MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF APPLIED SCIENCES

UNIVERSITY ORDINARY EXAMINATION

2017/2018 ACADEMIC YEAR

FIRST YEAR **FIRST** SEMESTER EXAMINATION FOR THE BACHELOR OF EDUCATION SCIENCE

APH 101 – MECHANICS I

DURATION: 2 HOURS

DATE: 6TH DECEMBER, 2017

TIME: 2.00 – 4.00 P.M.

Instructions to Candidates:

1. Answer **Question 1** and **Any Other Two** questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

SECTION ONE - COMPULSORY

QUESTION ONE

(a) List three limitations of dimensional analysis (3 marks)

(b) Distinguish between fundamental quantities and derived quantities and give one example of each (4 marks)

(c) State the principle of homogeneity of dimensions (1 mark)

(d) Derive the dimensional formula for heat capacity (5 marks)

(e) Check the correctness of the equation $n = \frac{1}{2\pi}\sqrt{\frac{g}{L}}$ by dimensional analysis, where n is frequency, g is acceleration due to gravity and L is length. (5 marks)

(f) A car is accelerating uniformly as it passes two checkpoints that are 30m apart, the time taken between the checkpoints is 4s and the car's speed at the first check point is 5m/s. Find the car's acceleration and speed at the second checkpoint (6 marks)

(g) Distinguish between elastic and inelastic collisions (2 marks)

(h) A 60 kg archer stands at rest on frictionless ice and fires a 0.5kg arrow horizontally at 50m/s. With what velocity does the archer move across the ice after firing the arrow? (4 marks)

SECTION TWO – ANSWER ANY TWO QUESTIONS

QUESTION TWO

(a) A tennis player receives a shot with the ball (0.06kg) travelling horizontally at 50m/s and returns the shot with the ball travelling horizontally at 40m/s in the opposite direction

i) What is the impulse delivered to the ball by the racquet? (5 marks)

ii) What work does the racquet do on the ball? (5 marks)

(b) A railroad car of mass 2.5×10^4kg is moving with a speed of 4m/s. It collides and couples with three other coupled railroad cars, each of the same mass as the single car, and moving in the same direction with initial speed of 2m/s.

i) What is the speed of the four cars after the collision (5 marks)

ii) How much mechanical energy is lost in the collision? (5 marks)

QUESTION THREE

(a) A stone is thrown straight upwards with an initial speed of 40m/s. It is caught on its way down at a point 8m above where it was thrown.

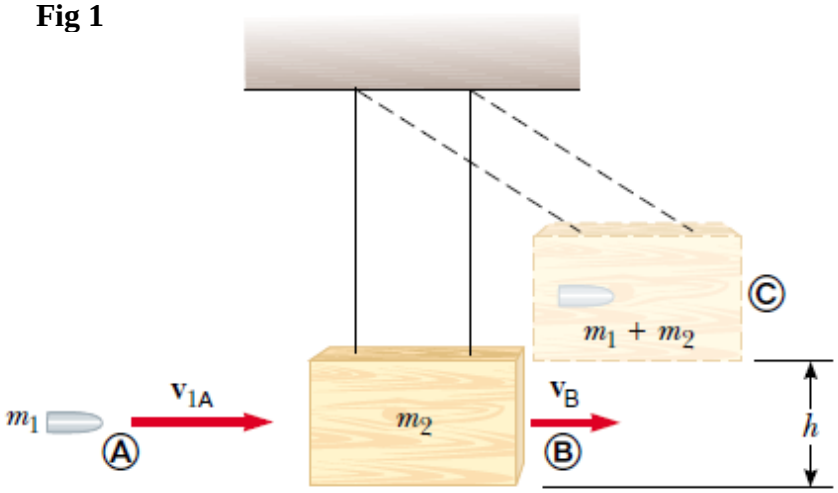
i) How high did it rise? (3 marks)

ii) How fast was it moving when it was caught? (3 marks)

iii) How long did the trip take? (3 marks)

(b) A student performs a ballistic pendulum experiment using the apparatus similar to that shown in Fig 1 below. She obtains the following average data h=8.68cm, m_1=68.8g and m_2=263g.

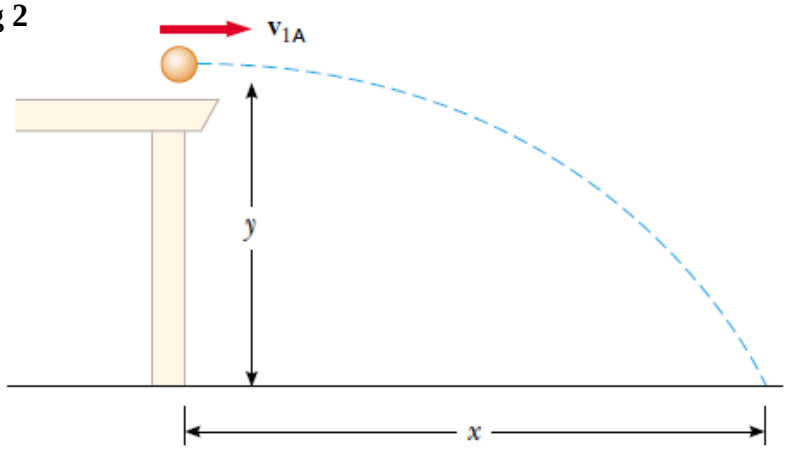
Fig 1



i) Determine the initial speed V_{1A} of the projectile (5 marks)

ii) The second part of her experiment is to obtain V_{1A} by firing the same projectile horizontally (with the pendulum removed from the path), by measuring its final horizontal position x and distance of fall y as shown in fig 2

Fig 2



Show that the initial speed of the projectile is related to x and y through the relation

$$V_{1A} = \frac{x}{\sqrt{2y/g}}$$ (6 marks)

QUESTION FOUR

(a) State Newton's laws of motion (3 marks)

(b) Vicky driving at 35m/s enters a one lane tunnel. He notices a slow moving van 155m ahead traveling at 5m/s. He applies brakes and can only accelerate at -2m/s^2. Will there be a collision? If yes, determine how far into the tunnel the collision occurs. If no, determine the distance of closest approach between Vicky's car and the van (7 marks)

(c) An elevator is required to lift a body of mass 70kg. Find the acceleration of the elevator which could cause a reaction of 900N on the floor. Take g=10N/kg. (5 marks)

(d) A body of mass 4kg initially at rest is moved by a horizontal force of 1N on a smooth frictionless table. Obtain the work done by the force in 8 seconds and show that this is equal to the change in Kinetic energy of the body (5 marks)

QUESTION FIVE

(a) A soccer player kicks a ball from the ground with an initial speed of 19.5m/s at an angle of 45°. A player 55meters away in the direction of the kick starts running to meet the ball at the instant it is to land on the ground. What must be his average speed if he is to meet the ball just before it hits the ground? Neglect air resistance (6 marks)

(b) A particle initially at point x_i moving at a velocity V_{xi} undergoes a uniform acceleration a_x in time t. In this motion its position changes to x_f and its velocity to V_{xf}. Using the given information derive the three main equations of motion for the particle (9 marks)

(c) A car travelling at a constant speed of 45m/s passes a stationary powerful motorcycle. One second after the speeding car passes, the motorcyclist races after the car, accelerating at a constant rate of 3m/s. How long does it take her to overtake the car? (5 marks)