P510/1
PHYSICS
Paper 1
July/August
2½ hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

PHYSICS

Paper 1

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

- *Answer **five** questions, including **at least one**, but not more than **two** from each of the Sections **A**, **B** and **C**.*
- *Any additional question(s) answered will **not** be marked.*
- *Non programmable silent scientific calculators may be used.*

Assume where necessary:

Acceleration due to gravity	g	=	$9.81\ ms^{-2}$
Electron charge	e	=	$1.6 \times 10^{-19}\ C$
Electron mass		=	$9.11 \times 10^{-31}\ kg$
Mass of earth		=	$5.97 \times 10^{24} kg$
Planck'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		=	$3.0 \times 10^{8} m$
Specific heat capacity of water		=	$4{,}200 Jkg^{-1}K^{-1}$
Specific latent heat of fusion of ice		=	$3.34 \times 10^{5}\ Jkg^{-1}$
Universal gravitational constant,	G	=	$6.67 \times 10^{-11} Nm^{2}kg^{-2}$
Avogadro's number	N_A	=	$6.02 \times 10^{23}\ mol^{-1}$
Density of mercury		=	$13.6 \times 10^{3} kgm^{-3}$
Charge to mass ratio,	e/m	=	$1.8 \times 10^{11}\ Ckg^{-1}$
The constant $^{1}/_{4\pi\varepsilon_0}$		=	$9.0 \times 10^{9}\ F^{-1}m$
Density of water		=	$1000 kgm^{-3}$
Gas constant	R	=	$8.31 Jmol^{-1}K^{-1}$
Wien's displacement constant		=	$2.90 \times 10^{-3}\ m\ K$
Surface tension of soap solution		=	$2.0 \times 10^{-2}\ Nm^{-1}$
Electron charge to mass ratio, e/m		=	$1.8 \times 10^{11}\ C\ kg^{-1}$
One electron volt, (eV)		=	$1.6 \times 10^{-19}\ J$

SECTION A

1. (a) (i) Define **linear momentum**. (01 mark)

(ii) State the **law of conservation of linear momentum**. (01 mark)

(iii) Show that the law of conservation in (a) (ii) above follows from Newton's laws of motion. (04 marks)

(b) A man whose weight is 490.5 N, jumps onto the ground from a 2.5 m high wall.

(i) Explain why he has to bend his knees when landing on the ground. (02 marks)

(ii) Calculate the force with which his legs hit the ground if his body comes to rest in 0.5 s on reaching the ground. (04 marks)

(c) (i) Distinguish between **perfectly elastic** and **perfectly inelastic** collisions, and give **one** example of each. (03 marks)

(ii) Two bodies each of mass m_1 and m_2 initially moving with velocities u_1 and u_2 respectively collide perfectly inelastically. Show that the loss in kinetic energy is given by the expression:

$$\frac{m_1 m_2 (u_1 - u_2)^2}{2(m_1 + m_2)}$$ (04 marks)

(iii) State any **two** applications of the law of conservation of linear momentum. (01 mark)

2. (a) Define the following terms as applied to circular motion:

(i) **centripetal acceleration**. (01 mark)

(ii) **angular velocity**. (01 mark)

(b) (i) What is the purpose of banking a track? (01 mark)

(ii) Derive an expression for the angle of banking for a case of a car of mass **M** moving with a speed v round a banked track of radius **r**. (04 marks)

(iii) A car moves round a circular track of radius 65 m which is banked at an angle $\tan^{-1} 5/12$ to the horizontal. Find the speed at which the car should be driven for no tendency to slip. (03 marks)

(c) (i) State **Kepler's laws** of gravitation. (03 marks)

(ii) Describe an experiment you would carry out in the laboratory to determine the universal gravitational constant. (05 marks)

(iii) A body of mass 10 kg is first weighed on a balance at the top of a tower 30m high and later transferred to the ground and is reweighed. Calculate the difference in the weights of the body. (02 marks)

3. (a) (i) Define **surface tension**. (01 mark)

(ii) Briefly describe an experiment you would use to show that surface tension of a liquid decreases with increase in temperature. (03 marks)

(iii) State how **one** other factor affects surface tension of a liquid. (02 marks)

(b) (i) Derive an expression for pressure difference across a soap bubble in air. (04 marks)

(ii) Two soap bubbles of radii 1.5 cm and 3.0 cm respectively coalesce to form a single bubble under isothermal conditions. Calculate the excess pressure inside the resulting soap bubble. (03 marks)

(c) (i) Define **coefficient of viscosity**. (01 mark)

(ii) Explain briefly how temperature affects viscosity of a liquid. (03 marks)

(d) A liquid of negligible viscosity flows steadily through a pipe whose cross sectional area at one point is 15 cm^2 at a velocity of 0.5 ms^{-1}. Find the pressure difference between this point and another point whose cross sectional area is 3.0 cm^{-2}. (03 marks)

4. (a) What is meant by the following terms as applied to mechanical properties of materials?

