

P510/1

PHYSICS

Paper 1

Jul/ Aug 2019

2 ½ Hours

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	=	$1.6 \times 10^{-19}\text{C}$
Electron mass	=	$9.11 \times 10^{-31}\text{kg}$
Gas constant R	=	$8.31\text{Jmol}^{-1}\text{K}^{-1}$
Density of water	=	1000kgm^{-3}
Radius of the earth	=	$6.4 \times 10^6\text{m}$
Radius of the sun	=	$7.0 \times 10^8\text{m}$
Radius of earth's orbit about the sun	=	$1.5 \times 10^{11}\text{m}$
Mass of the earth	=	$5.97 \times 10^{24}\text{kg}$
Universal gravitational constant, G	=	$6.67 \times 10^{-11}\text{Nm}^2\text{kg}^{-2}$
Specific heat capacity of water	=	$4200\text{Jkg}^{-1}\text{K}^{-1}$
Specific latent heat of vaporization of water	=	$2.26 \times 10^6\text{Jkg}^{-1}$
Speed of light in vacuum	=	$3.0 \times 10^8\text{ms}^{-1}$
Plank's constant, h	=	$6.6 \times 10^{-34}\text{Js}$
Avogadro's number N_A	=	$6.02 \times 10^{23}\text{mol}^{-1}$
The constant $\frac{1}{4\pi\epsilon_0}$	=	$9.0 \times 10^9 \text{F}^{-1}\text{m}$

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^{-1} at an angle of 20.04° 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 $V \text{ ms}^{-1}$. **(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. **(1 mark)**
- (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 $2 \times 10^{11} \text{ Pa}$, 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 mm^2 is heated from temperature 45° to 90° . 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 $1.1 \times 10^{-5} \text{ K}^{-1}$]

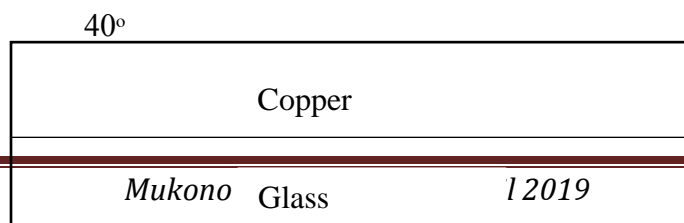
3. (a) (i) Define surface energy and derive its dimensions. **(3 marks)**
- (ii) Derive an expression for the pressure difference across a soap bubble of radius r and surface tension γ . **(3 marks)**

- (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 $1.4 \times 10^{-4} \text{ Nm}^{-1}$, 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.



If the temperature of the outer faces of the plate are 40°C and 10°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 $40\text{ Wm}^{-1}\text{K}^{-1}$ and $6\text{ Wm}^{-1}\text{K}^{-1}$ 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 28°C . Electric power is supplied to the heater for 10 minutes. If the specific heat capacity of the liquid is $2.5 \times 10^3\text{ Jkg}^{-1}\text{K}^{-1}$, its specific latent heat of vaporization is $8.54 \times 10^3\text{ Jkg}^{-1}$ and its boiling point is 78°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 5.2Ω at the ice point of water and 9.4Ω at the steam point. If the resistance is 6.5Ω at an unknown temperature θ , find θ 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 C_v and state its units. **(2 marks)**

(ii) Derive the expression $C_p - C_v = R$ for n moles of a gas. **(4 marks)**

(c) An ideal gas at 27°C had a pressure of $1.01 \times 10^7\text{ Pa}$. The gas was compressed isothermally until its volume was halved. It was then allowed to expand adiabatically to its original volume. Given the ratio, $C_p/C_v = 1.40$

(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 ${}^{60}_{27}\text{Co}$ decays to ${}^{60}\text{Ni}$ by emission of a beta particle and two gamma photons. The half-life of ${}^{60}_{27}\text{Co}$ 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 ${}^{60}_{27}\text{Co}$.
- [Mass of ${}^{60}_{27}\text{Co}$ = 59.9338u
mass of ${}^{60}\text{Ni}$ = 59.9308u
mass of ${}^0_{-1}e$ = 0.0005u] **(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 $3 \times 10^{18}\text{Hz}$ 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 20.74° . Find the:
- (i) the spacing between consecutive planes. **(2 marks)**
- (ii) the relative molecular mass of Sodium Chloride. **(4 marks)**
- [Density of Sodium Chloride = $2,166 \text{ kgm}^{-3}$]

(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

(i) Copy the diagram and on it indicate the electron transitions that lead to the emission of Ultra-violet and Infra-red spectra. **(2 marks)**

(ii) 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 $1.2 \times 10^6 \text{ ms}^{-1}$ 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 $7.26 \times 10^{-7} \text{ m}$ and of density 880 kgm^{-3} is held stationary in an electric field of intensity $1.72 \times 10^4 \text{ Vm}^{-1}$. Calculate the number of electronic charges on the drop. **(3 marks)**

[Density of air = 1.29 kgm^{-3}]

END