P510/1
Physics
Paper 1
July - August 2022
2 ½ Hours

UGANDA MUSLIM TEACHERS' ASSOCIATION

UMTA JOINT MOCK EXAMINATIONS 2022

UGANDA ADVANCED CERTIFICATE OF EDUCATION

Physics

Paper 1

2 Hours 30 Minutes

INSTRUCTIONS TO CANDIDATES

- *Answer 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.*

Assume where necessary

- *Universal gravitational constant, G* = $6.67 \times 10^{-11}\ Nm^3\ Kg^{-2}$
- *Stefan's — Boltzmann's constant, σ* = $5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$
- *Speed of light in vacuum, C* = $3.0 \times 10^{8} ms^{-1}$
- *Specific heat capacity of water* = $4200 Jkg^{-1}k^{-1}$
- *Radius of earth* = $6.4 \times 10^{6} m$
- *Radius of sun* = $7x10^{8} m$
- *Radius of earth's orbit about the sun* = $1.5 \times 10^{11} m$
- *Planck's constant, h* = $6.6 \times 10^{-34} Js$
- *Gas constant, R* = $8.31\ Jmol^{-1}K^{-1}$
- *Electron mass* = $9.11 \times 10^{-31}\ Kg$
- *Electron charge, e* = $1.6 \times 10^{-19} C$
- *Density of water* = $1000\ Kgm^{-3}$
- *Density of Mercury* = $13600\ Kg\ m^{-3}$
- *Specific latent heat of vaporization of water* = $2.26 \times 10^{6} JKg^{-1}$
- *Viscosity of air* = $1.8 \times 10^{-5} Ns^{-1}m^{-1}$
- *Avogadro's number, NA* = $6.02 \times 10^{23}\ mol^{-1}$
- *Acceleration due to gravity, g* = $9.81\ ms^{-2}$
- *Mass of sun* = $2.0x10^{30} Kg$
- *Mass of earth* = $6.0 \times 10^{24} Kg$
- *Temperature of sun* = $6000K$
- *Specific latent heat of fusion of ice* = $3.4x10^{5} JKg^{-1}$
- *Thermal conductivity of brass* = $109 Wm^{-1}K^{-1}$

SECTION A

1(a) (i) What is meant by uniformly accelerated motion? (1 mark)

(ii) Sketch a position- time and velocity time- graphs for the motion a (i). (2 marks)

(b) A parachutist bails out from an aeroplane and after dropping through a distance of 40m he opens the parachute and decelerates at $2ms^{-2}$. If he reaches the ground with a speed of $2ms^{-1}$,

(i) How long is he in air? (3 marks)

(ii) At what height did he bail out from the plane? (3 marks)

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

(ii) Explain why a rifle gives a backward kick on firing a bullet. (3 marks)

(iii) A ball **A** of mass 2.5kg undergoes a perfectly elastic collision with another ball **B** that is stationary. After collision **A** continues moving in its original direction with speed $\frac{1}{5}$ of its original speed. Determine the mass of **B**. (4 marks)

(d) A particle is projected at an angle θ from the horizontal with kinetic energy, **E**. Show that kinetic energy of the particle at the highest point is $\mathbf{E}\cos^2\theta$ (3 marks)

2. (a)(i) What is meant by banking of a curved path? (1 mark)

(ii) Explain why a cyclist leans inward when moving along a curved path. (4 marks)

(iii) Derive the expression for the angle through which a cyclist bends from the vertical while negotiating a curve. (4 marks)

(b) A ball of mass 100g is suspended by a string 30cm long keeping the string taut, the ball describes a horizontal circle of radius 15cm.

