P510/1
PHYSICS
Paper 1
[redacted]
2½ hours

Uganda Advanced Certificate of Education

[redacted]

PHYSICS PAPER 1

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Attempt **five** *questions, including at least* **one** *but* **not** *more than* **two** *questions from each of the sections* **A**, **B** *and* **C**. *Any additional question(s) answered will* **not** *be marked.*

Non-programmable scientific electronic calculators may be used.

Assume where necessary:

Acceleration due to gravity, g	=	$9.81ms^{-2}$
Electronic charge, e	=	$1.6 \times 10^{-19}C$
Electron mass	=	$9.11 \times 10^{-31}kg$
Mass of the earth	=	$5.97 \times 10^{24}kg$
Plank's constant, h	=	$6.6 \times 10^{-34}Js$
Stefan's – Boltzmann's constant σ	=	$5.67 \times 10^{-8}WM^{-2}K^{-4}$
Radius of the earth	=	$6.4 \times 10^{6}m$
Radius of the sun	=	$7.0 \times 10^{8}m$
Radius of earth's orbit about the sun	=	$1.5 \times 10^{11}m$
Speed of light in a vacuum, C	=	$3.0 \times 10^{8}ms^{-1}$
Thermal conductivity of copper	=	$390Wm^{-1}K^{-1}$
Thermal conductivity of aluminium	=	$210Wm^{-1}K^{-1}$
Specific heat capacity of water	=	$4200Jkg^{-1}K^{-1}$
Universal gravitational constant, G	=	$6.67 \times 10^{-11} Nm^2kg^{-2}$
Avogadro's number, N_A	=	$6.02 \times 10^{23}mol^{-1}$
Surface tension of water	=	$7.0 \times 10^{-2}Nm^{-1}$
Density of water	=	$1000Kgm^{-3}$
Gas constant, R	=	$8.31Jmol^{-1}K^{-1}$
Charge to mass ratio, $^{e}/_{m}$	=	$1.8 \times 10^{11} Ckg^{-1}$
The constant , $\frac{1}{4\pi\varepsilon_o}$	=	$9.0 \times 10^{9}F^{-1}m$
Specific heat capacity of copper	=	$400JKg^{-1}K^{-1}$.
Specific latent heat of fusion of ice	=	$3.3 \times 10^{5}JKg^{-1}$.
Faraday constant, *F*	=	$9.56 \times 10^{4}Cmol^{-1}$

Turn Over

SECTION A

1. (a) (i) What is meant by the term simple harmonic motion? (01 mark)

(ii) Show that a simple pendulum oscillates with $S.H.M$ when slightly displaced and derive an expression for the period of the motion. (06 marks)

(b)

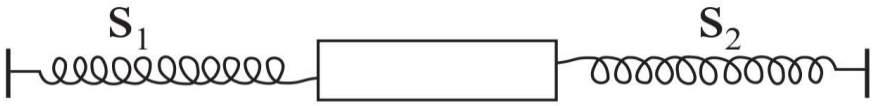

Fig. 1

Figure 1 above shows a block of mass $0.1kg$ resting on a smooth horizontal surface and attached to two springs S_1 and S_2 of force constants $60Nm^{-1}$ and $100Nm^{-1}$ respectively. The block is pulled through a distance of $4.0cm$ to the right and released.

(i) Find the frequency of oscillation. (03 marks)

(ii) Find the new amplitude of oscillation when a mass of $60.0g$ is dropped vertically on the block as the block passes the equilibrium position. Assume that the mass sticks to the block. (06 marks)

(c) With the aid of sketch graphs, explain what is meant by critically damped and under damped oscillations. (04 marks)

2. (a) (i) State Archimede's principle. (01 mark)

(ii) Show that the weight of fluid displaced is equal to the upthrust on the body. (04 marks)

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

(ii) Describe an experiment to verify the law of floatation. (05 marks)

(c) (i) State Bernoullis theorem. (01 mark)

(ii) Write down the expression for the Bernoullis theorem and identify each term in the equation. (04 marks)

(d) Explain the origin of the dynamic lift on the wings of an aeroplane's take off. (04 marks)

3. (a) (i) State Newton's laws of motion. (03 marks)

(ii) Use Newton's laws of motion to show that linear momentum is conserved when two particles moving in a straight line collide. (04 marks)

(b) Balls $\boldsymbol{P}$, $\boldsymbol{Q}$ and $\boldsymbol{R}$ of masses $\boldsymbol{m_1}$, $\boldsymbol{m_2}$ and $\boldsymbol{m_3}$ lie on a smooth horizontal surface in a straight line. The balls are initially at rest. Ball $\boldsymbol{P}$ is projected with a velocity $\boldsymbol{u_1}$is towards $\boldsymbol{Q}$ and makes an elastic collision with $\boldsymbol{Q}$. if $\boldsymbol{Q}$ makes a perfectly inelastic collision with $\boldsymbol{R}$, show that $\boldsymbol{R}$ moves with a velocity.

$$V_2 = \frac{2m_1m_2u_1}{(m_1+m_2)(m_2+m_3)}$$ (06 marks)

(c) (i) Define the impulse of a force. (01 mark)

(ii) Explain what is meant by the term weightlessness. (03 marks)

4. (a) State Kepler's laws of planetary motion. (03 marks)

(b) Describe an experiment to determine the gravitational constant G. (06 marks)

(c) (i) What is meant by a parking orbit of an earth satellite? (01 mark)

