

RESOURCE MOCK

**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 scientific calculators may be used.

Assume where necessary

Acceleration due to gravity,  $g$ ,

$$= 9.81\text{ms}^{-2}$$

Electron charge,  $\epsilon$

$$= 1.6 \times 10^{-19}\text{C}$$

Electron mass

$$= 5.97 \times 10^{-31}\text{kg}$$

Mass of the earth

$$= 5.97 \times 10^{24} \text{ kg}$$

Plank's constant,  $h$ ,

$$= 6.6 \times 10^{-34}\text{Js}$$

Stefan's –Boltzmann's constant,  $\sigma$

$$= 5.67 \times 10^{-8}\text{Wm}^{-2}\text{K}^{-4}$$

Radius of the earth

$$= 6.4 \times 10^6\text{m}$$

Radius of the sun

$$= 7 \times 10^8 \text{ m}$$

Radius of earth's orbit about the sun

$$= 1.5 \times 10^{11}\text{m}$$

Speed of light in a vacuum,  $c$ ,

$$= 3.0 \times 10^8\text{ms}^{-1}$$

Thermal conductivity of copper

$$= 390\text{Wm}^{-1}\text{K}^{-1}$$

Thermal conductivity of aluminum

$$= 210\text{Wm}^{-1}\text{K}^{-1}$$

Specific heat capacity of water

$$= 4.200\text{Jkg}^{-1}\text{K}^{-1}$$

Universal gravitational constant,  $G$

$$= 6.67 \times 10^{-11}\text{Nm}^2\text{kg}^{-2}$$

Avogadro's number,  $N_A$

$$= 6.02 \times 10^{23}\text{mol}^{-1}$$

Surface tension of water

$$= 7.0 \times 10^{-2} \text{ Nm}^{-1}$$

Density of water

$$= 1000\text{kgm}^{-3}$$

Gas constant  $R$

$$= 8.31\text{Jmol}^{-1}\text{K}^{-1}$$

Charge to mass ratio,  $e/m$

$$= 1.8 \times 10^{11}\text{Ckg}^{-1}$$

The constant  $\frac{1}{4\pi\epsilon_0}$

$$= 9.0 \times 10^9\text{F}^{-1}\text{m}$$

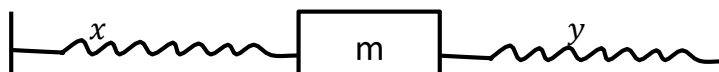
Faraday constant,  $F$

$$= 9.65 \times 10^4 \text{ Cmol}^{-1}$$

**Turn over**

## SECTION A

1. (a) (i) Explain what is meant by **centripetal force**. (2 marks)
- (ii) A body moving in a circular path of radius 0.5m makes 40 revolutions per second. Find the centripetal force if the mass is 1kg. (3 marks)
- (b) Describe an experiment to determine the centre of gravity of a plane sheet of material having irregular shape. (4 marks)
- (c) (i) State the **work-energy theorem** (1 mark)
- (ii) A bullet of mass 0.1kg moving horizontally with a speed of 420ms<sup>-1</sup> strikes a block of mass 2.0kg at rest on smooth table and becomes embedded in it. Find the kinetic energy lost if they move together. (4 marks)
- (d) Explain why more energy is required to push a wheel barrow uphill than on a level ground. (3marks)
- (e) Show that the pressure,  $P$ , exerted at a depth,  $h$ , below the free surface of a liquid of density,  $\rho$ , is given by  $P = h\rho g$ . (3marks)
2. (a) (i) State **Newton's laws** of motion. (3marks)
- (ii) Explain why passengers in a bus are thrown back wards when the bus suddenly starts moving. (3 marks)
- (b) (i) What is meant by **viscosity**? (1 mark)
- (ii) Explain the effect of increase in temperature on viscosity of a liquid. (3 marks)
- (c) Derive an expression for the terminal velocity of a sphere of radius,  $a$ , falling in a liquid of viscosity. (4 mark)
- (d) Show that Newton's law of universal gravitation is consistent with Kepler's third law. (3 marks)
- (e) The period of the moon around the earth is 27.3 .If the distance of the moon from the earth is  $3.83 \times 10^5$ km. Calculate the acceleration due to gravity at the surface of the earth. (3 marks)
3. (a) Using the molecular theory, explain the laws of friction between solid surfaces . (6 marks)
- (b) (i) What is meant by **a couple in mechanics**? (1 mark)
- (ii) State the conditions for equilibrium of a system of coplanar forces. (2 marks)



Two springs  $x$  and  $y$  of spring constants  $K_x$  and  $K_y$  respectively are connected to a mass  $m$  as shown in the figure above. The surface on which the mass slides is frictionless.