Calculate the;

(i) angular speed. (4 marks)
(ii) tension in the string. (2 marks)

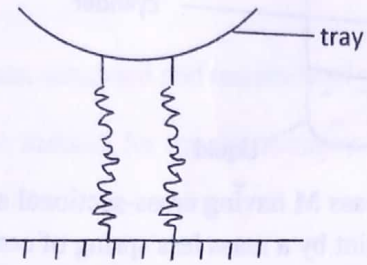
(c)(i) Define universal gravitational constant. (1 mark)

(ii). With aid of a diagram, describe an experiment to determine the universal gravitational constant **G** (6 marks)

3.(a)(i)State the basic conditions for the motion of a particle to be simple harmonic.
(2 marks)

(ii) Distinguish between free and forced oscillations. (4 marks)

(b)



A tray of mass 12kg is supported by two vertical identical strings. The tray is pressed down slightly and released.

(i) show that it executes simple harmonic motion. (3 marks)

(ii) if its time period is 1.5seconds,what is the force constant of each spring ? (2 marks)

(iii) When a block of mass **M** is placed on the tray, the period of s.h.m changes to 3.0 seconds .What is the mass of the block? (3 marks)

c)(i) Describe an experiment to determine acceleration due to gravity using a simple pendulum. (5 marks)

(ii) State any sources of error in the experiment in c (i) above. (1 mark)

4.a(i) State stoke's law. (1 mark)

(ii) State **two** conditions under which stoke's law is valid. (2 marks)

(b)(i) Describe an experiment to determine the coefficient of viscosity of a liquid using stoke's law (6 marks)

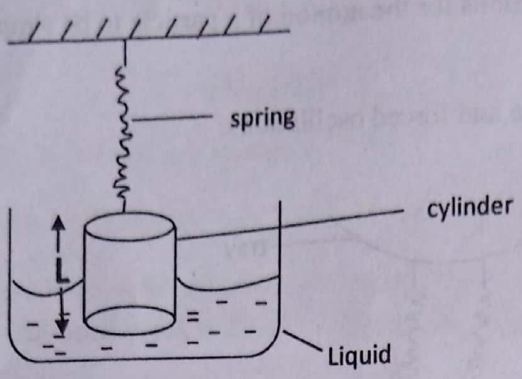
(ii) State any precautions taken in b (i) (1 mark)

(c) An alloy made of zinc and copper weighs 12.9g in air .When completely immersed in water it weighs 11.3g .If relative density of zinc and copper are 7.1 and 8.9 respectively, Calculate the;

(i) Mass of copper in the alloy (4 marks)

(ii) Density of the alloy (2 marks)

d)



A uniform cylinder of length **L** and mass **M** having cross-sectional area ,**A** is suspended with its length vertical from a fixed point by a mass less spring of constant **K** such that it is half submerged in a liquid of density σ at equilibrium position. Show that extension, e, of the spring when it is in equilibrium is given by

$$e = \frac{mg}{k}\left(1 - \frac{LA\sigma}{2M}\right)$$ (4 marks)

SECTION B

5(a)(i) Define cooling correction. (1 mark)

(ii) Describe an experiment to determine cooling correction in the method of mixtures to determine specific heat capacity of a poor conductor. (6 marks)

(b) (i) With reference to a Platinum resistance thermometer ,explain how a thermodynamic scale is established. (3 marks)

(ii) State two properties of platinum which makes it useful in a resistance thermometer (2 marks)

The electrical resistance (Ω) of a certain thermometer varies with temperature according to the expression:

$$R = R_0\left[1 + 5 \times 10^{-3}(T - T_0)\right]$$

The resistance is 101.6Ω at the triple point of water and 165.5Ω at the melting point of lead which is 600.5K .What is the temperature when resistance is 123.4Ω. (5 marks)

(d)(i) Define specific heat capacity. (1 mark)

(ii) Briefly explain why the coolant used in a car engine should have a high specific capacity (2 marks)

6(a)(i) State Dalton's law of Partial Pressures. (1mark)

(ii) Use Kinetic theory expression of pressure of an ideal gas to deduce Dalton's law of Partial Pressures. (4 marks)

(b)(i) Distinguish between saturated and unsaturated vapours. (2 marks)

(ii) Use kinetic theory to account for the occurrence of saturated vapour pressure.

