



**Year 12 Methods Unit 3,4
Test 6 2021**

**Calculator Assumed
Sampling**

STUDENT'S NAME _____

DATE: Monday 30 August

TIME: 50 minutes

MARKS: 50

INSTRUCTIONS:

Standard Items: Pens, pencils, drawing templates, eraser

Special Items: Three calculators, notes on one side of a single A4 page (these notes to be handed in with this assessment)

Questions or parts of questions worth more than 2 marks require working to be shown to receive full marks.

1. (12 marks)

A survey in Perth for high school students was conducted on ownership of a mobile phone. Out of 1845 students the survey found 1271 students owned a phone which was less than 1 year old.

Determine the following.

(a) (i) The sample proportion of high school students who own a mobile phone less than 1 year old. [1]

(ii) A 90% confidence interval for the proportion of Perth high school students who owned a mobile phone less than 1 year old. [2]

(ii) What assumption was made in calculating this interval? [1]

(b) The margin of error in the calculated confidence interval. [2]

Another three surveys of Perth high school students were conducted on ownership of a mobile phone less than 1 year old.

Survey 2 1635 out of 2338 high school students

Survey 3 840 out of 1298 high school students

Survey 4 2076 out of 3026 high school students

(c) Which of these surveys were more likely to have been taken outside of Perth? Justify your answer. [3]

- (d) Using the sample proportion from the initial survey, calculate the sample size that will halve the margin of error for the proportion of Perth high school students who have a mobile phone less than 1 year old. [3]

2. (3 marks)

A 99% confidence interval for a population proportion based on a sample size of 300 has a width d . What sample size is required to obtain a 99% confidence interval of width $\frac{d}{4}$?

3. (13 marks)

The Talsla Car Company produces electric cars. It wants to gather information consumers' interest in electric cars.

- (a) In each of the following cases, comment, giving reasons, whether or not the proposed sampling method introduces bias.
- (i) A Talsla Company representative stood near the Talsla display at a Car expo and asked people walking by "if they were to purchase an electric car, would it be a Talsla or an inferior brand"? [2]
- (ii) Two thousand randomly chosen mobile phone numbers were called and people asked "which brand of electric car would you prefer to buy"? [2]

One common problem with a particular electric car is the battery overheating. The manufacturer has found that 1% of their cars will suffer from this defect in the first two years. A sample of 250 is taken. Let the random variable X be the number of cars with overheating battery problems in the first two years in the sample of 250.

- (b) What is the distribution of X ? [2]
- (c) What is the probability that more than four cars will have overheating battery problems within two years? [2]

In the random sample of 250 cars, three of them had battery over heating problems within the first two years.

- (d) Calculate an approximate 94% confidence interval for the proportion of cars that have battery over heating problems within the first two years. [2]
- (e) The company's quality control department wants the proportion of cars with battery problems to be between 0.5% and 1%. Based on your confidence interval, decide whether the quality control department is meeting its target. Justify your answer. [2]
- (f) Give an interpretation of the meaning of the 94% confidence interval. [1]

4. (11 marks)

A beekeeper takes a sample of 290 bees in a beehive and determines that 34 of them are male drone bees.

(a) Determine a 90% confidence interval for the true proportion of drone bees in the hive. [2]

It is an accepted fact that healthy beehives have a 0.15 proportion of drone bees.

(b) Determine whether the beehive is likely to be healthy. Justify your answer. [2]

(c) The beekeeper decides to take another sample.

(i) If a new sample of 320 bees is taken, and knowing the true proportion of drones is 0.15, what is the probability that the sample proportion is at most 0.17? [3]

- (ii) If a larger sample is taken, will the probability in (i) increase or decrease. Explain your answer. [2]
- (iii) If the margin of error determined from a 90% confidence interval is to remain unchanged, how will the value of n , the sample size, change for a 99% confidence interval? Explain your answer. [2]

5. (11 marks)

The proportion of boats on the road being towed by vehicles that have the incorrect towing capacity is p .

(a) Show, using calculus, that to maximise the margin of error a value of $\hat{p} = 0.5$ should be used. Note: as z and n are constants, the standard error formula can be reduced to

$$E = \sqrt{\hat{p}(1 - \hat{p})}. \quad [4]$$

(b) A consulting firm wants to determine p within 6% and with 99% confidence. How many towing vehicles should be tested at a random check? [3]

(c) Another random check sampling towing vehicles is made three months later. A 99% confidence interval calculated for the proportion of vehicles with incorrect towing capacity is (0.269, 0.373). Determine the number of vehicles in the sample that have an incorrect towing capacity. [4]