

QQQ – Further Statistics 2 – Chapter 5 – Estimation, Confidence Intervals and Tests Using a Normal Distribution (Version 2)

Total Marks: 25

(25 = Platinum, 23 = Gold, 20 = Silver, 17 = Bronze)

1. A biased coin has a probability p of landing on heads, where $0 < p < 1$

Simon spins the coin n times and the random variable X represents the number of heads.

Taruni spins the coin m times, $m \neq n$, and the random variable Y represents the number of heads.

Simon and Taruni want to combine their results to find unbiased estimators of p .

Simon proposes the estimator $S = \frac{X + Y}{m + n}$ and Taruni proposes $T = \frac{1}{2} \left[\frac{X}{n} + \frac{Y}{m} \right]$

- (a) Show that both S and T are unbiased estimators of p . (3)

- (b) Prove that, for all values of m and n , S is the better estimator. (4)

(Total 7 marks)

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2. The waiting times, in minutes, of patients at a doctor's surgery follows a normal distribution with unknown mean μ and known standard deviation σ

A random sample of 120 patients was taken.

- (a) Find, in the form $k\sigma$, the width of a 99% confidence interval for μ based on this sample.
Give the value of k to 2 decimal places. (3)

A further random sample of 100 patients from the surgery gave a 90% confidence interval for μ of (5.14, 6.25)

- (b) Use this confidence interval to determine whether or not it provides evidence that $\mu = 6$
State the hypotheses being tested here and write down the significance level being used.
You do not need to carry out any further calculations. (3)

- (c) Find the value of σ (3)

(Total 9 marks)

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3. An engineer has developed a new battery. She claims that the new battery will last more than 8 hours longer, on average, than the old battery. To test the claim, the engineer randomly selects a sample of 50 new batteries and 40 old batteries. She records how long each battery lasts, x hours for the new batteries and y hours for the old batteries. The results are summarised in the table below.

	n	Sample mean	s^2
New battery	50	$\bar{x} = 83$	7
Old battery	40	$\bar{y} = 74$	6

- (a) Test, at the 5% level of significance, whether or not there is evidence to support the engineer's claim. State your hypotheses and show your working clearly. (7)
- (b) Explain the relevance of the Central Limit Theorem to the test in part (a). (2)

(Total 9 marks)