**P510/****1**

**PHYSICS**

Paper 1

Jul/ Aug 2016

2 ½ hours

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**MUKONO EXAMINATIONS COUNCIL**

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.**
* *Non-programmable scientific calculators may be used.*

*Assume where necessary:*

Acceleration due to gravity, *g* = 9.81ms-2

Electron charge, *e*  = 1.6 × 10-19C

Electron mass = 9.11 × 10-31 kg

Radius of the earth = 6.4 × 106m

Plank’s constant, *h*  = 6.6 × 10-34 Js

Stefan’s- Boltzmann’s constant, σ = 5.67 × 10-8Wm-2K-4

Speed of light in a vacuum, c = 3.0 × 108 ms-1

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

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

Density of water = 1,000 kg m-3

Thermal conductivity of Aluminium = 40 Wm-1k-1

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

Specific heat capacity of Aluminium = 400 Jkg-1K-1

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

**SECTION A**

**1** (a) (i) State the laws of uniformly accelerated motion. ***(03 marks)***

(ii) Use the laws stated above to show that when any two bodies collide, their total momentum remains constant ***(04 marks)***

(b) A bullet of mass 0.5kg is fired from a gun on top of a cliff 200m above the ground. The bullet leaves the gun at a speed of 700 ms-1. If the bullet takes 40 seconds to hit the ground below, find

(i) the angle between the horizontal and the speed of projection of the bullet.

***(04marks)***

(ii) the horizontal distance covered by the bullet. ***(02 marks)***

(iii) the kinetic energy of the bullet as it hits the ground ***(03 marks)***

(c) (i) What is meant by “relative velocity of body A with respect to body B”?

***(01 mark)***

(ii) A car moves at a velocity of 60kmh-1 on a level ground as rain drops fall vertically at a speed of 6.0ms-1. Find the relative velocity of the rain drops with respect to the people inside the car. ***(03 marks)***

**2.** (a) (i) Define simple harmonic motion.  ***(01 marks)***

(ii) Give two examples of bodies executing simple harmonic motion. ***(02 marks)***

(b) A wooden cylindrical block of cross sectional area A, floats vertically in a liquid of density **ρ**. The block is pushed down through a small distance and then released.

(i) Show that the block executes simple harmonic motion and find the expression of the frequency of this motion. ***(04 marks)***

(ii) Explain why the block eventually stops moving.  ***(02 marks)***

(c)

S1

S2

0.2kg

Two springs S1 and S2 of force constants 100Nm-1 and 96Nm-1 respectively are suspended from a rigid support and a mass of 0.2kg hanged on them as shown in the figure above. Calculate;

(i) the extension caused by the 0.2kg mass. ***(02 marks)***

(ii) the total energy stored in the system. ***(02 marks)***

(iii) the period of oscillation if the mass is given a small vertical displacement and then released. ***(02 marks)***

(iv) draw a graph of total energy of the mass against displacement . ***(01 mark)***

(d) A body of mass 2.0kg moves in a circular path of radius 0.6m. If the body covers an angular displacement of 270° in 5 seconds find

(i) its angular velocity.  ***(02 marks)***

(ii) the centripetal force acting on the body. ***(02 marks)***

**3.** (a) Define the following;

(i) Work

(ii) Energy

(iii) Power ***(03 marks)***

(b) State the conditions for a rigid body to be in mechanical equilibrium. ***(02 marks)***

(c) A mass of 5.0kg is suspended from the end A of a uniform beam of mass 1.5kg and length 2.0m. The end B of the beam is hinged in a vertical wall. The beam is kept horizontal by an inextensible rope attached to A and to a point C in the wall at a height 0.75m above B.

(i) Draw a sketch diagram to show the forces acting on the beam. ***(02 marks)***

(ii) Calculate the tension in the rope.  ***(03 marks)***

(iii) Calculate the force exerted on the beam by the hinge. ***(05 marks)***

(d) A car of mass 1000kg climbs a track which rises by 1.0m for every 2.0m covered along the track. The speed of the car at the bottom of the track is 36.0kmh-1. If the coefficient of kinetic friction is 0.3 and the engine exerts a force of 4000N, how far up the track does the car move before coming to rest. ***(05 marks)***

**4.** (a) (i) State **Archimedes’ Principle** **(01 mark)**

(ii) A piece of metal of mass 2.6 × 10-2kg is attached to a block of wax of mass

1.0 × 10-4 kg and density 2.0 ×102 kg m-3, when the two are immersed in water they float with wax just submerged. Find the density of the metal. ***(04 marks)***

(b) Explain the

(i) terms **laminar** and **turbulent** flow. ***(02 marks)***

(ii) the effect of temperature on the viscosity of liquids and gases. ***(03 marks)***

(c) A simple hydrometer, consisting of a loaded glass stem of uniform cross-section of 1.0cm2 and a bulb of volume 3.0cm3, sinks in water so that a certain mark X on its stem is 4.0cm below the water surface. It sinks in a liquid of density 0.9gcm-3 until X is 6.0cm below the surface. It is then placed in a liquid of density 1.1gcm-3. Calculate the

(i) Distance of mark X from the bulb of the hydrometer. ***(03 marks)***

(ii) Depth of X below the surface of the liquid whose density is 1.1gcm-1 ***(02 marks)***

(c) A spherical ball of radius **r** and density **ρ** falls through a fluid of density **σ** and coefficient of viscosity **η,** obtain an expression for the terminal velocity **v0** of the ball in terms of the quantities given.

