**P510/1**

**PHYSICS**

**Paper 1**

**Jul/ Aug 2019**

**2 ½ Hours**

**MUKONO EXAMINATION COUNCIL**

**Uganda Advanced Certificate of Education**

**PHYSICS**

**Paper 1**

**2 hours 30 minutes**

**INSTRUCTIONS TO CANDIDATES**

*Attempt* ***five*** *questions with at least* ***one but not more than two questions*** *from each of the sections* ***A****,* ***B*** *and* ***C****.*

*Assume where necessary;*

*Acceleration due to gravity = 9.81ms-2*

*Electron charge = 1.6 ×10-19C*

*Electron mass = 9.11×10-31kg*

*Gas constant R = 8.31Jmol-1K-1*

*Density of water = 1000kgm-3*

*Radius of the earth = 6.4×106m*

*Radius of the sun = 7.0×108m*

*Radius of earth’s orbit about the sun = 1.5×1011m*

*Mass of the earth = 5.97×1024kg*

*Universal gravitational constant, G = 6.67×10-11Nm2kg-2*

*Specific heat capacity of water = 4200Jkg-1K-1*

*Specific latent heat of vaporization of water = 2.26×106Jkg-1*

*Speed of light in vacuum = 3.0×108ms-1*

*Plank’s constant, h = 6.6×10-34Js*

*Avogadro’s number NA = 6.02×1023mol-1*

*The constant  = 9.0×109 F-1m*

**SECTION A**

**1.**  (a) (i) Define acceleration due to gravity. ***(1 mark)***

(ii) Define the terms **range** and **trajectory** as used in projectile motion***. (2 marks)***

(b) Describe an experiment to determine the acceleration due to gravity. ***(6 marks)***

(c) A shell is fired from a gun towards a target located 12.5 km away. The shell is given a velocity of 400 ms-1at an angle of 20.04ᵒ to the horizontal. Find:

(i) the distance by which the shell misses the target. ***(3 marks)***

(ii) the adjustment required to be made to the angle of projection so that the shell fired next, hits the target. ***(3 marks)***

(c) (i) State the work-energy theorem. ***(1 mark)***

(ii) A body of mass **m** kg, initially at rest is accelerated uniformly. Derive an expression for the kinetic energy of the body at the instant its velocity is **V** ms-1. ***(4 marks)***

**2.**  (a) (i) State Hooke’s law. ***(1 mark)***

(ii) Define **Young’s Modulus** and **strength** of a material. ***(2 marks)***

(b) In an experiment to determine Young’s modulus, explain why the following precautions are taken;

(i) Two **long** and **thin** wires suspended from a **common support**. ***(3 marks)***

(ii) Vernier readings are also taken when the loads are gradually removed in steps. ***(1mark)***

(c) A wire of length 1.5 m is fixed horizontally at two points that are 1.5 m apart. A mass of 1.0 kg is then suspended on the wire at a point mid-way between A and B causing a strain of 2.67 ×10-2 in the wire. If Young’s modulus for the wire is 2×1011 Pa, find

(i) The depression of the wire at the point where the mass is suspended. ***(4 marks)***

(ii) The tension developed in the wire ***(3 marks)***

(iii) The stress in the wire. ***(2 marks)***

(d) A steel wire of cross sectional area 2.0 mm2 is heated from temperature 45◦ to 90ᵒ. Find

(i) The strain in the wire. ***(2 marks)***

(ii) Energy stored per unit volume of the wire. ***(2 marks)***

[Coefficient of linear expansion of the wire is 1.1×10-5k-1]

**3.** (a) (i) Define surface energy and derive its dimensions. ***(3 marks)***

(ii) Derive an expression for the pressure difference across a soap bubble of radius **r** and surface tension **γ**. ***(3 marks)***

(b) (i) State Bernoulli’s principle. ***(1 mark)***

(ii) Explain the effect of temperature on the viscosity of fluids. ***(4 marks)***

(c) (i) Draw a graph of velocity against time for a body falling through a viscous fluid and explain its main features. ***(5 marks)***

(ii) Given that the coefficient of viscosity of air is 1.4×10-4 Nm-1, find the terminal velocity of a spherical metal ball of radius 2.0 mm and density 900 kgm-3 falling through air of density 1.3 kgm-3. ***(4 marks)***

**4**. (a) (i) Define **centripetal acceleration**. ***(1 marks)***

(ii) Calculate the angle at which a pilot must bank the wings of an aeroplane moving at 600 kmh-1 in order to follow a circular path of radius 8.0km. *(3 marks)*

(b) (i) State Kepler’s laws of planetary motion. ***(3 marks)***

(ii) Calculate the acceleration due to gravity at a distance of 700 km above the earth’s surface. ***(3 marks)***

(c) Define simple harmonic motion. ***(1 mark)***

(d) A body of mass 0.1 kg suspended on a spring of force constant 24.5 Nm-1 is given a vertical displacement of 4.0 cm and then released.

(i) Show that the body executes simple harmonic motion after release. ***(3 marks)***

(ii) Find the frequency of oscillation of the mass. ***(3 marks)***

(iii) Calculate the displacement of the body from its equilibrium position 2.0 seconds after release. ***(3 marks)***

**SECTION B**

**5** (a) (i) Define thermal conductivity of a material and state its units. ***(2 marks)***

(ii) Explain why glass is a poor conductor of heat. ***(2 marks)***

(b) With use of a labelled diagram describe an experiment to determine the thermal conductivity of glass ***(6 marks)***

(c) A conduction plate of thickness 5.0 mm is made out copper and glass in a thickness ratio of 4:1 respectively, as shown in the diagram below.