(i) **elasticity**. (01 mark)

(ii) **force constant**. (01 mark)

(b) A wire of length l and cross sectional area **A** has a force constant **k**. The wire is stretched to a length $l + x$ by a constant force **F**. Show that:

(i) the force constant $k = EA/l$, where E is Young's modulus of the material of the wire. (03 marks)

(ii) the energy stored per unit volume is $\frac{1}{2} E(x/l)^2$. (03 marks)

(c) One end of a copper wire of length 1.0m and diameter 0.5mm is welded to a steel wire of length 0.5m and diameter 0.8mm, while its other end is fixed onto a rigid support. If a load of 12kg is suspended from the free end of the steel wire, calculate the:

(i) extension which results. (04 marks)

(ii) energy stored in the compound wire. (03 marks)

(d) (i) State **Bernoulli's principle**. (01 mark)

(ii) Explain why the roof of a building is likely to be blown off when a strong wind blows over it. (04 marks)

Turn Over

SECTION B

5. (a) Define the following terms as applied to heat:

(i) **Heat capacity.** (01 mark)

(ii) **Cooling correction.** (01 mark)

(b) (i) Describe an experiment to determine the specific heat capacity of a liquid using the continuous – flow method. (05 marks)

(ii) In the above experiment, state why the temperature differences are kept constant. (01 mark)

(ii) State **three advantages** of the continuous flow method over the method of mixtures. (03 marks)

(c) In a continuous – flow experiment, a steady difference of temperature of 2.0 ^{0}C is a maintained when the rate of liquid flow is 20 gs^{-1} and the power of the electrical heater is 40 W. When the liquid flow rate is adjusted to 75 gs^{-1}, 80 W of electrical power is required to maintain the same temperature difference.

Calculate the total heat energy lost in 5 minutes. (05 marks)

(d) (i) What is meant by **latent heat of fusion of ice**? (01 mark)

(ii) Explain briefly why ice tends to stick onto a sweaty hand. (03 marks)

6. (a) (i) Distinguish between an **isothermal** and **adiabatic** changes. (01 mark)

(ii) State **two conditions** for an adiabatic process to take place. (02marks)

(iii) State **two examples** of an adiabatic process. (02 marks)

(b) An ideal gas is expanded adiabatically to a final pressure of 1.0×10^7 Pa, when originally it had a pressure of 2.0×10^6 Pa and volume of 3.0 litres at a temperature of 50^{0}C.

Calculate the:

(i) number of moles of the gas. (03 marks)

(ii) final temperature of the gas. (04 marks)

(Take ratio of the specific heat capacity at constant pressure to that at constant volume to be 1.4).

(c) (i) Define **molar heat capacity at constant pressure.** (01 mark)

(ii) Derive the expression for the difference between the molar heat capacity at constant pressure and that at constant volume for one mole of an ideal gas. (05 marks)

(d) Explain briefly why a gas heats up when it is compressed. (02 marks)

7. (a) (i) What is meant by a **black body**? (01 mark)

(ii) State the **laws of black body radiation**. (02 marks)

(b) Using the same axes, sketch graphs to show the distribution of energy in the spectrum of radiation from a black body at three different temperatures, and explain their features. (05 marks)

(c) The tungsten filament of a lamp has an operating temperature of 3500^0C. If the effective surface area of the filament is 0.42 cm^2 and assuming that the energy radiated is 29 % that from a black body in similar conditions, calculate the:

(i) power of the lamp. (03 marks)

(ii) calculate the frequency of radiation emitted with maximum intensity. (03 marks)

(d) (i) Explain, using **molecular theory of matter**, the mechanism of thermal conduction in insulators. (03 marks)

(ii) Briefly account for the fact that metals are better conductors of heat than insulators. (03 marks)

SECTION C

8. (a) Define the following terms:

(i) **Photoelectric emission**. (01 mark)

(ii) **stopping potential.** (01 mark)

(b) Describe an experiment to determine the stopping potential of a given metal surface. (05 marks)

(c) A certain metal is illuminated by radiation of wavelength 145 nm. If it has a work function of 2.0 eV, calculate the:

(i) maximum speed of the photoelectrons. (03 marks)

(ii) threshold frequency. (02 marks)

(d) (i) What are **x – rays**? (01 mark)

(ii) Sketch a graph of intensity against wavelength of x – rays from an x – ray tube and describe its main features. (04 marks)

(iii) Calculate the maximum frequency of x – rays emitted by an x – ray tube with an operating voltage of 40 kV. (03 marks)

9. (a) (i) Define **background radiation**. (01 mark)

(ii) State the **three main sources** of background radiation. (02 marks)

(iii) Give **two examples** of background radiation. (01 mark)

Turn Over

(b) (i) State the **law of radioactive decay**. (01 mark)

(ii) Show that the half – life $T_{½}$ of a radioactive material is related to the decay constant λ by the expression $\lambda T_{½} = ln\ 2$. (02 marks)

(iii) A radioisotope of strontium of half – life 28 years providing a source of beta particles has been in use for some time. If originally 5 μg of strontium were present, find the number of atoms remaining after 15 years of use. (04 marks)

(c) (i) Describe the structure and mode of operation of the **scintillation counter**. (05 marks)

(ii) State **two advantages** of the scintillation counter over the Geiger – Muller tube. (02 marks)

(d) State **one industrial** use and **one medical** use of radioactivity. (02 marks)

10. (a) (i) Define **mass defect**. (01 mark)

(ii) State the mathematical relation between **mass defect** and **binding energy**. (01 mark)

(b) (i) Distinguish between **nuclear fusion** and **nuclear fission**. (02 marks)

(ii) State and explain **two** conditions necessary for nuclear fusion to occur. (04 marks)

(iii) Sketch a graph of binding energy per nucleon against mass number, showing its key features. (02 marks)

(c) Calculate the binding energy per nucleon in joules of boron $^{10}_{5}B$ given that:

Mass of a proton = 1.0080 U

Mass of a neutron = 1.5087 U

Mass of $^{10}_{5}B$ = 10.0129 U

1 U = 1.66×10^{-27} kg (05 marks)

(d) (i) State **Bohr's postulates** of the atom. (02 marks)

(ii) Explain the occurrence of the emission line spectrum. (03 marks)

END