- (i) Show that when the mass is displaced slightly, it oscillates with simple harmonic motion of frequency,  $f$ , given by  $f = \frac{1}{2\pi} \sqrt{\frac{K_x + K_y}{m}}$  (4 marks)
- (ii) If the two springs in the figure above are identical such that  $K_x = K_y = 4.0 \text{ Nm}^{-1}$  and  $m = 40 \text{ g}$ , calculate the period of the oscillation. (3 marks)
- (d) A body of mass  $1 \text{ kg}$  moving with simple harmonic motion has speeds of  $5 \text{ ms}^{-1}$  and  $3 \text{ ms}^{-1}$  when it is at distances of  $0.10 \text{ m}$  and  $0.20 \text{ m}$  respectively from the equilibrium point. Find the amplitude of the motion. (4 marks)
4. (a) Define the term **surface tension** in terms of surface energy (1 mark)
- (b) (i) Calculate the work done against surface tension forces in blowing a soap bubble of diameter  $1.5 \text{ cm}$  if the surface tension of the soap solution is  $3.0 \times 10^{-2} \text{ Nm}^{-1}$ . (3 marks)
- (ii) A soap bubble of radius  $r_1$ , is attached to another bubble of radius  $r_2$ , show that the radius of curvature of the common interface is  $\frac{r_1 r_2}{r_2 - r_1}$  (5 marks)
- (c) (i) What is meant by **Yong's modulus**? (1 mark)
- (ii) Explain the energy changes which occur during plastic deformation. (4 marks)
- (d) A horizontal pipe of cross-sectional area  $0.4 \text{ m}^2$ , tapers to a cross sectional area of  $0.2 \text{ m}^2$ . The pressure at the large section of the pipe is  $8.0 \times 10^4 \text{ Nm}^{-2}$  and the velocity of water through the pipe is  $1.5 \text{ ms}^{-1}$ . If atmospheric pressure is  $1.01 \times 10^5 \text{ Nm}^{-2}$ , Find the pressure at the small section of the pipe (6 marks)

### SECTION B

5. (a) (i) State Dalton's law of **partial Pressures**. (1 mark)
- (ii) A horizontal tube of uniform bore, closed at one end has some air trapped by a small quantity of water. The length of the enclosed air column is  $20 \text{ cm}$  at  $12^\circ \text{C}$ . Find, starting any assumptions made, the length of the air column when the temperature is raised to  $38^\circ \text{C}$ . (S.V.P of water at  $12^\circ \text{C}$  and  $38^\circ \text{C}$  are  $10.5 \text{ mmHg}$  and  $49.5 \text{ mmHg}$  respectively .Atmospheric pressure =  $750 \text{ mmHg}$ ) (5 marks)
- (b) Use Kinetic theory of matter to explain the following observations.
- (i) Saturated vapour pressure of a liquid increases with temperature. (3 marks)
- (ii) Saturated vapour pressure is not affected by a decrease in volume at constant temperature. (3 marks)

