KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR

FIRST YEAR FIRST SEMESTER
SUPPLEMENTARY/SPECIAL EXAMINATIONS

FOR THE DEGREE OF BSC (PURE PHYSICS/CHEMISTRY) AND BSC (RENEWABLE ENERGY AND BIOFUELS TECHNOLOGY)

COURSE CODE: SPC 111

COURSE TITLE: MECHANICS, HEAT & PROPERTIES OF MATTER

DURATION: 2 HOURS

DATE: 21/7/2022 **TIME: 11:00AM-1:00PM**

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.

Start every question on a new page and make sure question's number is written on each page
This paper consists of **3** printed pages. Please Turn Over

DENSITY of water= 1000 kg m^{-3}
g = 9.8 N kg^{-1} or 9.8 ms^{-2}

QUESTION ONE [30 Marks]

a) What is the meaning of the word *dimension* in physics? Differentiate between speed and velocity. [4 Marks]

b) Find the magnitude of the resultant sum of the two vectors $\vec{a} = (2.0\vec{i} + 4.0\vec{j})m$ and $\vec{b} = (5.0\vec{i} + 2.0\vec{j})m$ lying in the xy plane. [4 marks]

c) Using dimensional analysis, determine the units of acceleration. [3 marks]

d) A coin is thrown vertically upward from the ground with the speed of 10 m/s. How long does it take to reach the highest point? What is the maximum height reached by the coin? [4 Marks]

e) State the states of equilibrium. [3 Marks]

f) A container can withstand a pressure of 75 kPa. At what depth in sea-water will it collapse? Density of sea-water is 1.024 g/cm^3 [2 Marks]

g) The air in a plastic bag trebles in volume as it rises from the bottom of a fresh-water lake. Find the depth of the lake if the barometric height is 0.76 m of mercury. [3 Marks]

h) Define tensile stress and tensile strain. [2 Marks]

i) Calculate the resultant velocity of a boat which is rowed at 1.5 m/s^2 at right-angles to the direction of a current of 1

j) m/s^2. [4 Mark]

k) State the law of conservation of linear momentum. [2 Marks]

l) Find the maximum load which may be placed on a steel wire of diameter 1.0 mm if the permitted strain must not exceed $1/1000$ and the Young's modulus for steel is 2.0×10^{11} Nm^{-2}. [3 Marks]

QUESTION TWO [20 Marks]

a) Define the impulse of a force. State its unit. [2 mark]

I. A 1 kg ball drops vertically on the floor with a speed of 30 m/s and rebounds with an initial speed of 20 m/s. What is the impulse that acts on the ball during the impact? [4 marks]

II. A force of 200N pulls a box of mass 50 kg and overcomes a constant frictional force of 40 N. What is the acceleration of the sledge? [3 marks]

b) I. State two effects of force on an object. [2 marks]

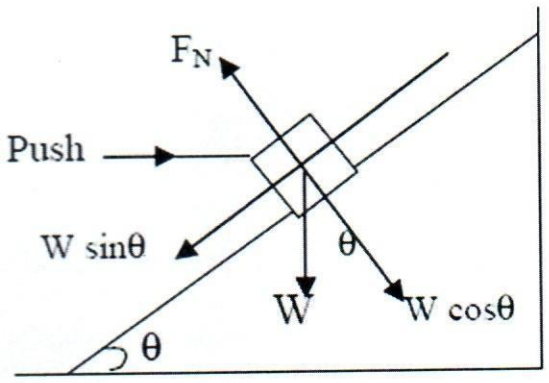
II. A model car moves round a circular track of radius 0.3 m at 2 revolutions per second. What is (a) the angular velocity, ω (b) The speed v of the car? [4 marks]

c) The figure below shows a person applying a horizontal force in trying to push a 25 kg block up a frictionless plane inclined at an angle of 15^0.

I. Calculate the force needed just to keep the block in equilibrium.

II. Suppose that she applies three times that force. What will be the acceleration of the block?

[5 marks]



QUESTION THREE [20 Marks]

a) State the assumptions of projectile motion. [2 marks]

b) A shell is projected with a velocity of 100 m/s with an elevation of 30^0 to the horizontal. Obtain the equations of motion. [5 marks]

c) A stone is projected with a horizontal velocity of 10 m/s from the top of a cliff 50 m above sea-level. Calculate the range at sea-level, and the velocity of impact. [10 marks]

d) A particle starts from origin at t=0 with initial velocity having an x-component of 20 m/s and a y-component of -15 m/s. The particle moves in in the xy plane with an x-component of acceleration only, given by a_x=4.0 m/s^2. Determine the components of velocity vector at any time and the total velocity vector at any time. [3 marks]

QUESTION FOUR [20 Marks]

a) What is Absolute Temperature? [2 Marks]

b) In a car lift used in a service station, compressed air exerts a force on a small piston that has a circular cross section and a radius of 5.0 cm. This pressure is transmitted by a liquid to a piston that has a radius of 15.0 cm. What force must the compressed air exert to lift a car weighing 13 300N? What pressure produces this force? [6 Marks]

c) A balloon contains 1.5 m^3 of helium at a pressure of 100 kPa and at a temperature of 27 °C. If the pressure is increased to 250 kPa at a temperature of 127 °C, calculate the new volume of the balloon. [3 Marks]

d) State Boyle's Law. Explain how Boyle's Law can be verified in a laboratory. [9 marks]

QUESTION FIVE [20 Marks]

a) Define linear momentum of a particle. [2 marks]

b) A bullet of mass 20 g travelling horizontally at 100 m/s, embeds itself in the center of a block of wood mass 1 kg which is suspended by light vertical strings 1 m long. Calculate the maximum inclination of the strings to the vertical. [5 marks]

c) Draw a stress-strain graph and mark on it the elastic region, yield point and breaking stress. [3 Marks]

d) Suppose 2 kg is attached to the end of a vertical wire of length 2 m and diameter 0.64 mm, and the extension is 0.60 mm. Determine the modulus of elasticity (Young's modulus) of the wire. [3 Marks]

e) Define specific heat capacity. [2 marks]

f) A metal of mass 0.2 kg at 100^0C is dropped into 0.08 kg of water at 15^0C contained in a calorimeter of mass 0.12 kg and specific heat capacity 400J/kg/K. The final temperature reached is 35^0C. Find the specific heat capacity of the metal. (Assume negligible heat losses and specific heat capacity of water is 4200J/kg/K)

[5 marks]

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