Hence calculate the value of **v0** if **r**=3.0cm, **ρ=**7.5×103 kgm-3,**σ**=9.40×102kgm-3 and **η=**2.42 Ns-2m-2 ***(05 marks)***

**SECTION B**

**5.** (a) (i) State the factors that determine the rate of heat flow through solids. ***(02 marks)***

(ii) Explain the mechanism of heat conduction through solids.  ***(04 marks)***

(b) With use of a well labelled diagram, describe an experiment to determine the coefficient of thermal conductivity of glass. ***(05 marks)***

(c) 2.5 kg of water in an aluminium container of mass 1.0kg, uniform thickness 3.0mm and base area 0.1m2 is heated by an electric fire and its temperature rise from 20°C to 100°C in 7 minutes 16 seconds. Assuming no heat is lost to the surrounding find

(i) The power of the electric fire.  ***(03 marks)***

(ii) the rate at which water boils away. ***(02 marks)***

(iii) the temperature of the underside of the aluminium container. ***(02 marks)***

(d) Explain why a metal surface feels cooler to the touch than a wooden one. ***(02 marks)***

**6**. (a) (i) What is meant by a **black body**? ***(01 mark)***

(ii) State Stefan’s law of black body radiation.  ***(01 mark)***

(iii) The sun is a black body of surface temperature 6000 K. If the radius of the earth’s orbit about the sun is 1.5 × 1011m, calculate the amount of radiant power approaching the earth from the sun. ***(05 marks)***

(b) Describe, with aid of a labelled diagram, how to measure high temperatures using an optical pyrometer. ***(05 marks)***

(c) State two advantages of a thermocouple as compared to a constant volume gas thermometer  ***(02 marks)***

(d) A thermocouple has its cold junction at 0°C and when the hot junction is at θ° C, the thermo e m f is given by E= (20θ - 0.02θ2) *μ*V.

(i) Find the range of temperature which can be measured by this thermocouple.

***(03 marks)***

(ii) Calculate the temperature of the hot junction if the thermo- emf produced is 6.5*m*V. ***(03 marks)***

**7.** (a) (i) What is the difference between an isothermal and an adiabatic change?

***(02 marks)***

(ii) What are the conditions for a reversible adiabatic change to be archived?

***(02 marks)***

(b) (i) State any three differences between real and ideal gases. ***(03 marks)***

(ii) Draw sketches showing the P-V isothermals for a real gas above and below the critical temperature. Mark on the curve, the liquid, saturated vapour and gaseous states.  ***(03 marks)***

(c) One mole of a gas occupies 2.24 × 10-2m3 at a pressure of 1.01× 105 Nm-2 at 0°C. If the molar heat capacity at constant pressure is 28.5 Jmol-1 K-1, calculate the molar heat capacity at constant volume. ***(03 marks)***

(d) 20g of the gas in (c) initially at 27°C is heated at constant pressure of 1.0 × 105 Nm-2 and its volume increased from 0.250 m3 to 0 .375m3.

Calculate,

1. The external work done.  ***(02 marks)***
2. The increase in internal energy  ***(05 marks)***

[Relative molecular mass of the gas =2]

**SECTION C**

**8.** (a) Distinguish between cathode rays and positive rays. ***(02 marks)***

(b) (i) Draw a well labelled diagram to show the main features of a cathode ray oscilloscope

(CRO).  ***(02 marks)***

(ii) Explain how the CRO can be used to measure the peak value voltage of a sinusoidal voltage source. ***(03 marks)***

(c) Explain the formation of

(i) Line spectrum and  ***(03 marks)***

(ii) Continuous spectrum during the production of x-rays ***(02 marks)***

(d) (i) With use of a well labelled diagram explain how Bainbridge mass spectrometer can be used to measure the specific charge of positive rays. ***(05 marks)***

(ii) A singly ionised positive atom passes un-deflected through crossed magnetic and electric fields of magnitude 0.3T and 3.6 × 104 Vm-1 respectively. It then enters a region of uniform magnetic field 0.5T. If the ion describes a circular path of radius 3.0cm, find its mass. ***(03 marks)***

**9.** (a) Define the following as used in the study of particle,

(i) Photon ***(01 mark)***

(ii) Intensity  ***(01 mark)***

(b) State the characteristics of photoelectric effect.  ***(04 marks)***

(c) Sketch a graph to show the variation of photo current against voltage

(i) For two different frequencies of incident radiation at the same intensity

***(02 marks)***

(ii) for two different intensities of incident radiation at the same frequency

***(02 marks)***

(d) (i) What is radioactivity? ***(01 mark)***

(ii) Explain briefly, how radioactivity is applied in archaeological dating.

***(03 marks)***

(e) (i) A radioactive element 238U has a half-life of 4.5 × 109 years. Find the activity of 2.0g of 238U after it has been decaying for 3.5 × 109 years***. (04 marks)***

(ii) Draw a decay curve for a radioactive material and explain how it can be used to determine its half-life. ***(02 marks)***

**10.** (a) What is meant by

(i) Bohr model of an atom ***(02 marks)***

(ii) Binding energy of a nucleus? ***(01 mark)***

(b)(i) Explain what is observed when a beam of α-particles is incident on a gold foil.

***(06 marks)***

(ii) A beam of α-particles of energy 5.0MeV is incident normal to a gold foil. Calculate the closest distance of approach by the α-particles to the nucleus of the gold

[Atomic number of gold =79]  ***(04 marks)***

(c) (i) What is meant by emission line spectra? ***(03 marks)***

(ii)

E∞

E4

E3

E2

E1

0eV

-0.85eV

-1.5eV

-3.4eV

-13.6eV

The diagram above shows some of the energy levels of hydrogen.

Copy the diagram and indicate the electron transition for the emission of the visible spectrum and Ultra Violet radiation  ***(02 marks)***

(iii) Calculate the highest possible frequency of radiation emitted from the hydrogen

atom  ***(02 marks)***

**END**