P510/1
PHYSICS
Paper 1
July / Aug. 2022
2 ½ hours

UGANDA TEACHERS' EDUCATION CONSULT (UTEC)

Uganda Advanced Certificate of Education

PHYSICS

Paper 1

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Attempt **FIVE** *questions, including at least* **one**, *but not more than* **two** *from each of the Sections* ***A***, ***B*** *and* ***C***.

Assume where necessary:

Acceleration due to gravity	*g*	=	$9.81\ ms^{-2}$
Electron charge	*e*	=	$1.6 \times 10^{-19}\ C$
Electron mass		=	$9.11 \times 10^{-31} kg$
Radius of earth		=	$6.4 \times 10^{6}\ m$
Planck's constant	*h*	=	$6.6 \times 10^{-34} Js$
Speed of light in vacuum, c		=	$3.0 \times 10^{8} ms^{-1}$
Stefan's – Boltzmann's constant, σ		=	$5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$
Wien's displacement constant		=	$2.90 \times 10^{-3}\ m\ K$
Specific heat capacity of water		=	$4.2 \times 10^{3} J\ kg^{-1}\ K^{-1}$
Gas constant, R		=	$8.31\ J\ mol^{-1}K^{-1}$
Universal gravitational constant, G		=	$6.67 \times 10^{-11} N\ m^{-2}kg^{-2}$
Charge to mass ratio, e/m		=	$1.8 \times 10^{11} C\ kg^{-1}$
Avogadro's number, N_A		=	$6.02 \times 10^{23} mol^{-1}$
The constant $\frac{1}{4\pi\varepsilon_o}$		=	$9.0 \times 10^{9} F^{-1}m$
One electron volt, (eV)		=	$1.6 \times 10^{-19} J$
Mass of the earth		=	$5.97 \times 10^{24} kg$
Mass of the sun		=	$2.0 \times 10^{30} kg$
Radius of the sun		=	$7.0 \times 10^{8} m$
Radius of earth's orbit round the sun		=	$1.5 \times 10^{11} m$
Density of water		=	$1000 kgm^{-3}$
Young's modulus of steel		=	$1.9 \times 10^{11} Pa$
Specific latent heat of vaporization of water		=	$2.3 \times 10^{6} Jkg^{-1}$

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SECTION A:

1. (a) (i) What is **Linear acceleration**? (01 mark)

(ii) A body starts moving from rest and accelerates at a rate $\alpha\, ms^{-2}$ for a time $t\,(seconds)$ covering a distance S (metres). Show that $S = \frac{1}{2}at^2$. (04 marks)

(b) Define the following according to materials.

(i) Creep (01 mark)

(ii) Malleability. (01 mark)

(c) Describe an experiment to determine the ratio of tensile stress to tensile strain of a wire. (06 marks)

(d) State;

(i) two measurements carried out during the experiment. (01 mark)

(ii) two precautions taken during the experiment. (01 mark)

(e) A steel wire has diameter 0.4cm, length 20cm and temperature coefficient of expansivity 4.0 x 10^{-3} K^{-1}. If its temperature is increased from 20°C to 35°C, calculate;

(i) extension produced. (02 marks)

(ii) energy density due to expansion. (03 marks)

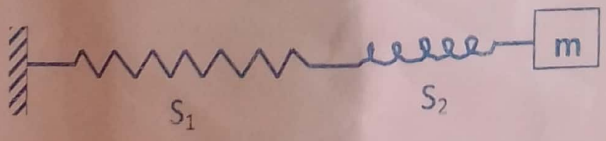
2. (a) (i) Define simple harmonic motion. (s.h.m). (01 mark)

(ii) State two applications of s.h.m. (01 mark)

(b) (i) Mention the characteristics of simple harmonic motion. (02 marks)

(ii) Sketch a combined graph of kinetic energy and potential energy with Displacement for s.h.m. (02 marks)

(c)



The system above shows two springs S_1 and S_2 of force constants K and 2K respectively connected in series with the free end of S_1 fixed and the free end of S_2 attached to an object of mass **m** and lying in a horizontal position on a smooth table surface.

