1)510/1
PHYSICS
Paper 1
2% hours

WAKISSHA

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.
- Non programmable silent scientific calculators may be used.

Assume where necessary:

Acceleration due to gravity		=	9.81 ms ^{2}
Electron charge		=	1.6 x 1ff ^{19} C
Electron mass		=	9.11 x 10-31 kg
Mass of earth		=	5.97 x 10^{24}kg
Planck's constant,	h	=	6.6 x 10
Stefan 's — Boltzmann 's constant,	σ	=	5.67 x Wm ^{2}K ^{4}
Radius ofthe earth		=	6.4 x 10^{6}m
Radius of the sun		=	7.0 x 10^{8}m
Radius of earth 's orbit about the sun		=	1.5 x 10 ^{11}m
Speed oflight in a vacuum		=	3.0 x 10^{8}m
Specific heat capacity ofwater		=	4,200Jkg-lKl
Specific latent heat offusion ofice		=	3.34 x 10^{5} Jkg-l
Universal gravitational constant,	G	=	6.67 x I(T ^{ll}Nm ^{2}kg 2
Avogadro 's number		=	6.02 x 10^{23} mol-I
Density ofmercury		=	13.6 x 10^{3}kgm-3
Charge to mass ratio,	e/m	=	1.8x 10^{11} Ckg ^{l}

The constant $\frac{1}{4\pi\varepsilon_o}$ = $9.0 \times 10^9 F^{-1}m$

Density of water = $1000 kgm^{-3}$

Gas constant = 8.31JD101-lKl

SECTION A

1. (a) (i)Define the terms displacement and uniform velocity. (2 marks)

(ii) Sketch displacement — time and speed — time graphs for a body thrown vertically upwards. (2 marks)

(b)

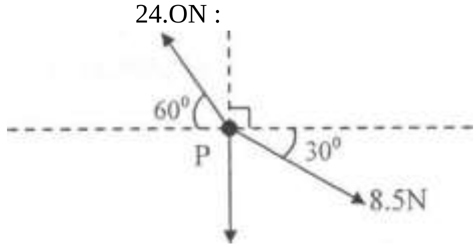

Fig. 1

Three forces of 24.0N, 12.0N and 8.5N act on a body P of mass 0.5kg as shown in fig. l . Find the acceleration produced on P. (4 marks)

(c) (i) What is meant by saying that a body is moving with velocity v relative to another? (l mark)

(ii) A car is travelling in a direction due East at $30kmh^{-1}$ while a bus is travelling at $40 kmh^{-1}$ due North. Find the velocity of the bus relative to the car. (3 marks)

(iii) If the bus in (c) (ii) above is 15km due East of the car at 11.00 a.m, find the shortest distance between them and the time when this occurs. (5 marks)

(d) (i) What is meant by torque of a couple? (1 mark)

(ii) State the conditions for a body to be in equilibrium. (2 marks)

2. (a) (i) What is meant by the term centripetal acceleration? (1 mark) (ii) Derive an expression for the centripetal force acting on a body of mass m moving in a circular path of radius r. (4 marks)

(iii) Explain why a body moving in a circular path with uniform speed has an acceleration. (3 marks)

(b) (i) State Newton's law of gravitation. (1 mark) (ii) Describe, with the aid of a labeled diagram, an experiment to determine the universal gravitational constant, G. (6 marks)

(c) (i) What is meant by gravitational potential? (l mark) (ii) Calculate the period of a satellite which is 100km above the surface of the earth. (4 marks)

3. (a) (i) What is meant by hydrostatic pressure? (l mark) (ii) Derive the expression for the pressure at a point which is at a depth h below the surface of a liquid of density p. (3 marks)

(b) (i) State Archimedes' principle. (1 mark) (ii) Using Archimedes' principle and the principle of moments, describe an experiment to determine relative density of a liquid. (5 marks)

(c) An empty cylindrical metal can of radius 4.5cm is made to float vertically in water. If 5 litres of engine oil of density 800 kgm-3 is poured into the can, find the extra depth to which the can will sink. (5 marks)

(d) (i) State Bernoulli's principle. (l mark)

(ii) A cylinder of large cross sectional area, containing water, stands on a horizontal bench. The water surface is at a height h above the bench. Water emerges horizontally from a hole in the side of the cylinder, at a height x above the bench. Use Bernoulli's principle to derive expressions for the speed at which the water emerges from the hole. (4 marks)

4. (a) What is meant by the following terms as applied to materials:

(i) Tensile stress (l mark)

(ii) Yield point (l mark)

(b) Derive an expression for the energy stored in a unit volume of a stretched metal wire in terms of stress and strain. (4 marks)

(c) A rubber cord of a catapult has an unscratched length of 10 cm and cross sectional area $2.0mm^2$. The catapult is loaded with a small mass of 20g and is stretched to 15cm.

