



# MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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## UNIVERSITY EXAMINATIONS 2023/2024

FIRST YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR  
OF SCIENCE IN FOOD SCIENCE AND TECHNOLOGY

### SPS 3150: PHYSICS

DATE: APRIL 2024

TIME: 2 HOURS

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

#### Constants

$$R=8.31 \text{ J/mol.k}$$

$$g=9.80 \text{ N/kg}$$

$$G=6.67 \times 10^{-11} \text{ N.m}^2/\text{kg}^2$$

#### QUESTION ONE (30 MARKS)

- a) i. Write three equations are applied for uniformly accelerated motion. (3 Marks)  
ii. Derive third equation of linear motion. (5 Marks)  
iii. A body moving with uniform acceleration of  $10 \text{ m/s}^2$  covers a distance of 320 m. if its initial velocity was 60 m/s. Calculate its final velocity. (4 Marks)
- b) i. State Newton's first law of motion. (1 Mark)  
ii. An airboat with mass  $3.50 \times 10^2 \text{ kg}$ , including passengers, has an engine that produces a net horizontal force of  $7.70 \times 10^2 \text{ N}$ , after accounting for forces of resistance.  
a. Find the acceleration of the airboat. (3 Marks)



MUST is ISO 9001:2015 and



ISO/IEC 27001:2013 CERTIFIED

- b. Starting from rest, how long does it take the airboat to reach a speed of 12.0 m/s?  
(3 Marks)
- c. After reaching this speed, the pilot turns off the engine and drifts to a stop over a distance of 50.0 m. Find the resistance force, assuming it's constant. (4 Marks)
- c) i. Define the term Gravitational Force (1 Mark)
- d) ii. Find the gravitational force exerted by the Sun on a 70.0-kg man located on Earth. The distance from the Sun to the Earth is about  $1.50 \times 10^{11}$  m, and the Sun's mass is  $1.99 \times 10^{30}$  kg  
(3 Marks)
- e) An astronaut on a space mission lands on a planet with three times the mass and twice the radius of Earth. What is her weight  $w_x$  on this planet as a multiple of her Earth weight  $W_E$ ?  
(3 Marks)

## QUESTION TWO (20 MARKS)

- a) i. Define the term linear momentum. (1 Mark)
- ii. A golf ball with mass  $5.0 \times 10^{-2}$  kg is struck with a club as in Figure 1. The force on the ball varies from zero when contact is made up to some maximum value (when the ball is maximally deformed) and then back to zero when the ball leaves the club, as in the graph of force vs. time in Figure 2. Assume that the ball leaves the club face with a velocity of + 44 m/s.
- a. Find the magnitude of the impulse due to the collision. (3 Marks)
- b. Estimate the duration of the collision and the average force acting on the ball. (6 Marks)



- iii. If the elevator cable breaks, what does the scale read? (3 Marks)
- b) Two objects of mass  $m_1$  and  $m_2$ , with  $m_2 > m_1$ , are connected by a light, inextensible cord and hung over a frictionless pulley, as in Active Figure 3. Both cord and pulley have negligible mass. Find the magnitude of the acceleration of the system and the tension in the cord. (6 Marks)

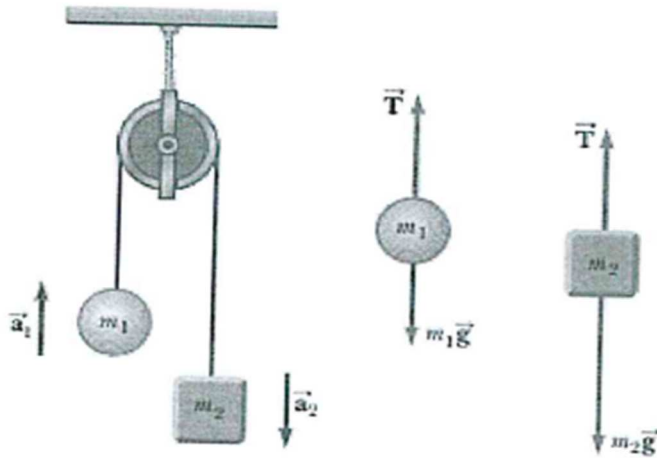


Figure 3

- c) State three assumptions made by kinetic theory of gases model. (3 Marks)

#### QUESTION FOUR (20 MARKS)

- a) Suppose a block with a mass of 2.50 kg is resting on a ramp as shown in figure 4. If the coefficient of static friction between the block and ramp is 0.350, what maximum angle can the ramp make with the horizontal before the block starts to slip down? (5 Marks)

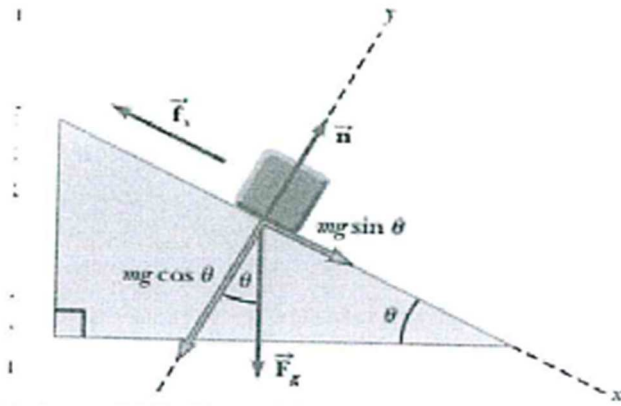


Figure 4

- b) The temperature gradient between the skin and the air is regulated by cutaneous (skin) blood flow. If the cutaneous blood vessels are constricted, the skin temperature and the temperature of the environment will be about the same. When the vessels are dilated, more blood is brought to the surface. Suppose that during dilation the skin warms from  $72.0^{\circ}\text{F}$  to  $84.0^{\circ}\text{F}$ .
- i. Convert these temperatures to Celsius and find the difference. (3 Marks)
  - ii. Convert the temperatures to Kelvin, again finding the difference. (4 Marks)
- c) An ideal gas at  $20.0^{\circ}\text{C}$  and a pressure of  $1.50 \times 10^5 \text{ Pa}$  is in a container having a volume  $1.00\text{L}$ .
- i. Determine the number of moles of gas in the container. (4 Marks)
  - ii. The gas pushes against a piston, expanding to twice its original volume, while the pressure falls to atmospheric pressure. Find the final temperature. (4 Marks)