(i) If the mass is given a small horizontal displacement and released, show that it oscillates with a frequency $f = \frac{1}{2\pi}\sqrt{\frac{2K}{3m}}$ (05 marks)

(ii) Given that $K_1 = 80Nm^{-1}$, $K_2 = 100Nm^{-1}$ and that a horizontal pulling force of 4N is applied to the mass, calculate the total energy developed in the springs. (03 marks)

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(d) (i) Explain the behavior of a speeding bodaboda cyclist on a level circular track. (03 marks)

(ii) A conical pendulum has a period of $\frac{\pi}{2}$ seconds when the string is inclined at an angle 30° to the horizontal while carrying an object of mass 120g. Calculate the radius of the circle described. (03 marks)

3. (a) (i) Define coefficient of viscosity. (01 mark)

(ii) State two factors that determine the rate of volume flow of a fluid through a horizontal pipe. (01 mark)

(b) (i) Distinguish between steady flow and turbulent flow. (03 marks)

(ii) A horizontal composite pipe has two parts each of length 40cm. One part has a radius five – times the radius of the other part which is 2cm. Water of coefficient of viscosity 9.0×10^{-3} Nsm^{-2} flows through the pipe uniformly setting up a pressure difference of 5.2 Kpa across the ends of the pipe. Calculate the rate of mass flow of water through the pipe at a given time. (07 marks)

(c) (i) State Bernoulli's principle. (01 mark)

(ii) What is a constriction? (01 mark)

(iii) When water is flowing out of a tap, explain what happens to pressure and velocity of flow when part of the tap outlet is closed off using a thumb. (02 marks)

(d) A person uses an umbrella of surface area 4.0×10^4 cm^2 during a windy – rainy day. A wind blows over the umbrella with speed $120ms^{-1}$ and below it at a speed of $80ms^{-1}$. If density of air is $1.29kgm^{-3}$, Calculate the magnitude of an upwards force that takes away the umbrella from the person's hands. (04 marks)

4. (a) Define;

(i) A satellite (01 mark)

(ii) A parking orbit (01 mark)

(b) State the laws that govern motion of planets round the sun in the universe. (03 marks)

(c) (i) Explain how world – wide communication is received using satellites. (03 marks)

(ii) An artificial satellite orbits the Earth at a height of 42227km above the earth's surface. Calculate its period and comment on the result. (05 marks)

(d) Show that the height of artificial satellite while in a circular orbit round the earth in a region where acceleration due to gravity is one – nineth the acceleration due to gravity on the earth is $2r_2$ where r_2 is radius of the earth. (04 marks)

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(e) The satellite in (d) above can be forced to reduce radius of orbit towards the earth. Explain the cause and resultant effect on it. (03 marks)

SECTION B

5. (a) (i) Define a **Kelvin.** (01mark)

(ii) Explain how a Kelvin scale of temperature defined on a thermometric property **X** can be set up. (02 marks)

(b) (i) Mention two desirable features of a good thermometric property. (01 mark)

(ii) Describe how a liquid – in – glass thermometer can be used to measure temperature on a centigrade scale. (03 marks)

(c) Resistance $R(\Omega)$ of a pure metal wire varies with temperature t^oC according to $R = R_o(4 + \beta t^2)$. Find the resistance at 40°C if its values are 40Ω and 60Ω at temperatures of 10°C and 25°C respectively.

(d) (i) Mention two ways of minimizing heat loss during calorimetric experiments. (01 mark)

(ii) Explain how mass of a body affects its rate of cooling. (02 marks)

(e) Steam from boiling water is passed into a water – ice mixture contained in a copper calorimeter of heat capacity $40Jk^{-1}$ at 0°C. If mass of water is 250g and that of ice is 150g, calculate total mass of water in the calorimeter at 10°C. (05 marks)

6. (a) (i) Define thermal conduction. (01 mark)

(ii) Explain the mechanism of heat transfer through a solid. (03 marks)

(b) Describe an experiment to determine coefficient of thermal conductivity of cork. (06 marks)

(c) Heat is supplied at a rate of 300W to one face of a conductor of diameter 10.0cm, thickness 2.5cm and coefficient of thermal conductivity $110wm^{-1}K^{-1}$ using an electric heater. If temperature at the face remote to the heater is 55°C, find the temperature at the face immediate to the heater. (04 marks)

(d) (i) Define a black body. (01 mark)

(ii) Give two examples of a black body. (01 mark)

(e) A filament of a lamp has length 4cm and diameter 2mm. If it radiates heat at a rate of 400W and that 75% of this heat is equivalent to that radiated by a black body at the same temperature. Calculate the wave length of heat radiations emitted. (04 marks)

7. (a) (i) Define an **adiabatic change** (01 mark)

(ii) State two conditions that can sustain occurrence of an adiabatic process. (01 mark)