(4 marks)

(c) Two vessels **A** and **B** of equal volume are connected by a tube of negligible volume .The vessels contain a total mass of 3.0g of air initially both vessels are at 27°C when pressure is $1.01\times 10^{5}Nm^{-2}$. Now when **A** is put into pure melting ice and **B** in steam, Calculate the;

(i) mass of gas in each vessel. (4 marks)

(ii) new pressure in the vessels. (3 marks)

(d) Briefly explain why if an insulated tyre bursts, the air escaping out is cooled (2 marks)

7(a) Define;

(i) solar constant. (1mark)
(ii) temperature gradient. (1 mark)

(b) With aid of a diagram, describe how a bolometer works. (5 marks)

(c) The mean distance from the sun to the earth is $1.5\times 10^{11}m$ and that from the sun to mars is $2.32\times 10^{11}m$ .Given that the solar constant on earth is $1400Wm^{-2}$, find the;

(i) solar constant on mars (3 marks)

(ii) temperature of mars if it's in radiative equilibrium with the sun. (3 marks)

(d)(i) Define coefficient of thermal conductivity. (1 mark).

(ii) Why is it necessary to use a thin specimen of a large diameter in an experiment to determine thermal conductivity of cork. (2 marks)

(e) A cylindrical brass boiler of diameter 30.0cm and thickness 1.2cm is filled with water and placed on an electric heater. If the water boils at a rate of $12000gmin^{-1}$, calculate the temperature of the heater filament. (4 marks)

SECTION C

8. (a) Explain the observations made in Rutherfords scattering experiment. (6 marks)

(b)(i) Define a Bohr atom. (1 mark)

(ii) An electron of mass, **m** and Charge, **e**, is considered to move in a circular orbit about a proton. Show that total energy, **E**, of the electron is given by

$$E = \frac{-me^4}{8\varepsilon_0^2 n^2 h^2}$$

Where n is an integer and, **h**, is Plank's constant. (5 marks)

(c) The energy levels of an atom are -12.8eV,-3.5eV and -1.8eV;

(i) find the ionization energy in Joules. (2 marks)

(ii) calculate the speed of the electron that would just ionize the atom (2 marks)

(iii) calculate the wavelength of radiation emitted when an electron in the second excited state makes a transition to the ground state. (3 marks)

(iv) why is the energy negative? (1 mark)

9(a)(i) Draw a labeled diagram of an X-ray tube. (2 marks)

(ii) In an X-ray tube, what features makes it suitable for continuous production of X-rays? (4 marks)

(b) Describe briefly one medical use of X-rays. (2 marks)

(c) X-rays of wavelength 1.55A°are incident on a copper crystal of atomic spacing

4.5×10^{-10}m

(i) Calculate the smallest glancing angle at which the radiation will be reflected. (2 marks)

(ii) The temperature of the crystal is increased by 60°C.Calculate the change in the angle obtained in c (i).Coefficient of linear expansion of the crystal is $1.7\times 10^{-5}K^{-1}$ (4 marks)

d (i) Define work function of a metal. (1 mark)

(ii) State two applications of a photo cell. (2 marks)

(iii) Radiation of wave length 5.89×10^{-7}m is incident on the cathode of a photocell .The maximum speed of electrons emitted by the cathode is $3.56 \times 10^{5}ms^{-1}$. Calculate the threshold frequency for the material of the cathode. (3 marks)

10(a)(i) Distinguish between mass defect and binding energy per nucleon. (2 marks)

(ii) Sketch a graph of binding energy per nucleon against mass number and explain its features. (4 marks)

(b)With aid of a labelled diagram describe the action of a Geiger-Muller tube

(6 marks)

(c) An atom ^{226}Ra of half-life 3.5 days emits an alpha particle of energy 6.2 Mev.

Calculate the;

(i) decay constant. (2 marks)

(ii) amount of energy released by 3.0×10^{-6}kg of ^{226}Ra after 7. 2 days (4 marks)

d) Describe one industrial use of radio isotopes. (2 marks)

END