P510/1
PHYSICS
Paper 1
AUGUST, 2023
2½ hours

JINJA JOINT EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

MOCK EXAMINATIONS – AUGUST, 2023

PHYSICS

Paper 1

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

*Attempt not more than **five** questions including at least one but **not more than two** from each of the sections **A**, **B** and **C**.*
Any additional question(s) answered will not be marked

Where necessary, assume the following constants:

Acceleration due to gravity, g	=	$9.81\ m\ s^{-2}$
Electronic charge, e	=	$1.6 \times 10^{-19}C$
Electronic mass	=	$9.11 \times 10^{-31}kg$
Avogadro's number, N_A	=	$6.02 \times 10^{23}\ mol^{-1}$
Mass on earth	=	$5.97 \times 10^{24}kg$
Charge to mass ratio of an election	=	$\mathbf{1.8 \times 10^{11} CKg^{-1}}$
One electron volt, eV	=	$1.6 \times 10^{-19}\ J$
Planck's constant, h	=	$6.6 \times 10^{-34}\ J\ s$
Radius of the earth	=	$6.4 \times 10^{6}m$
Specific heat capacity of water	=	$4.2 \times 10^{3}\ J\ kg^{-1}K^{-1}$
Specific latent heat of fusion of ice	=	$3.36 \times 10^{3}JKg^{-1}K^{-1}$
Stefan's – Boltzmann's constant, δ	=	$5.67 \times 10^{-8}\ W\ m^{-2}K^{-4}$
Speed of light in Vacuum, c	=	$3.0 \times 10^{8}\ m\ s^{-1}$
Unified mass unit, U	=	$1.66 \times 10^{-27}kg$
Universal gravitational constant, G	=	$6.67 \times 10^{-11}NM^{2}Kg^{-2}$
Gas constant, R	=	$8.31Jmol^{-1}K^{-1}$
Permittivity of free space, ϵ_o	=	$8.85 \times 10^{-12}Fm^{-1}$

SECTION B

5. (a) (i) Define specific heat capacity. (1 mark)
(ii) What is meant by the term specific heat capacity of water is $4200 Jkg^{-1}K^{-1}$? (1 mark)
(b) (i) Describe an experiment to determine specific heat capacity of water by continuous flow method. (6 marks)
(ii) State two advantages and two disadvantages of the method in (b) (i) above. (2 marks)
(c) The temperature of 50g of a liquid contained in a calorimeter is raised from 15^0C to 45^0C in 530s by an electrical heater dissipating 10.0W. When 100g of liquid is used and the same change in temperature occurs in the same time, the power of the heater is 16.1W. Calculate the specific heat capacity of the liquid. (5 marks)
(d) Describe the steps taken to set up thermodynamic scale of temperature for alcohol-in glass thermometer. (3marks)

6. (a) i) Distinguish between Ideal and Real gases. (2 marks)
ii) Define the term Critical temperature. (1 mark)
b) (i) Derive the ideal gas equation $P = \frac{1}{3}\rho\bar{C}^2$ where the terms take their usual meaning. (7 marks)
ii) Explain why oxygen and Nitrogen are gases found in the atmosphere close to the earth's surface (3 marks)
c) The total pressure in a closed vessel containing air and saturated vapor at 35^0C is 1.01×10^5 Pa. If the saturation vapor pressure at 35^0C and 87^0C are 3.99×10^3 Pa and 7.18×10^4 Pa respectively. Calculate the total pressure in the vessel at 87^0C assuming the air remains saturated. (5 marks)
d) (i) define root mean square speed of molecules of a gas. (1 mark)
(ii) State the conditions required for an isothermal process to occur. (2 marks)

