the Central Limit Theorem in part (a).

(1)

5. A manager of a large company is investigating the time it takes the company's employees to complete a task.

The manager believes that the mean time for full-time employees to complete the task is more than a minute quicker than the mean time for part-time employees to complete the task.

The manager collects a random sample of 605 full-time employees and 45 part-time employees and records the times, t minutes, it takes each employee to complete the task.

The results are summarised in the table below.

	n	$\bar{t}$	s^2
Full-time employees	605	5.6	9
Part-time employees	45	7.0	4

(a) Test, at the 5% level of significance, the manager's claim.

You should state your hypotheses, test statistic, critical value and conclusion clearly.

(8)

(b) State two assumptions you have made in carrying out the test in part (a)

(2)

The company increases the size of the sample of part-time employees to 46
The time taken to complete the task by the extra employee is 8 minutes.

(c) Find an unbiased estimate of the variance for the sample of 46 part-time employees.

(4)

1. A machine makes screws with a mean length of 30 mm and a standard deviation of 2.5 mm.

A manager claims that, following some repairs, the machine is now making screws with a mean length of less than 30 mm. The manager takes a random sample of 80 screws and finds that they have a mean length of 29.5 mm.

Use a suitable test, at the 5% level of significance, to determine whether there is evidence to support the manager's claim. State your hypotheses clearly.

(5)

3. A biologist is investigating the weights of rabbits in two different regions, region A and region B

The biologist collects random samples of 50 rabbits from region A and 40 rabbits from region B and records the weight, x kg, of each rabbit.

The table shows a summary of the biologist's data.

	Sample size	$\sum x$	$\sum x^2$	Unbiased estimate of the mean	Unbiased estimate of the variance
Region A	50	132.5	354.555	2.65	0.07
Region B	40	118	350.05	p	q

(a) Calculate the value of p and the value of q

(3)

The biologist believes that the mean weight of rabbits in region A is smaller than the mean weight of rabbits in region B

(b) Stating your hypotheses clearly, carry out a suitable test to assess the biologist's belief. Use a 5% level of significance and state your critical value.

(7)

(c) Explain how you have used the fact that the sample sizes are large in your answer to part (b)

(2)

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8. The random variable X has a continuous uniform distribution over the interval $[\alpha + 3, 2\alpha + 9]$ where α is a constant.

The mean of a random sample of size n, taken from this distribution, is denoted by $\bar{X}$

(a) Show that $\bar{X}$ is a biased estimator of α

(2)

(b) Hence find the bias, in terms of α, when $\bar{X}$ is used as an estimator of α

(1)

Given that $Y = \frac{2\bar{X}}{3} + k$ is an unbiased estimator of α

(c) find the value of the constant k

(2)

A random sample of 8 values of X is taken and the results are as follows

4.8 5.8 6.5 7.1 8.2 9.5 9.9 10.6

(d) Use the sample to estimate the maximum value that X can take.

(3)

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