Glass

Copper

10ᵒ

40ᵒ

If the temperature of the outer faces of the plate are 40ᵒ C and 10ᵒ C, respectively and if the rate of heat flow through the plate is 60 W, find:

(i) The temperature of the interface between copper and glass. ***(3 marks)***

(ii) The cross sectional area of the plate. ***(2 marks)***

[Conductivities of copper and glass are 40 Wm-1K-1 and 6 Wm-1K-1 respectively]

(d) Describe how heat transfer by convection takes place. ***(3 marks)***

(e) Define and give one example of a black body. ***(2 marks)***

**6.** (a) (i) Define specific latent heat of vaporisation.  ***(1 mark)***

(ii) With the aid of a well labelled diagram, describe the accurate method of determining the specific latent heat of vaporisation of water. *(6 marks)*

(b) An electrical heater rated 500 W is immersed in a liquid of mass 2.0 kg contained in a large thermos flask of heat capacity 840 Jkg-1 at 28ᵒ C. Electric power is supplied to the heater for 10 minutes. If the specific heat capacity of the liquid is 2.5×103 Jkg-1K-1, its specific latent heat of vaporization is 8.54×103Jkg-1 and its boiling point is 78ᵒ C, estimate the amount of liquid which boils off. ***(7 marks)***

(c) (i) Define **ice point** and **steam point** as used in thermometry. ***(2 marks)***

(ii) The resistance of a platinum resistance thermometer is 5.2 at the ice point of water and 9.4 at the steam point. If the resistance is 6.5 at an unknown temperature, find on the Kelvin scale.***(3 marks)***

(iii) State one advantage and one disadvantage of an optical pyrometer.  ***(1 mark)***

**7**. (a) (i) Differentiate between an isothermal and an adiabatic change. ***(2 marks)***

(ii) State the conditions for a reversible isothermal expansion to occur*.* ***(2 marks)***

(b) (i) Define molar heat capacity of a gas Cv and state its units. ***(2 marks)***

(ii) Derive the expression Cp - Cv = R for n moles of a gas. ***(4 marks)***

(c) An ideal gas at 27oC had a pressure of 1.01 x 107 Pa. The gas was compressed isothermally until its volume was halved. It was then allowed to expand adiabatically to its original volume. Given the ratio, Cp/Cv = 1.40

(i) Calculate the final temperature and pressure of the gas.  ***(5 marks)***

(ii) Sketch the P-V graph showing the changes. ***(2 marks)***

(d) Explain why a liquid boils at a higher temperature when the surrounding pressure is raised. ***(3 marks)***

**SECTION C**

**8.** (a) Define the following terms as used for a radioactive substance.

(i) Isotopes ***(1 mark)***

(ii) Mass number ***(1 mark)***

(iii) Activity ***(1 mark)***

(b) With the aid of a labelled diagram, explain how a Geiger Muller tube is used to detect radioactive substances. ***(6 marks)***

(c) A radio isotope Co decays to  by emission of a beta particle and two gamma photons. The half-life of Co is 5.27 years.

(i) Calculate the maximum energy in MeV of the gamma radiation given off per disintegration. ***(4 marks)***

(ii) Find the power of the radiation emitted by 5g of Co.

[Mass of Co = 59.9338µ

mass of  = 59.9308µ

mass of  = 0.0005µ] ***(5 marks)***

(d) State any two applications of radioisotopes. ***(2 marks)***

**9.**  (a) (i) State Bragg’s law of X-ray diffraction. ***(1 mark)***

(ii) Draw a sketch graph of intensity against frequency of X-rays and indicate the line

and background spectra. ***(2 marks)***

(b) Outline the principles underlying the generation of the line spectrum in an X-ray tube. ***(3 marks)***

(c) A beam of X-rays of frequency 3×1018Hz is incident on a set of cubic planes of a Sodium Chloride crystal. The second order diffracted beam is obtained for a glancing angle of 20.74ᵒ. Find the:

(i) the spacing between consecutive planes. ***(2 marks)***

(ii) the relative molecular mass of Sodium Chloride. ***(4 marks)***

[Density of Sodium Chloride = 2,166 kgm-3]

(d) State the principles of Bohr’s model of an atom. ***(3 marks)***

(e) The diagram below shows the energy levels of Bohr’s hydrogen atom model. n=……………………………………………….. 0 eV

n=4 ………………………………………………... -0.85 eV

n=3 ………………………………………………... -1.51 eV

n=2 ………………………………………………... -3.4 eV

n=1 ………………………………………………... -13.6 eV

1. Copy the diagram and on it indicate the electron transitions that lead to the emission of Ultra-violet and Infra-red spectra. ***(2 marks)***
2. Calculate the shortest wavelength of the Infra-red radiation band. ***(3 marks)***

**10** (a) State the characteristics of photoelectric emission. ***(4 marks)***

(b) Describe a simple experiment to demonstrate photoelectric emission. ***(4 marks)***

(c) (i) Define an electron-volt. ***(1 mark)***

(ii) When electromagnetic radiation falls on a metal surface of work function 2.0eV,

electrons with maximum velocity of 1.2×106 ms-1 are emitted. Calculate the frequency of the incident electromagnetic radiation. ***(3 marks)***

(d) (i) What is meant by specific charge of an ion? ***(1 mark)***

(ii) Draw a well labelled diagram of a Cathode-Ray Oscilloscope and explain how it can be used to measure the e.m.f of dc source. ***(4 marks)***

(e) A charged oil drop of radius 7.26×10-7 m and of density 880 kgm-3 is held stationary in an electric field of intensity 1.72×104 Vm-1. Calculate the number of electronic charges on the drop. ***(3 marks)***

[Density of air = 1.29 kgm-3]

**END**