General Certificate of Education
June 2005
Advanced Level Examination

MATHEMATICS AND STATISTICS (SPECIFICATION B) Unit Statistics 7

MBS7

Monday 20 June 2005 Morning Session

In addition to this paper you will require:
- an 8-page answer book;
- the AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

Time allowed: 1 hour 15 minutes

Instructions
- Use blue or black ink or ball-point pen. Pencil should only be used for drawing.
- Write the information required on the front of your answer book. The *Examining Body* for this paper is AQA. The *Paper Reference* is MBS7.
- Answer **all** questions.
- All necessary working should be shown; otherwise marks for method may be lost.
- The **final** answer to questions requiring the use of tables or calculators should normally be given to three significant figures.

Information
- The maximum mark for this paper is 60.
- Mark allocations are shown in brackets.

Advice
- Unless stated otherwise, formulae may be quoted, without proof, from the booklet.

Answer **all** questions.

1 In the production of cough syrup, it is important to control the variability of each ingredient.

The data below show the amount, in milligrams, of pholcodine in each of a random sample of ten 200-millilitre bottles of a particular cough syrup.

201 202 199 198 203 197 200 201 198 201

Assuming pholcodine content to be normally distributed, construct a 99% confidence interval for the standard deviation of the pholcodine content of 200-millilitre bottles of this particular cough syrup. *(7 marks)*

2 Tanya, a teacher, travels by car each day between her home in Thirsk and her school in Middlesbrough. She leaves home at the same time each day and also leaves school at about the same time each day.

An analysis of the journey times, in minutes, of a random sample of 10 of Tanya's journeys from Thirsk to Middlesbrough results in an unbiased estimate of the population variance of 4.3.

For a random sample of 12 of Tanya's journeys from Middlesbrough to Thirsk, the corresponding unbiased estimate is 20.2.

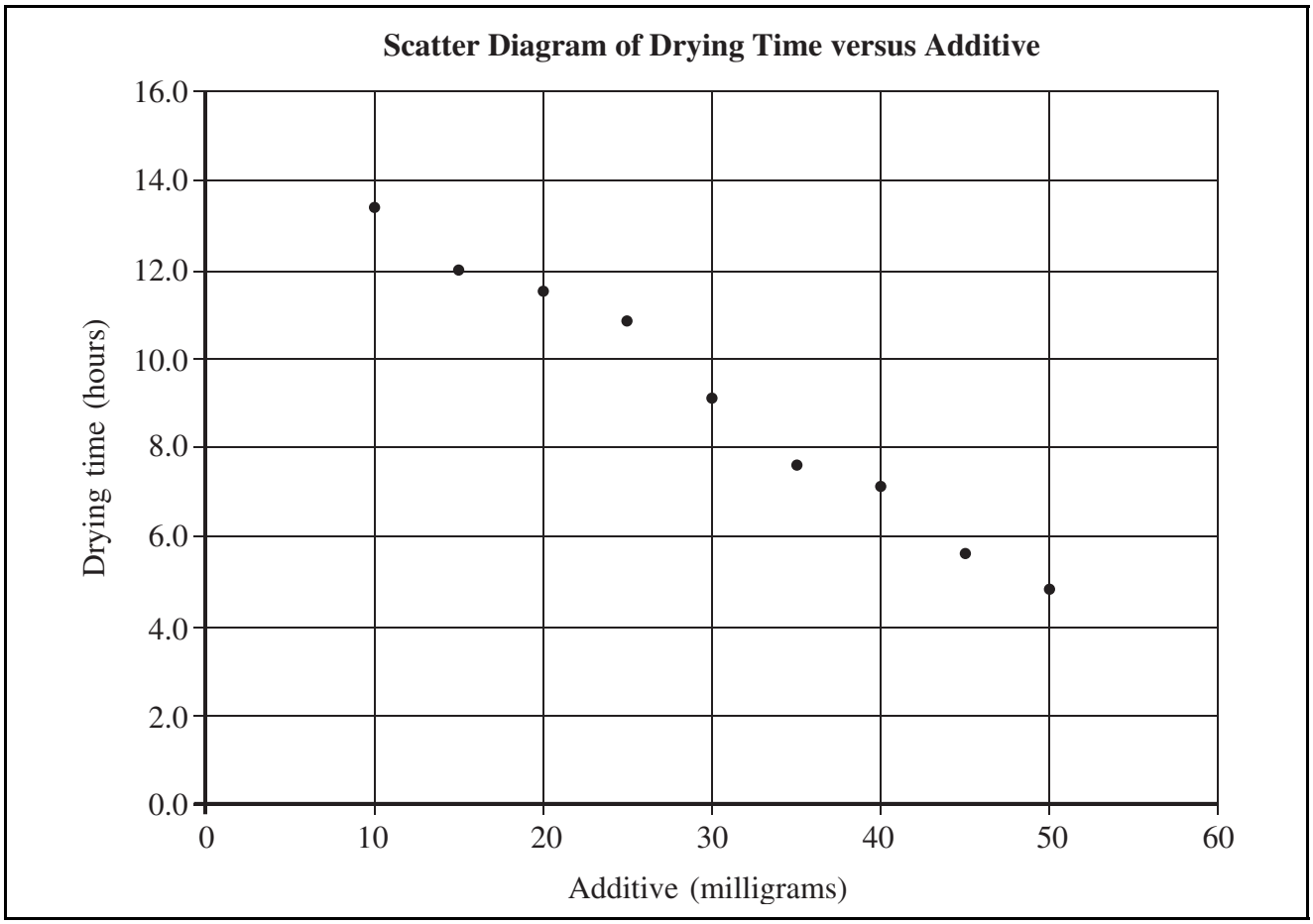
For each direction of travel, Tanya's journey times may be assumed to be normally distributed.

