P510/1
PHYSICS
(Theory)
Paper 1
2

SENIOR EDUCATION CONSULTANT (SEC)
UGANDA ADVANCED CERTIFICATE OF EDUCATION
MOCK EXAMINATIONS 2023
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**

Assume where necessary:

Acceleration due to gravity, g	=	9.81
Electron charge, e	=	1.6 x C.
Electron mass	=	9.11 x 10 kg
Mass of the earth	=	5.97×10^{24}kg
Plank's constant, h	=	6.6×10^{-34} Js
Stefan's constant,	=	5.67×10^{-8}Wm^{-2}k^{-4}
Speed of light in a vacuum, c	=	3×10^{8}ms^{-1}
Avogadro's number N_A	=	6.02×10^{23}mol^{-1}
Gas constant, R	=	8.31Jmol^{-1}k^{-1}
Universal gravitational constant, G	=	6.67×10^{-11}Nm^{2}Kg^{-2}
Radius of the earth	=	6.4×10^{6}m
Radius of the sun	=	7×10^{8}m
Radius of earth's orbit about the sun	=	1.5×10^{11}m
Specific heat capacity of copper	=	400 Jkg^{-1}K^{-1}
Specific heat capacity of water	=	4200Jkg^{-1}K^{-1}
Specific latent heat of vaporisation of water	=	2.26×10^{6} Jkg^{-1}
Specific latent heat of fusion of ice	=	3.36×10^{5} Jkg^{-1}
Permittivity of free space,	=	8.85×10^{-12} Fm^{-1}
Charge to mas ratio, e/m	=	1.8×10^{11} Ckg^{-1}
Density of water	=	1000kgm^{-3}
Density of mercury	=	13600kgm^{-3}
Electron volt (eV)	=	1.6×10^{-19} J

SECTION A

1. (a) (i) State the law of conservation of linear momentum. (01 mark)

(ii) Use Newton's laws of motion to derive the law in (a) (i) above. (04 mark)

(b) Distinguish between a **perfectly elastic collision** and a **perfectly inelastic collision**. (01 mark)

(c) An object X of mass 1.6kg traveling with a velocity of $30ms^{-1}$ undergoes elastic collision with a stationary object Y of mass 2.56kg. If X rebounds at 90^{o} to the incident path, calculate;

(i) the recoil velocity, (04 marks)

(ii) the direction of object Y (02 marks)

(d) (i) Define uniform acceleration (01 mark)

(ii) With the aid of a velocity – time graph, describe the motion of a body projected vertically upwards (03 marks)

(iii) A ball is kicked at an angle of 30^{o} to the horizontal and just clears a goal post 12m high and 40m from the point of projection. Find the speed of projection of the ball. (04 marks)

2. (a) (i) Define surface tension. (01 mark)

(ii) With the aid of a labelled diagram, describe how you would measure the surface tension of a liquid by the capillary tube method.

(05 marks)

(b) A soap bubble of radius r_1 is attached to another soap bubble of radius r_2. If the radius of the common interface of the bubbles is r, obtain an expression of r given that r_2 is greater than r_1. (04 marks)

(c) (i) Define coefficient of viscosity and obtain its dimensions.

(04 marks)

(ii) Explain why a solid sphere released in a fluid will fall with decreasing acceleration until it attains a terminal velocity. (02 marks)

(d) An oil drop of radius 3.0 x 10^{-6}mfalls through air of coefficient of viscosity 1.8 x 10^{-5}Ns. Given that density of oil = 900kgm^{-3} and density of air is negligible, find the terminal velocity of the oil. (04 marks)

3. (a) (i) What is meant by coefficient of viscosity? (01 mark)

(ii) Explain the effect of temperature on the viscosity of a gas. (02 mark)

(b) Stoke's law for the viscous force, **F** acting on a sphere of radius, ***a*** falling with velocity, **v** through a large expanse of a fluid of viscosity, **η** is expressed by the equation $\mathbf{F} = 6\pi\boldsymbol{a}\boldsymbol{\eta}\mathbf{v}$.Use the expression to explain the motion of a sphere into the fluid. (04 marks)

(c) Find the terminal velocity of an oil drop of radius 2.5 x 10^{-6} m which falls through air . Neglect the density of air.
(Viscosity of air = 1.8 x 10^{-5} Pas, Density of oil = 0.9gcm^{-3}). (04 marks)

(d) (i) State Archimedes principle. (01 marks)

(ii) State two applications of the principle in (d)(i). (02 marks)

(e) A solid weighs 237.5g in air and 12.5 g when totally immersed in a fluid of density, 0.9gcm^{-3}calculate the density of the liquid in which the solid would float with one fifth of its volume exposed above the liquid surface. (06 marks)

4. (a) (i) Define pressure. (01 mark)

(ii) Derive an expression for the pressure at a point in a liquid in terms of density, of the liquid and depth, h of the point below the surface. (03 mark)

(b) (i) State the law of floatation. (01 mark)

(ii) A cubical block of brass 10cm on each side floats on mercury in a vessel. If the density of brass is 8730kgm^{-3}, determine the height of the block above mercury level. (04 marks)

(c) (i) Write Bernoulli's equation and define the symbols used. (02 marks)

(ii) Water leaves the jet of a horizontal horse (pipe) at 10ms^{-1}. If the velocity of the water with in the horse is 0.4ms^{-1}, calculate the pressure within the horse.(Atmospheric pressure = 76cmhg). (03 marks)

