P510/1
PHYSICS
Paper 1
2½ hrs

STANDARD HIGH SCHOOL ZZANA

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** *questions 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	=	$9.81ms^{-2}$
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	=	$7 \times 10^{8}m$
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) State Archimedes principle. (01 mark)

(ii) Describe an experiment to determine the relative density of an irregular solid which floats in water. (03 marks)

(b) A solid weighs $237.5g$ in air and $12.5g$ when totally immersed in a fluid of density $900Kgm^{-3}$. Calculate the density of the liquid in which the solid would float with one fifth of its volume exposed above the liquid surface. (06 marks)

(c) (i) What is meant by viscosity. (01 mark)

(ii) Explain the effect of temperature on the viscosity of a liquid. (03 marks)

(d) (i) State the work – energy theorem. (01 mark)

(ii) A bullet of mass 100g moving horizontally with a speed of $420ms^{-1}$ strikes the block of mass $2000g$ at rest on a smooth table and becomes embedded in it. Find the kinetic energy lost if they move together. (05 marks)

2. (a) (i) Define centre of gravity. (01 mark)

(ii) Describe an experiment to find the centre of gravity of a regular piece of card board. (03 marks)

(b) Explain using the molecular theory the laws of solid friction. (07 marks)

(c) (i) Define surface tension. (01 mark)

(ii) Explain the origin of surface tension. (03 marks)

(d) Explain why rain drops hit the ground with less force than they should. (05 marks)

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

(b) A body $\boldsymbol{X}$ of mass m_1 moves with velocity u_1 and collides head on elastically with another body, $\boldsymbol{Y}$ of mass m_2 which is at rest. If the velocities of $\boldsymbol{X}$ and $\boldsymbol{Y}$ are v_1 and v_2 respectively and given that $A = m_1/m_2$ show that ;

(i) $\frac{u_1}{v_1} = \frac{A+1}{A-1}$ (04 marks)

(ii) $\frac{v_2}{v_1} = \frac{2A}{A-1}$ (03 marks)

(c) Describe an experiment to determine the acceleration due to gravity using a spiral spring of known force constant. (05 marks)

(d) Explain the following:

(i) A mass attached to a string rotating at a constant speed in a horizontal circle will fly off at a tangent if the string breaks. (02 marks)

(ii) A cosmonaut in a satellite which is in a free circular orbit around the earth experiences a sensation of weightlessness even though there is influence of gravitational field of the earth. (03 marks)

4. (a) (i) What is meant by simple harmonic motion? (01 mark)

(ii) State **four** characteristics of simple harmonic motion. (02 marks)

(b) A mass, $\boldsymbol{m}$ is suspended from a rigid support by a string of length, $\boldsymbol{X}$. The mass is pulled a side so that the string makes an angle, θ with the vertical and then released. Show that the mass executes simple harmonic motion with a period $T = 2\pi\sqrt{\frac{X}{g}}$. (05 marks)

(c) A horizontal spring of force constant $300Nm^{-1}$ fixed at one end has a mass of $3kg$ attached to the free end and resting on a smooth horizontal surface. The mass is pulled through a distance of $5.0cm$ and released. Calculate;

(i) angular speed, (02 marks)

(ii) maximum velocity attained by the vibrating body. (02 marks)

(iii) acceleration when the body is half way towards the centre from its initial position. (02 marks)

(d) (i) What is meant by a couple in mechanics? (01 mark)

(ii) State the conditions for equilibrium of a system of coplanar forces. (02 marks)

(e) Explain why a person standing near a railway line is sucked towards the railway line when a fast moving train passes. (03 marks)

Turn Over

SECTION B

5. (a) (i) Define thermal conductivity. (01 mark)

(ii) Explain the mechanism of heat transfer in metals. (03 marks)

(b) A double glazed window has two glass sheets of thickness $5.0mm$, separated by a layer of air of thickness $1.2mm$. If the two inner air – glass surfaces have steady temperatures of 25^oC and . 5^oC respectively, find the:

(i) temperature of the outer – glass surfaces. (03 marks)

(ii) amount of heat that flows across an area of the window of $3m^2$ in 3 hours. (03 marks)

(Conductivity of glass = $0.72Wm^{-1}K^{-1}$ and that of air $= 0.025Wm^{-1}K^{-1}$)

(c) (i) What is a perfectly black body? (01 mark)

(ii) The energy intensity received by a spherical planet from a star is $1.5 \times 10^3Wm^{-2}$, The star is of radius 7.0×10^5Km and is 1.4×10^8Km from the planet. Calculate the surface temperature of the star. (04 marks)