Test, at the 5% level of significance, the hypothesis that there is no difference in the variability of Tanya's journey times for the two directions of travel. *(6 marks)*

3 The drying time of a certain gloss paint varies according to the quantity of a drying additive.

Nine samples, each of 200 millilitres, were taken from a batch of the paint. Into each sample a measured quantity, x milligrams, of the additive was thoroughly mixed. The paint from the samples was then used under carefully controlled conditions and the drying time, y hours, measured for each sample.

The results are illustrated in the following scatter diagram.



(a) Explain why the above information suggests that the relationship between x and y may be modelled by:

$$y = \alpha + \beta x + \varepsilon \quad \text{where} \quad \varepsilon \sim \mathrm{N}(0, \sigma^2).$$ *(2 marks)*

(b) Given the following additional information, determine the equation of the least squares regression line, $y = \hat{\alpha} + \hat{\beta}x$.

$$\bar{x} = 30 \qquad \bar{y} = 9.1 \qquad S_{xx} = 1500 \qquad S_{xy} = -328 \qquad S_{yy} = 72.54$$ *(2 marks)*

(c) Calculate an unbiased estimate of σ^2. *(2 marks)*

(d) Test, at the 5% level of significance, the hypothesis that $\beta = -0.2$. *(6 marks)*

(e) Explain, in context, the implications of your conclusion to part (d). *(2 marks)*

Turn over ▶

4 The table below shows the daily hours that a branch library is open, together with the daily number of customers served during a randomly selected week.

Day	**Monday**	**Tuesday**	**Thursday**	**Friday**	**Saturday**
Hours	7.5	3.5	7.5	9.0	4.5
Customers	136	43	89	127	85

Use a χ^2 goodness of fit test and the 10% level of significance to test the claim that the average number of customers served per hour is constant throughout the week. *(9 marks)*

5 Cartons of semi-skimmed milk have weights that may be assumed to be normally distributed with a mean of 1085 grams and a standard deviation of 18 grams.

A box holds 6 randomly selected cartons. The weights of these boxes are independent of the weights of the cartons and may be assumed to be normally distributed with a mean of 420 grams and a standard deviation of 6 grams.

(a) (i) Calculate values for the mean and variance of the weight, W, of a box plus 6 cartons. *(3 marks)*

(ii) Hence determine the probability that W is less than 7 kilograms. *(2 marks)*

(b) Determine the probability that the difference in weight between two randomly selected cartons is more than 50 grams. *(6 marks)*

6 A rail company claims that more than 40% of its trains arrive early at a particular terminus.

Assume that early arrivals of trains at the terminus are independent.

(a) A check of a random sample of 30 trains that had arrived at the terminus showed that 15 trains had arrived early.

Investigate the company's claim at the 10% level of significance. *(5 marks)*

(b) A check of a second random sample of 150 trains that had arrived at the terminus showed that 73 trains had arrived early.

Re-investigate the company's claim, again at the 10% level of significance. *(6 marks)*

(c) Comment, with a reason, on the likely validity of the assumption that early arrivals of trains at the terminus are independent. *(2 marks)*

END OF QUESTIONS