# KIBABII UNIVERSITY

## UNIVERSITY EXAMINATIONS
## 2020/2021 ACADEMIC YEAR

### FIRST YEAR FIRST SEMESTER
### MAIN 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:** 01/02/2022                    **TIME: 8-10AM**

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<u>INSTRUCTIONS TO CANDIDATES</u>
- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- The following constants might be used: density of water $=1000 kgm^{-3}$ and acceleration due to gravity, $g = 9.8 ms^{-2}$.

KIBU observes ZERO tolerance to examination cheating

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**QUESTION ONE [30 Marks]**

a) What is a rectilinear motion? Differentiate between displacement and distance. [3 Marks]

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

c) Show that the expression $v = at$ is dimensionally correct, where $v$ represent speed, $a$ acceleration, and $t$ a time interval. [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) Calculate the pressure exerted on the ground by a light truck of mass 1600 kg if each wheel has an area of 0.02 m$^2$ in contact with the ground. [3 Marks]

f) Calculate the pressure due to the water at a depth of 15 m in water. [2 Marks]

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

h) A motor bike rider travels 20.0 km due north and 35.0 km in a direction $60.0^0$ west of north. Find the magnitude and direction of the motor bike's resultant displacement. [4 Marks]

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

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


**QUESTION TWO [20 Marks]**

a) i) State Newton's second Law of motion. [2 mark]

   ii) An object of mass 2.0 kg is attached to the hook of a spring balance, and latter is suspended vertically from the roof of a lift. What is the reading on the spring balance when the lift is (i) ascending with an acceleration of 20 cm/s$^2$ (ii) descending with an acceleration of 10 m/s$^2$ ? [5 Marks]

   iii) 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 pendulum consists of a sphere of mass m attached to a light cord of L as shown.


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## 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) Find the pressure on a diver working at the depth of 10m in the sea on a day when the barometer stands at 750mmHg. (Density of sea water = 1050kgm$^{-3}$). Express your answer in (a) mmHg and (b) Nm$^{-2}$. [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 $100^0$C is dropped into 0.08 kg of water at $15^0$C contained in a calorimeter of mass 0.12 kg and specific heat capacity 400J/kg/K. The final temperature reached is $35^0$C. 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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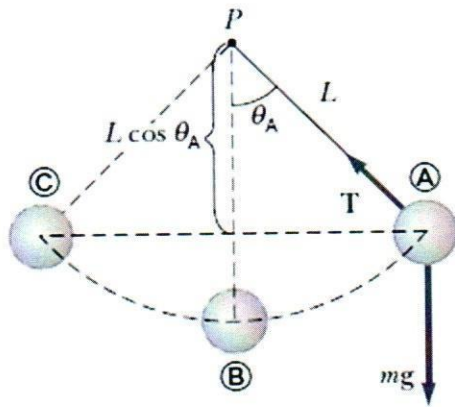
The sphere is released from rest when the cord makes an angle $\theta_A$ with the vertical, and the point at P is frictionless. Find the speed of the sphere when is at the lowest point. [3 marks]

c) Suppose that a 12 m ladder of 20 kg is placed at an angle of $60^0$ to the horizontal, with one end B leaning against a smooth wall and the other end A on the ground. (As shown below). Determine using moments the unknown forces $\vec{R}$ and $\vec{F}$. [5 marks]



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