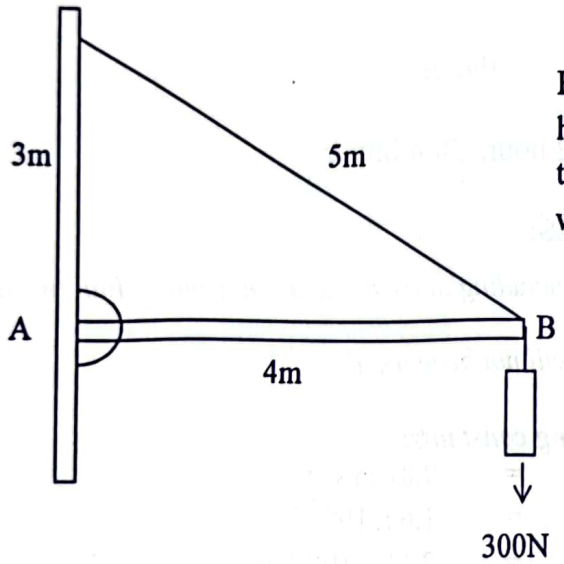
7. (a) (i) Define thermal conductivity. (1 mark)
(ii) State factors which determine the rate of heat transfer through a material. (3 mark)
(b) (i) When a quantity of heat Q is supplied to a conductor of thickness L and cross-sectional area A, a temperature difference of θ_1 is set up across the ends of the thermal conductor of same cross-sectional area and equal thickness but twice the thermal conductivity, in the same time a temperature difference θ_2 is obtained across its ends, show that $\boldsymbol{\theta_1 = 2\theta_2}$. (4marks)
(ii) Water in an aluminum sauce pan of diameter 16cm and thickness 4mm is kept boiling at 100^0C on a hot stove. The water boils off at rate of 2.28×10^{-4} kgs^{-1}. Calculate the temperature of the underside of the sauce pan assuming it is uniformly heated and neglecting heat losses from the sides (Thermal conductivity of aluminum $= 2.06 \times 10^2$ $Wm^{-1}k^{-1}$, latent heat of vaporization of water $= 2.26 \times 10^6$ $J\,kg^{-1}$) (4marks)
(c) (i) Explain why the center of fire appears white? (2marks)
(ii) What is meant by a black body? How can it be realized in practice? (5 marks)
(iii) State two devices that can detect thermal radiations (1 mark)

SECTION A

1. a) Sketch a graph of;
   (i) Speed
   (ii) Distance fallen as a function of time, for a body falling under the influence of gravity. (2 marks)

   b) (i) Explain the term free fall of a body. (3 marks)
   (ii) A stone is dropped from the roof of a high building. A second stone dropped 1.0s later. How far apart are the stones when the second one has reached a speed of $23ms^{-1}$. (5 marks)

   c) (i) State the conditions under which a body is in equilibrium under the action of coplanar forces. (2 marks)
   (ii) AB is a uniform beam of weight 200N and of length 4.0m. The beam is hinged to the wall at A.



Find the tension in the cable and the horizontal and vertical components of the force exerted on the beam at the wall. (5 marks)

   d) Distinguish between conservative and non-conservative forces. Give one example of each. (3 marks)

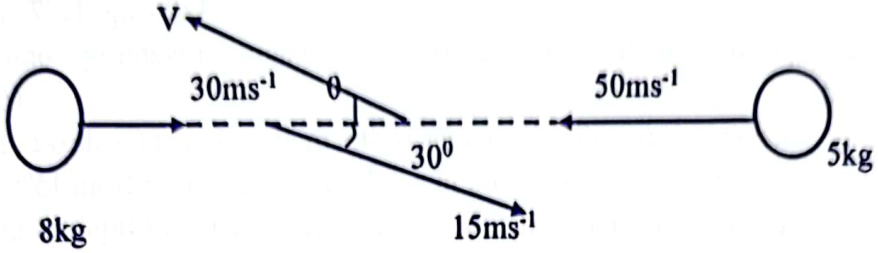
2. (a) (i) define the term ***angular velocity*** ω. (1mark)
   (ii) A particle of mass 0.2kg moves in a circular path with an angular velocity 5 $rads^{-1}$ under the action of a centripetal force of 4N. Find the radius of the path. (3marks)

   (b) (i) State four characteristics of simple harmonic motion. (4 marks)
   (ii) Show that the speed of a body moving with simple harmonic motion of angular frequency, ω is given by $V = \omega(A^2 - X^2)^{\frac{1}{2}}$, where A is the amplitude and X is the displacement from the equilibrium position. (4 marks)
   (iii) Sketch graphs to show the variation with displacement, of the kinetic and potential energies of a body moving with simple harmonic motion (2 marks)

   c) A satellite of mass 250kg moves in a circular equatorial orbit at a distance of 500km above the surface of the earth. Find;
   (i). Period (3 marks)
   (ii). Total energy of the satellite (3 marks)

3. (a) (i) Distinguish between elastic and inelastic collision and in each case state an example of each. (03 marks)

(ii) The two balls shown below collide and bounce off each other.