(ii) Calculate the period of a satellite which is $100Km$ above the surface of the earth. (05 marks)

(d) (i) Define uniform acceleration and state its units. (02 marks)

(ii) Explain why a body moving in a circular path with uniform speed has an acceleration. (03 marks)

SECTION B

5. (a) (i) What is meant by the term triple point? (01 mark)

(ii) Define the term Kelvin. (01 mark)

(iii) What are the requirements of a good thermometric property? (03 marks)

(b) With the aid of a well labeled diagram, describe the structure and mode of operation of the disappearing filament pyrometer. (06 marks)

(c) The resistance of a wire at a temperature θ^oC measured on a standard scale is given by $R_\theta = R_0(1 + A\theta + 10^{-3}A\theta^2)$ where A is a constant. When the thermometer is at a temperature of 50^oC on the standard scale, what will be the temperature indicated on the resistance scale? (05 marks)

(d) (i) What is meant by a cooling correction? (01 mark)

(ii) Explain why a small body of same material cools faster than a larger one. (03 marks)

Turn Over

6. (a) (i) What are the molecular differences between a real gas and an ideal gas? (03 marks)

(ii) Show that the average kinetic energy of translation of a molecule in random motion within a container is directly proportional to its absolute temperature. (05 marks)

(b) (i) Explain why passage of sound waves through air is considered as an adiabatic process. (03 marks)

(ii) Sketch a graph of pressure against volume for a real gas under going compression below critical temperature and explain the shape of your graph. (04 marks)

(c) A beam of 2×10^{20} oxygen atoms each of mass $2.32 \times 10^{-24} Kg$ is incident normally on a wall of cubical container of edge $10.0cm$. The beam is reflected through 180^o. If the mean speed of atoms is $4.80ms^{-1}$, derive the expression for the pressure exerted by the oxygen gas and hence deduce the pressure. (05 marks)

7. (a) (i) State the laws of black body radiation. (02 marks)

(ii) With the aid of a diagram, explain how a black body can be approximated in a laboratory. (04 marks)

(iii) With the aid of sketch graphs explain the main features of the spectral distribution of black body radiation for three different temperatures. (04 marks)

(b) (i) Define the coefficient of thermal conductivity of a material. (01 mark)

(ii) State any **two** factors on which the rate of flow of heat through a material depends.. (02 marks)

(c) Explain briefly the variation of temperature gradient along un lagged metal bar. (02 marks)

(d) In the determination of thermal conductivity of copper of diameter $50mm$, one end of the insulated copper bar is in steam at 100^oC. The temperatures at two positions along the bar are 74^oC and 55^oC respectively. The other end is cooled by water piped through a metal tubing wrapped round that end. The temperature of the water at the in let and out let to the pipe are 16^oC and 25^oC respectively. Water collected at outlet is $150g$ per minute. Calculate the thermal conductivity of copper. (05 marks)

SECTION C

8. (a) What is meant by unified atomic mass unit? (01 mark)

(b) A typical nuclear reaction is given by;
$^{235}_{92}U + {}^{1}_{0}\cap \rightarrow {}^{95}_{42}Mo + {}^{139}_{57}La + 2\,{}^{1}_{0}\cap + 7\,{}^{0}_{-1}e$. Calculate the total energy released by $1g$ of uranium. (05 marks)

Mass of $^{1}_{0}\cap = 1.009\,u$

$^{0}_{-1}e = 0.0005\,u$

$^{95}_{42}Mo = 94.906\,u$

$^{139}_{57}La = 138.906\,u$

$^{235}_{92}\cup = 235.044\,u$

$1u = 1.66 \times 10^{-27}Kg$

(c) (i) What is meant by a line spectrum? (02 marks)

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

(d) Explain using suitable sketch graphs, how x – ray spectra in an x – ray tube are formed. (05 marks)

(e) A beam of x – rays of wave length $8.42 \times 10m^{-11}$ is incident on a sodium chloride crystal of interplanal separation 2.82×10^{-10}. Calculate the first order diffraction angle. (03 marks)

9. (a) (i) State Rutherford's model of the atom. (01 mark)

(ii) Explain Rutherford's model of the atom. (04 marks)

(b) (i) What is a Bohr atom? (02 marks)

(ii) Explain what is observed when a beam of alpha particles is directed into a thin gold foil. (06 marks)

(iii) Explain briefly why the experiment in (b) (ii) above is carried in a vacuum. (02 marks)

(c) A radioactive source produces alpha particles of energy $60MeV$. If 20% of the alpha particles enter the ionization chamber a current of $0.2A$ flows. Find the activity of the alpha source if the energy needed to produce an ion pair is $32MeV$. (05 marks)

Turn Over

10. (a) (i) What are cathode rays? (01 mark)

(ii) State **four** properties of cathode rays. (04 marks)

(iii) Describe briefly how the sign of charge of cathode rays is determined. (02 marks)

(b) (i) What is meant by the term specific charge? (01 mark)

(ii) Describe with the aid of a labeled diagram, the structure and mode of operation of a Bain bridge mass spectrometer. (06 marks)

(c) (i) What is an electron volt? (01 mark)

(ii) Electrons are accelerated by a p.d of $2.0 \times 10^{3} V$ and pass at right angles into a uniform magnetic field of strength $1.0 \times 10^{-2} Wbm^{-2}$. Find the radius of their path. (05 marks)

END