



Structural Sample - Assessment Lab

Statistics & Mechanics - Sample Paper

Method Room Assessment Lab - Section A: Statistics, Section B: Mechanics

Time allowed: 2 hours	Total marks: 100 (50 + 50)
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Section A (Statistics) and Section B (Mechanics) each carry 50 marks. Answer ALL questions in both sections. Take $g = 9.8 \text{ m s}^{-2}$ throughout.

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SECTION A: STATISTICS (Answer ALL questions in this section)

1.

For events A and B, $P(A) = 0.4$, $P(B) = 0.5$, and $P(A \cap B) = 0.15$.

- (a) Find $P(A \cup B)$. **(2 marks)**
- (b) Find $P(A \mid B)$. **(3 marks)**
- (c) Determine, showing your reasoning, whether A and B are independent. **(3 marks)**
- (d) Draw a Venn diagram to represent this information, showing the probability in each region. **(4 marks)**

(Total for Question 1 is 12 marks)

2.

A biased coin is flipped 15 times. The random variable X, the number of heads, is modelled as $X \sim B(15, 0.3)$.

- (a) Find $P(X = 5)$. **(3 marks)**
- (b) Find $P(X \leq 3)$. **(3 marks)**
- (c) Find $P(X \geq 8)$. **(3 marks)**
- (d) State the mean and variance of X, and state one condition required for the binomial model to be valid in this context. **(4 marks)**

(Total for Question 2 is 13 marks)

3.

The heights of adult males in a population are modelled as $X \sim N(65, 8^2)$, measured in inches.

- (a) Find $P(X > 70)$. **(4 marks)**
- (b) Find $P(55 < X < 70)$. **(4 marks)**
- (c) Find the height h such that $P(X > h) = 0.10$, giving your answer to 1 decimal place. **(5 marks)**

(Total for Question 3 is 13 marks)

4.

A researcher collects 12 paired observations and calculates a sample product-moment correlation coefficient of $r = 0.62$. She tests, at the 5% significance level, whether there is evidence of positive correlation in the population.

- (a) State suitable null and alternative hypotheses for this test. **(2 marks)**
- (b) Given that the critical value for a one-tailed test at the 5% level with $n = 12$ is 0.4973, state the critical region and carry out the test, interpreting your conclusion in context. **(6 marks)**
- (c) State one assumption required about the population for this hypothesis test to be valid. **(4 marks)**

(Total for Question 4 is 12 marks)

SECTION B: MECHANICS (Answer ALL questions in this section - take $g = 9.8 \text{ m s}^{-2}$)

5.

A particle moves in a straight line with initial velocity 5 m s^{-1} and constant acceleration 2 m s^{-2} .

- (a) Find the displacement of the particle after 6 seconds. **(4 marks)**
- (b) Find the velocity of the particle after 6 seconds. **(3 marks)**
- (c) Sketch a velocity-time graph for the motion over these 6 seconds, labelling the axes. **(3 marks)**

(Total for Question 5 is 10 marks)

6.

Two particles, P of mass 5 kg and Q of mass 3 kg, are connected by a light inextensible string passing over a smooth, fixed pulley. The particles hang freely on either side of the pulley and the system is released from rest.

- (a) Draw a force diagram for each particle, showing all forces acting. **(3 marks)**
- (b) By forming an equation of motion for each particle, find the acceleration of the system. **(6 marks)**
- (c) Find the tension in the string. **(4 marks)**

(Total for Question 6 is 13 marks)

7.

A ball is projected from a point on horizontal ground with speed 28 m s^{-1} at an angle of 40° above the horizontal. Air resistance is negligible.

- (a) Find the horizontal and vertical components of the initial velocity. **(3 marks)**
- (b) Find the time of flight of the ball. **(4 marks)**
- (c) Find the horizontal range of the ball. **(4 marks)**
- (d) Find the greatest height reached by the ball. **(3 marks)**

(Total for Question 7 is 14 marks)

8.

A uniform beam AB of length 8 m rests horizontally on supports at A and B. The beam has weight 240 N acting at its centre. An additional load of 100 N is placed on the beam at a point 2 m from A.

- (a) Draw a diagram showing all the forces acting on the beam. **(3 marks)**
- (b) By taking moments about A, find the reaction force at B. **(6 marks)**
- (c) Find the reaction force at A. **(4 marks)**

(Total for Question 8 is 13 marks)

END OF PAPER