(d) Explain the green house effect and how it is related to global warming. (05 marks)

6. (a) Define specific heat capacity of a substance. (01 mark)

(b) (i) Describe an electrical method for the determination of the specific heat capacity of a metal. (06 marks)

(ii) State the assumptions made in the above experiment. (02 marks)

(c) Steam at 100^oC is passed into a copper calorimeter of mass $150g$ containing $340g$ of water at 15^oC. This is done until the temperature of the calorimeter and its content is 71^oC. If the mass of the calorimeter and its contents is found to be $525g$ calculate the specific latent heat of vaporization of water. (06 marks)

(d) (i) State the assumptions made in the derivation of the expression

$P = \frac{1}{3}\rho C^{-2}$ for the pressure of an ideal gas. (02 marks)

(ii) Use the expression in (d) (i) above to deduce Dalton's law of partial pressures. (03 marks)

7. (a) Define a thermometric property and give **two** examples. (02 marks)

(b) The resistance, R_θ of platinum varies with temperature $\theta^o C$ as measured by a constant volume gas thermometer according to the equation:

$$R_\theta = 50.0 + 0.17\theta + 3.0 \times 10^{-4}\theta^2$$

(i) Calculate the temperature on the platinum scale corresponding to $60^o C$ on the gas scale. (06 marks)

(ii) Account for the difference between the two values and the temperature at which they agree. (02 marks)

(c) Use the kinetic theory of matter to explain the following observations:

(i) Saturated vapour pressure of a liquid increases with temperature. (03 marks)

(ii) Saturated vapour is not affected by a decrease in volume at constant temperature. (03 marks)

(d) An ideal gas of volume $100cm^3$ at s.t.p expands a diabatically until its pressure drops to a quarter its original value. Find the new volume and temperature if the ratio of the principal specific heat capacities is 1.4 (04 marks)

SECTION C

8. (a) (i) What is meant by the terms: radio active, decay, half life and decay constant? (03 marks)

(ii) Show that the half –life $t_{\frac{1}{2}}$ of a radio isotope is given by $t_{\frac{1}{2}} = \frac{693}{\lambda}$ where λ is the decay constant. (Assume the decay law $N = Noe^{-\lambda t}$). (03 marks)

(b) With the aid of a diagram describe the structure and action of a diffusion cloud chamber. (05 marks)

(c) The radio isotope $^{90}_{38}X$ decays by emission of $\beta -$ particles. The half – life of the isotope is 28.8 year. Determine the activity of $1g$ of the isotope.(05 marks)

(d) (i) What are cathode rays? (01 mark)

(ii) An electron accelerated by a $p.d$ of $1000V$ passes through a uniform electric field intensity crossed with a uniform magnetic field of flux density $0.3T$. If the electron emerges undeflected, calculate the electric field intensity. (03 marks)

Turn over

9. (a) (i) Define space charge as applied to thermionic diodes. (01 mark)

(ii) Draw anode current – anode voltage curves of a thermionic diode for two different filament currents and explain their main features. (06 marks)

(b) Derive the expression for the amplification factor μ in terms of anode resistance, R_a and mutual conductance, g_m for a triode valve. (03 marks)

(c) A triode with mutual conductance $3mAV^{-1}$ and anode resistance of $10k\Omega$ is connected to a load resistance of $20k\Omega$. Calculate the amplitude of the output signal if the amplitude of the input signal is $30mV$. (04 marks)

(d) (i) What is a photon? (01 mark)

(ii) Explain using the quantum theory, the experimental observations on photo electric effect. (05 marks)

10. (a) A beam of α - particles is directed normally to a thin gold foil. Explain why

(i) most of the alpha particles past straight through the foil, (02 marks)

(ii) few alpha particles are deflected through angles more than 90^o. (02 marks)

(b) Calculate the least distance of approach of a $4.0MeV$ alpha particles to the nucleus of a gold atom. (Atomic number of gold $= 79$). (04 marks)

(c) Explain, using suitable sketch graphs, how X – ray spectra in an X – ray tube are produced. (06 marks)

(d) A beam of X – rays of wave length $9 \times 10^{-11}m$ is incident on a sodium chloride crystal of interplanar separation $9.0 \times 10^{-10}m$. Calculate the first order diffraction angle. (03 marks)

(e) (i) Distinguish between nuclear fussion and nuclear fission. (02 marks)

(ii) State the conditions necessary for each of the nuclear reactions in (e) (i) to occur. (01 mark)

END