(i) Calculate the velocity at which the mass is fired on releasing the cord. Take Young's modulus for rubber to be 1.0 x 10 x^8 pa. (4 marks) (ii) State any assumptions made in the calculation in (c) above. (l mark)

(d) (i) Distinguish between elastic deformation and plastic deformation. (2 marks)

(ii) On the same axes, draw the stress — strain curves for rubber and glass, and compare their elastic properties. (4 marks)

(e) Outline the measurements to be made in the determination of Young's modulus for the material of steel. (3 marks)

SECTION B

5. (a) State the assumptions made in the derivation of the kinetic theory expression for the pressure of an ideal gas. (2 marks)

(ii) Which of the assumptions made above have to be modified for real gases? (l mark)

(iii) The equation of state of one mole of a real gas is given by the expression:

$(P + a/V^2)(V - b)$ RT.

Account for the terms a/V^2 and b. (3 marks)

(b) Calculate the root-mean-square speed of molecules of an ideal gas at 147^0C given that the density ofthe gas at a pressure of 1.01 x 10^5 Nm-2 at a temperature of 0^0 C is 1.5kgm-3 . (5 marks)

(c) (i) Explain why the pressure of a fixed mass of gas in a closed container of fixed volume increases when temperature of the container is raised. (2 marks)

(ii) Explain, with the aid of a volume — temperature sketch graph, what happens to a gas cooled at constant pressure from room temperature to zero kelvin. (4 marks)

(d) An ideal gas of volume $400cm^3$ at — 129^0C expands adiabatically to a temperature of— 136^0C. Calculate its new volume. (Take y 1.40).

(3 marks)

6. (a)(i)State the desirable properties a material must have in order to be used as a thermometric property. (2 marks)

(ii) Explain why a constant — volume gas thermometer is used to calibrate other thermometers. (2 marks)

(b) Describe, with the aid of a labeled diagram, how an optical pyrometer can be used to measure high temperatures. (6 marks)

(c) (i) What is meant by latent heat of fusion? (1 mark)

(ii) Explain why specific latent heat of vaporization of a substance is much higher than specific latent heat of fusion of same substance. (3 marks)

(d) 50g of ice at O^OC is added to 200g of water initially at 70^0C in a vacuum flask. When all the ice has melted, the temperature of the flask and its contents dropped to 40^0C. On adding a further 80g of ice, the temperature of the flask and its contents became 10^0C when all the ice melted.

Calculate the specific latent heat of fusion of ice. (6 marks)

7. (a) (i) Define thermal conductivity. (1 mark)

(ii) Explain the mechanism of heat transfer in metals. (3 marks)

(b) A window having two glass panes each of thickness I()mm are separated by an air gap of thickness 5.0mm. The outer faces of the panes are maintained at 20^0C and 5^0C respectively.

(i) Calculate the temperatures of the inner surfaces of the panes.

(6 marks)

(ii) Compare the rate of heat loss through the layer of air with that through a single glass layer. (3 marks) Take thermal conductivity of air and glass to be respectively 0.02 Wm-l k-l and O.6Wm-1 1<-1 (c)(i) State Stefan's law of blackbody radiation. (l mark)

(ii) The average distance of a certain planet from the sun is about 40 times that of the Earth from the sun. If the sun radiates as a blackbody at 6000K, calculate the surface temperature of the planet. (6 marks)

SECTION C

8. (a) (i) What is meant by photoelectric emission? (l mark)

(ii) Explain, using quantum theory, the experimental observations on the photoelectric effect. (5 marks)

(iii) When light of wavelength 455 nm falls on certain metal surface, electrons of maximum kinetic energy 0.75 ev are emitted.
Find threshold frequency for the metal. (4 marks)

(b) Explain, using suitable sketch graphs, how X-ray spectra in an X-ray tube are formed. (6 marks)

(c) The current in a water — cooled X-ray tube operating at 60kV is 30 mA. If 99% of the energy supplied to the tube is converted into heat at the target and is removed by water flowing at a rate of 0.060kgs-l , calculate the increase in temperature of the cooling water. (4 marks)

9. (a) What is meant by the following terms as applied to radioactivity:

(i) Half-life. (l mark)
(ii) Decay constant. (1 mark)
(iii) Radioisotopes. (l mark)

(b) Given the radioactive law N = Noe -it, obtain the relation between and half-life 0/2. (2 marks)

(c) Describe briefly how the age of a fossil can be estimated using uranium dating. (4 marks)

(d) A certain radioisotope X having mass number 90 and atomic number 38 decays by emission of beta particles. If the half-life of the radioisotope X is 30 days, determine the activity of 2g of the isotope. (5 marks)

(i) Sketch the count rate — voltage characteristics of the Geiger — Muller tube and explain its main features. (4 marks)

(ii) Identify, giving reasons, the suitable range in (e) (i) of the operation of the tube. (2 marks)

10. (a) State Rutherford's model of the atom. (2 marks)

(ii) Explain two main failures of Rutherford's model of the atom. (3 marks)

(b) (i) What is meant by a line spectrum? (2 marks)

(ii) Explain how line spectra account for the existence of discrete energy levels in atoms. (4 marks)

(c) The energy levels in a mercury atom are — 10.4eV, -5.5eV, -3.7eV and -1.6eV. (i) What is an energy level? (1 mark) (ii) Why are the energies for the different levels negative? (1 mark)

(iii) Find the ionization energy of mercury in joules. (2 marks)

(d) (i) Define space charge as applied to thermionic diodes. (1 mark)

(ii) Draw a node current — anode voltage characteristics of a thermionic diode for two different filament currents and explain their main features. (4 marks)

END