WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
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504/01

MATHEMATICS MS

MECHANICS AND STATISTICS

A.M. WEDNESDAY, 25 January 2006

(1 $\frac{1}{2}$ hours)

LEGACY SPECIFICATION

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:

- a 12 page answer book;
- a Formula Booklet;
- a calculator;
- statistical tables (Murdoch and Barnes or RND/WJEC Publications).

INSTRUCTIONS TO CANDIDATES

Answer **all** questions.

Take g as $9{\cdot}8\,\text{ms}^{-2}$.

INFORMATION FOR CANDIDATES

Graphical calculators may be used for this paper.

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

1. The number of local telephone calls received in t hours at a certain office has a Poisson distribution with mean $6{\cdot}4t$. Independently, the number of long distance telephone calls received in t hours at the same office has a Poisson distribution with mean $1{\cdot}6t$.

(a) Find the probability that the **total number** of local and long distance telephone calls received in a period of 1 hour will be at least 9. [2]

(b) Use an appropriate distributional approximation to find the probability that fewer that 60 **local** telephone calls will be received during a working day of 8 hours. [5]

2. A car of mass 1100 kg travels up a straight hill inclined at an angle α to the horizontal, where $\sin\alpha = \frac{1}{22}$. The car's engine works at a rate of 27 kW. The resistance to the car's motion is constant and equals 790 N. Calculate the acceleration of the car up the hill when its speed is $18\,\text{ms}^{-1}$. [6]

3. A gardener plants 120 seeds in a large tray. Independently of all other seeds, the probability that any particular seed will germinate is $0{\cdot}65$. Use an appropriate distributional approximation to find the probability that fewer than 75 of these seeds will germinate. [7]

4. A golf ball is driven from a point A on a golf course with initial velocity $51\,\text{ms}^{-1}$ at an angle of elevation 21° above the horizontal. The ball hits the ground again at a point B whose horizontal distance from A is 200 m.

(a) Calculate the time taken for the ball to travel from A to B. Give your answer correct to one decimal place. [2]

(b) (i) Find the vertical displacement of B from A.

(ii) State whether the horizontal level of B is above or below that of A. Justify your answer.

[4]

(c) Find the speed of the ball at B. [4]

5. Gwyn sleeps between 6 and 9 hours each night. The time, X hours, that Gwyn sleeps per night may be modelled as a continuous random variable whose probability density function f is given by

$$f(x) = \frac{2}{9}(9 - x), \qquad \text{for } 6 \leqslant x \leqslant 9,$$

$$f(x) = 0, \qquad \text{otherwise.}$$

(a) Calculate the mean time that Gwyn sleeps per night. [4]

(b) Calculate the variance of the time that Gwyn sleeps per night. [5]

6. One end of a light elastic string of modulus 39·15 N and natural length 0·9 m is attached to a fixed point A and the other end is attached to a particle of mass 0·5 kg. Initially, the particle is held at A and is then released from rest. Find the speed of the particle at B, where B is the point 1·3 m vertically below A. [6]

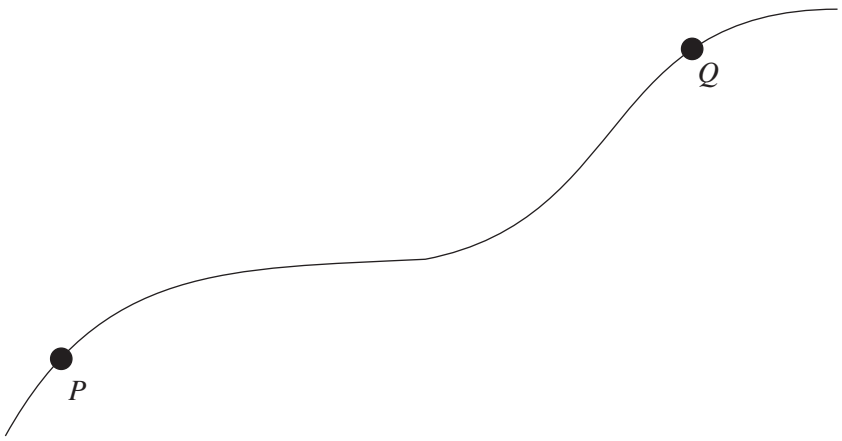
7. A supermarket sells orange juice in cartons. The volume of orange juice in a carton is normally distributed with mean 514 ml and standard deviation 8 ml.

(a) Cerys buys one carton of orange juice from the supermarket. Find the probability that the volume of orange juice in the carton will be greater than 500 ml. [2]

(b) Whenever Dafydd buys a carton of orange juice from the supermarket, he empties its contents into a jug. He knows from past experience that only 3% of the cartons contain sufficient orange juice to make the jug overflow. Find the capacity of the jug, giving your answer correct to the nearest ml. [3]

(c) Each week, Sara buys nine cartons of orange juice from the supermarket. Find the standard deviation of the total volume of orange juice bought by Sara each week. [2]

8.



The diagram shows two points, P and Q, on a mountain road, with the horizontal level of Q above that of P. A cyclist starts from rest at P, rides up the mountain road, and 3 minutes later reaches Q. Throughout his journey from P to Q, the cyclist works at a constant rate of 190 W. The cyclist's speed at Q is $5\ \text{ms}^{-1}$ and the combined mass of the cyclist and his bike is 80 kg. The total work done against the resistance of the road as the cyclist travels from P to Q is 9680 J. Find the vertical height of Q above P. [6]

TURN OVER

9. A computer is programmed to randomly generate numbers in the interval (1·6, 3·4). Once a number has been generated, the computer then calculates the value of its square. Let X denote a number generated by the computer and let Y denote the value of its square.

(a) Suggest an appropriate model for the distribution of X. [1]

(b) Write down the mean of X. [1]

(c) Find the variance of X. [2]

(d) Calculate the mean of Y. [3]

10. A uniform ladder AB of length 5 m and mass 18 kg has one end A resting against a rough vertical wall and the other end B resting on rough horizontal ground. The coefficient of friction between the ladder and the **ground** is 0·3. The ladder is inclined at an angle α to the ground, where $\sin \alpha = 0{\cdot}8$, and is on the point of slipping.

(a) Show that the magnitude of the normal reaction of the ground on the ladder is 147 N. [6]

(b) Find the value of the coefficient of friction between the ladder and the wall. [4]