What is the final velocity of the 5kg ball if the 8kg ball has a speed of $15ms^{-1}$. Is the collision perfectly elastic (6 marks)

b) Explain briefly what is meant by internal energy of a substance. (3 marks)

c) (i) State the principle of conservation of mechanical energy. (1 mark)

(ii) Prove the work – energy theorem for a body moving with constant acceleration. (3 marks)

d) Describe a simple experiment to determine the coefficient of kinetic friction between two solid surfaces. (4 marks)

4. (a) what is meant by the following terms when used in reference to fluid motion?

i) Viscosity (1 mark)

ii) Viscous drag (1 mark)

iii) Velocity gradient (1 mark)

b) (i) Explain the effect of temperature on the viscosity of a gas. (3 marks)

(ii) Sketch the acceleration time graph for the motion of an oil drop in air. (1 mark)

(iii) Find the terminal velocity of an oil drop of radius $2.5x10^{-6}m$ which falls through air. Neglect the density of air. *(Viscosity of air = $1.8x10^{-5}Nsm^{-2}$, Density of oil = $900kgm^{-3}$)* (3 marks)

c) (i) Find the dimensions of Young's Modulus (2 marks).

ii) Sketch the stress versus strain curves on the same axes for a copper wire, rubber strip, and a glass wire. State the difference between the materials. (5 marks)

iii) A steel wire of cross sectional area $1mm^2$ is heated from 15°C to 60°C. Find the force needed to prevent it from expanding. (*Young's modulus for steel = $2.0x10^{11}p.a$, Co-efficient of linear* expansivity of *steel = $1.1x10^{-5}k^{-1}$*). (3 marks)

SECTION C

8. a) Distinguish between nuclear fission and nuclear fussion and account for the energy released. (3 marks)

b) With the aid of a labeled diagram describe the working of the Geiger Muller tube. (5 marks)

c) i) Define the term Mass defect. (1 mark)

ii) Calculate the binding energy per nucleon of $^{235}_{92}U$ using the following information.

Mass of neutron ($^{1}_{0}n$) = 1.00767U

Mass of $^{235}_{92}U$= 235.03076U

Mass of proton($^{1}_{1}P$) = 1.00428U

Mass of an electron ($^{0}_{-1}e$)= 0.0055U

1U = 931M_ev. (4 marks)

d) i) Describe how the age of a fossil can be estimated using **carbon dating.** (3 mark)

ii) Wood from a buried ship has a specific activity of $1.2 \times 10^2 Bqkg^{-1}$ due to 14C whereas comparable living wood has an activity of $2.0 \times 10^2 Bqkg^{-1}$. Find the age of the ship if the half-life of 14C is 5.7×10^3 years. (4 marks)

9. a) i) State Bohr's postulates about an atom of an element. (3 marks)

(ii) Derive an expression for the total energy of the electron in an atom. (6 marks)

b) Some of the energy levels of mercury are shown in the diagram below.

n=5	———————	0
n=4	———————	-1.6
n=3	———————	-3.7
n=2	———————	-5.5
n=1	———————	-10.4

Level 1 is the ground state level occupied by electrons in an unexcited state.

i) Calculate the ionization energy of mercury atom in Joules. (3 marks)

ii) Calculate the wave length of radiation emitted when an electron moves from level 5 to level 3. (3 marks)

c) i) Define the term X-rays. (1 mark)

ii) Describe with an aid of a labeled diagram how x-rays can be produced in an x-ray tube. (5 marks)

10. a) (i) With the aid of a diagram, describe how cathode rays are produced. (5 marks)

(ii) Explain how the sign of the charge of cathode rays can be obtained. (2 marks)

(iii) State any three differences between the positive and cathode rays. (3 marks)

b) In a Millikan's oil drop experiment, a charged oil drop of radius 9.2×10^{-7}m and density $880kgm^{-3}$ is held stationary in an electric field of intensity $4.0 \times 10^4 Vm^{-1}$.

(i) How many electron charges are on the drop (3 marks)

(ii) Find the electric field intensity that can move the drop at $0.005ms^{-1}$ vertically upwards. (Density of air= $1.29kgm^{-3}$ and coefficient of viscosity= $1.8\times10^{-5}Nsm^{-2}$). (3 marks)

c) Explain briefly the mechanism of thermionic emission. (3 marks)

d) What is meant by the term rectification? (1 mark)

 End