(d) Explain how Bernoulli's principle applies to the lift of an aero foil. (03 marks)

(e) (i) What is meant by simple harmonic motion? (01 mark)

(ii) State the characteristics of simple harmonic motion. (02 marks)

SECTION B

5. (a) (i) Define triple point of water. (01 mark)

(ii) Explain how a thermodynamic scale of temperature defined on a thermometric property R can be set up. (02 marks)

(b) (i) Describe with the aid of a labelled diagram how an optical pyrometer can be used to measure the temperature of a furnace. (06 marks)

(ii) State **one** advantage and disadvantage of the thermometer in (b)(i). (02 mark)

(c) The resistance R(Ω) of a pure metal wire varies with temperature t^{o}C according to R = + , where are constants. Find the resistance of the wire at 40^{0}C if its values are 5.10Ω and 5.35Ω at temperatures 10^{o}C and 60^{o}C respectively. (05 marks)

(d) (i) State Charles law. (01 marks)

(ii) Explain why resistance of a fixed mass of gas increase when heated. (03 marks)

6. (a) (i) What is a black body (01 mark)

(ii) How can a black body be realized in practice? (03 marks)

(b) (i) Sketch the sphere distribution of black body radiation for three different temperatures and describe their main features. (05 marks)

(ii) As a metal is heated, it appears to change colour. Account for this observation. (04 marks)

(c) (i) The tungsten filament of an electric lamp has a length 0.5m and a diameter of 6×10^{-5} m. the power rating of the lamp is 60W. Assuming the radiation from the lamp is equivalent to 80% that of a perfect black body radiator at the same temperature, estimate the steady temperature of the filament. (04 marks)

(ii) Calculate the frequency emitted with maximum intensity.
[Wein's displacement constant = 2.9×10^{-3} mK]. (03 marks)

7. (a) What is meant by the following terms;
(i) a saturated vapour? (01 mark)

(ii) critical temperature? (01 mark)

(b) With the aid of a P – V diagram, explain what happens when a real gas is compressed at different temperatures. (04 marks)

(c) (i) State **Dalton's law** of partial pressure. (01 mark)

(ii) A narrow tube of uniform bore closed at the end has air trapped by small drop of water. If the atmospheric pressure 760mmHg and saturated vapour pressure of air at 10^{o}C and 30^{o}C are 10mmHg and 40mmHg respectively. Calculate the length of column of air at 30^{o}C, if it is 10cm at 10^{o}C . (04 marks)

(d) (i) Use the pressure formula from kinetic theory of a gas to deduce Avogadro's hypothesis. (03 marks)

(ii) The density of oxygen at s.t.p is 1.43kgm^{-3}. Find the root mean square speed of oxygen at s.t.p. (03 marks)

(e) The temperature of a gas in an expandable container is raised from 0^0C to 80^0C at constant pressure of 4.0 x 10^5Pa. If the total heat added is 5.0x10^4J, find the number of moles of the gas. Take molar heat capacity of the gas at constant volume= 20.79Jmol^{-1}K^{-1}. (03 marks)

SECTION C

8. (a) Distinguish between cathode rays and X-rays. (02 marks)

(b) (i) With the aid of a labeled diagram describe the working of an X-ray tube. (06 marks)

(ii) Describe the energy changes which occur in a working X-ray tube. (02marks)

(c) Explain how the following spectra are produced in an X-ray tube;
(i) Continuous spectrum (02 marks)

(ii) Line spectrum (02 marks)

(d) An electron having energy of 4.5x 10^2eV moves at right angles to a uniform magnetic field of flux density 2.0 x 10^{-3} T. Find,
(i) The radius of the path followed by the electron. (04 marks)

(ii) The period of the motion (02 marks)

9. (a) What is meant by the following terms?
(i) Radioactivity (01 mark)

(ii) Binding energy per nucleon (01 mark)

(b) Calculate the energy released during the decay of nucleus into and an alpha particle.
Given that; Mass of = 219.964176u
Mass of= 215.9557944u
Mass of an alpha particle = 4.001566u
1u = 931 Mev (04 marks)

(c) (i) Explain how would determine the half-life of a short lived radioisotope? (03 marks)

(ii) State **two** safety precautions that should be observed by a person working with radioisotopes. (02 marks)

(d) A sample of radioactive isotope has a half-life of 80 years. How long will it take for its activity to fall to 40% of its current value?(03 marks)

(e) Describe, with the aid of a labeled diagram, the action of the expansion cloud chamber. (06 marks)

10. (a) Define the term **electron volt.** (01 marks)

(b) (i) Explain the main observations in Rutherford's alpha particles scattering experiment. (06 marks)

(ii) In a head on collision between an alpha particle and a gold nucleus, the minimum distance of approach is 5.4×10^{-14}m. Calculate the energy of the alpha particle.
(Atomic number of gold = 79) (03 marks)

(c) (i) Distinguish between **excitation energy** and **ionisation potential.** (02 marks)

(ii) The ground state of a Hydrogen atom is **-13.4eV** and the next two energy levels are **-3.34eV** and **-1.5eV** respectively. A Hydrogen atom is excited from the level **-1.5eV** to the ground state.
Calculate the wave length of the radiation emitted and state the part of the electromagnetic spectrum in which it lies. (04 marks)

(d) Explain how line spectra account for the existence of discrete energy levels in atoms. (04 marks)

END