- (c) (i) Define the **triple point** of water.
- (ii) Describe how you would measure the temperature of a body on the thermodynamic scale using a thermo couple. *(3 marks)*
- (d) The temperature of one mole of helium gas at a pressure of  $1.0 \times 10^5 \text{ Pa}$  increases from  $20^\circ\text{C}$  to  $100^\circ\text{C}$  when the gas is compressed adiabatically. Find the final pressure of the gas. (Take  $\gamma = 1.67$ ) *(4 marks)*
6. (a) (i) Define latent **heat**. *(1 mark)*
- (ii) Explain the significance of latent heat in regulation of body temperature. *(3 marks)*
- (b) (i) Using kinetic theory's, explain boiling of a liquid. *(3 marks)*
- (ii) Explain why latent heat of vaporization is always greater than that of fusion. *(2 marks)*
- (c) The root mean square speed of the molecules of a gas is  $44.72 \text{ ms}^{-1}$ . Find the temperature of one mole of the gas if its density is  $9.0 \times 10^{-2} \text{ kg m}^{-3}$  and volume is  $42.0 \text{ m}^3$ . *(3 marks)*
- (d) An appliance rated 240v, 200w evaporates 20g of water in 5 minutes, find the heat loss if specific latent heat of evaporation is  $2.26 \times 10^6 \text{ J kg}^{-1}$ . *(3 marks)*
- (e) (i) Two thermometers are used to measure the temperature of a body. Explain why the temperature values may be different. *(2 marks)*
- (ii) A platinum resistance thermometer has resistance of  $5.42 \Omega$  at the triple point of water. Calculate its resistance at a temperature of  $50^\circ\text{C}$ . *(2 marks)*
7. (a) (i) What is meant by a **black body**? *(1 mark)*
- (ii) A spherical black body of radius 2.0cm at  $-73^\circ\text{C}$  is suspended in an evacuated enclosure whose walls are maintained at  $27^\circ\text{C}$ . If the rate of exchange of thermal energy is equal to  $1.85 \text{ Js}^{-1}$ , Find the value of stefan's constant,  $\sigma$  *(5 marks)*
- (b) (i) Define **thermal conductivity** *(1 marks)*
- (ii) Explain the mechanism of heat transfer in metals. *(3 marks)*
- (c) The wall of a furnace is constructed with two layers. The inner layer is made of bricks of thickness 10.0cm and thermal conductivity  $0.8 \text{ W m}^{-1} \text{ K}^{-1}$  and the outer layer is made of a material of thickness 10.0cm and thermal conductivity  $1.6 \text{ W m}^{-1} \text{ K}^{-1}$ .
- (i) Explain why at steady state, the rate of thermal energy transfer must be the same in both layers. *(1 mark)*
- (ii) Calculate the rate of heat flow per square metre through the wall. *(5 marks)*
- (d) Explain the occurrence of land and sea breeze. *(4 marks)*

## SECTION C

8. (a) Define the terms below as applied to a triode.
- (i) **Space charge** (1 mark)
  - (ii) **Amplification factor** (1 mark)
  - (iii) **Mutual conductance** (1 mark)
- (b) A triode with mutual conductance of  $3.0 \times 10^{-3} \text{AV}^{-1}$  and anode resistance  $1.0 \times 10^4 \Omega$ , is used as a single –stage amplifier. If the load resistance is  $3 \times 10^4 \Omega$ , Calculate the voltage gain of the amplifier. (5 marks)
- (c) Explain x-ray diffraction by crystals and derive Bragg’s law. (6 marks)
- (d) At a certain time, A  $\beta$ - particle detector registers a count rate of  $32 \text{s}^{-1}$ . After 10 days later, the count rate dropped to  $8 \text{s}^{-1}$ . Find the decay constant. (3 marks)
- (e) Describe with the aid of a diagram, the production of cathode rays. (3 marks)
9. (a) (i) What is **photon**? (1 mark)
- (ii) Explain using quantum theory, the experimental observation on the photoelectric effect. (6 marks)
- (b) Ultra-violet light of wave length  $3.3 \times 10^{-8} \text{m}$  is incident on a metal. Given that the work function of the metal is  $3.5 \text{eV}$ , calculate the maximum velocity of the liberated electron. (3 marks)
- (c) Describe briefly the steps involved in the determination of the charge of an electron by Millikan’s oil drop experiment. (4 marks)
- (d) A stream of singly ionized magnesium atoms is accelerated through a p.d of  $50 \text{v}$  and then enters a region of uniform magnetic field of flux density  $2.08 \times 10^{-2}$ . The ions describe a circular path of radius  $0.24 \text{m}$ . Calculate the atomic mass of the ions. (3 marks)
- (e) Distinguish between **nuclear fission** and **nuclear fusion** and account for the energy release. (3 marks)
10. (a) (i) What is **binding energy** of a nucleus? (1mark)
- (ii) Calculate the energy in MeV released by fusing four protons to form an alpha particle and two beta particles.
- Mass of beta particle =  $0.000549 \text{u}$ .  
Mass of hydrogen atom =  $1.007825 \text{u}$   
Mass of helium atom =  $4.002664 \text{u}$   
( $1 \text{u} = 931 \text{MeV}$ )

- (b) (i) Draw a graph to illustrate the variation of ionization current and p.d across an ionization chamber and explain its features. *(3 marks)*
- (ii) Explain how ionization chamber can be used to detect ionising radiation. *(4 marks)*
- (c) A radioactive source produces alpha particles each of energy 80MeV if 40% of the alpha particles enter an ionization chamber a current of  $0.4 \mu A$  flow. Find the activity of the alpha source, If the energy needed to make an ion pair in the chamber is 40 MeV. *(3 marks)*
- (d) A beam of  $\alpha$  –particle of energy 4.2 MeV is incident normal to a gold foil, .Find the closest distance of approach by the  $\alpha$ particles to the nucleus of a gold atom. (Atomic number of gold = 79) *(4 marks)*

**END**