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(b) A gas of pressure P_o, volume V at a temperature T_1 expands reversibly and adiabatically until its volume is doubled and its temperature drops to T_2 and pressure P. If γ is the ratio of molar heat capacities, show that;

(i) $\frac{T_1}{T_2} = 2^{\gamma - 1}$ (02 marks)

(ii) Work done during expansion is $\frac{P_o V}{\gamma - 1}(1 - 2^{1-\gamma})$. (04 marks)

(c) (i) Explain the effect of temperature rise on kinetic energy of a gas. (03 marks)

(ii) State the assumptions taken in the study of kinetic theory of an ideal gas. (02 marks)

(d) (i) Use the pressure formula $P = \frac{1}{3}\rho C^2$ from kinetic theory of a gas to deduce Avogadro's hypothesis. (03 marks)

(ii) One mole of an ideal gas has mass 40g and volume 2×10^{-3} m^3 at 0°C. Calculate the root mean square speed of its molecules. (03 marks)

SECTION C

8. (a) (i) Define photo electric emission. (01 mark)

(ii) Explain the mechanism of photo electric emission. (03 marks)

(b) Describe an experiment to determine threshold frequency of a photo cathode. (05 marks)

(c) In a photocell, light of wavelength 4.5×10^{-5} cm and power rating of 20mW is incident on a cathode. If 60% of the liberated photo electrons reach the anode per second, calculate the registered current. (04 marks)

(d) An electron of mass **m** and charge **e** is accelerated by a p.d. **V** and enters a uniform perpendicular magnetic field of flux density **B** and describes a circular path of radius r. Show that $\frac{e}{m} = \frac{2V}{B^2 r^2}$. (03 marks)

(e) An oil drop of density $900 kgm^{-3}$ and radius 1.2×10^{-6}m remains stationary between two horizontal electric plates 1.5cm apart with a p.d of 150V applied between them. Calculate the number of electrons on the oil drop if air density is ignored. (04 marks)

9. (a) (i) Define an energy level. (01 mark)

(ii) Explain the effect of passing a radiation through a gas. (03 mark)

(b) (i) The energy of an electron on the n^{th} orbit round the nucleus of an atom is $E_n = \frac{-K}{n^2}$ election volts where $K = \frac{me^4}{8\varepsilon_0^2 h^2}$. If the electron makes a transition from an orbit n_2 to an orbit n_1, show that it emits radiations of frequency $f = \frac{me^4(n_2^2 - n_1^2)}{8\varepsilon_0^2 n_1^2 n_2^2 h^3}$, where **m** is electron mass, **e** is electron charge and **h** is plank's constant. (03 marks)

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(ii) If K = 20eV, calculate the wave length of emitted radiations for a transition from n = 5 to n = 2 energy levels and name the type of the radiations emitted. (04 marks)

(c) (i) Explain the observations made from Rutherfold's alpha scattering experiment. (04 marks)

(ii) Why is a vacuum necessary for the experiment in (c) (i) above? (1 mark)

(d) An alpha particle of energy 4.2MeV is incident towards the nucleus of a gold atom and comes close to it at a distance of 5.4×10^{-12}cm. Calculate atomic number of the gold atom. (04 marks)

10. (a) Define;

(i) Atomic number (01 mark)

(ii) Activity (01 mark)

(b) Describe how a Geiger Muller tube (G.M) is used to detect ionizing radiations. (05 marks)

(c) Alpha particles of total energy 5Mev enter a GM – tube and cause ionization. If each ion pair requires 50eV of energy to be formed. Calculate the number of ionizations per millimeter in a range of 20mm. (03 marks)

(d) (i) A radio active sample has original mass 1g. show that $T_{\frac{1}{2}} = \frac{0.693}{\lambda}$ where $T_{\frac{1}{2}}$ is half life and λ is decay constant. (03 marks)

(ii) Mention the two factors which determine activity of a radioactive material. (02 marks)

(e) An atom $^{235}_{92}U$ is bombarded by a neutron and splits to form two atoms $_{42}X - 144$, $_{50}Y - 84$ and releases eight neutrons with release of energy. Given that;

$^{235}_{92}U = 233.132U$

$^{144}_{42}X = 144.212U$

$^{84}_{50}Y = 81.413U$

$^{1}_{0}\cap = 1.009U$

$^{1}_{1}P = 1.007U$

$1U = 931\ MeV$

(i) Write the equation of the reaction. (01 mark)

(ii) Calculate the energy released by 50g of $U - 235$. (05 marks)

END

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