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	=	$1.6 \times 10^{-19}C$
Electron mass	=	$9.11\times10^{-31}kg$
Gas constant R	=	$8.31Jmol^{-1}K^{-1}$
Density of water	=	$1000kgm^{-3}$
Radius of the earth	=	$6.4\times10^{6}m$
Radius of the sun	=	$7.0\times10^{8}m$
Radius of earth's orbit about the sun	=	$1.5\times10^{11}m$
Mass of the earth	=	$5.97\times10^{24}kg$
Universal gravitational constant, G	=	$6.67\times10^{-11}Nm^{2}kg^{-2}$
Specific heat capacity of water	=	$4200Jkg^{-1}K^{-1}$
Specific latent heat of vaporization of water	=	$2.26\times10^{6}Jkg^{-1}$
Speed of light in vacuum	=	$3.0\times10^{8}ms^{-1}$
Plank's constant, h	=	$6.6\times10^{-34}Js$
Avogadro's number N_A	=	$6.02\times10^{23}mol^{-1}$
The constant $\frac{1}{4\pi\varepsilon_0}$	=	$9.0\times10^{9}\ F^{-1}m$

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^o 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 2×10^{11} 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^o. 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 $1.1\times10^{-5}k^{-1}$]

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 $\boldsymbol{\gamma}$. ***(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)***

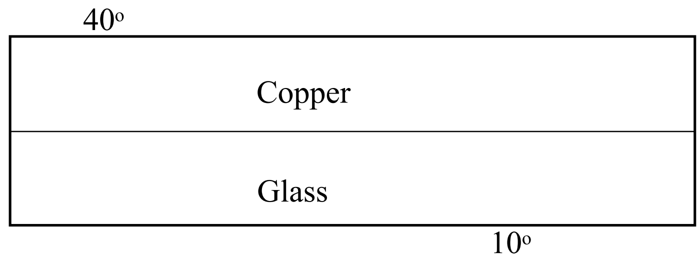
SECTION B

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.



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 $Wm^{-1}K^{-1}$ and 6 $Wm^{-1}K^{-1}$ 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 2.5×10^3 $Jkg^{-1}K^{-1}$, its specific latent heat of vaporization is $8.54 \times 10^3 Jkg^{-1}$ 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 $5.2\,\Omega$ at the ice point of water and $9.4\,\Omega$ at the steam point. If the resistance is $6.5\,\Omega$ 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 x 10^7 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}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 $^{60}_{27}\text{Co}$ = 59.9338μ

mass of ^{60}Ni = 59.9308μ

mass of $^{0}_{-1}e$ = 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 3×10^{18}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 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.

$n=\infty$ ………………………………………………..	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 1.2×10^{6} 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 1.72×10^{4} Vm^{-1}. Calculate the number of electronic charges on the drop. ***(3 marks)***

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

END