

P510/1
PHYSICS
PAPER ONE
2Hours 30 minutes

ST. LEO'S COLLEGE KYEGOBE
END OF YEAR EXAMINATIONS 2024
Uganda Advanced Certificate of Education

PHYSICS

Senior five

Paper 1

2 hours: 30 minutes

Instructions the candidates:

- ✓ Answer **five** questions, including at least **one**, but **not more than two** from each 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	9.81 ms^{-2}
Electron charge, e	$1.6 \times 10^{-19} \text{ C}$
Electron mass	$9.11 \times 10^{-31} \text{ kg}$
Mass of the earth	$5.97 \times 10^{24} \text{ kg}$
Plank's constant, h	$6.6 \times 10^{-34} \text{ Js}$
Stefan's-Boltzmann's constant, σ	$5.67 \times 10^{-8} \text{ Wm}^{-2} \text{ K}^{-1}$
Radius of the earth	$6.4 \times 10^6 \text{ m}$
Radius of the sun	$7 \times 10^8 \text{ m}$
Radius of the earth's orbit about the sun	$1.5 \times 10^{11} \text{ m}$
Speed of light in the vacuum, c	$3.0 \times 10^8 \text{ ms}^{-1}$
Thermal conductivity of copper	$390 \text{ Wm}^{-1} \text{ K}^{-1}$
Thermal conductivity of aluminum	$210 \text{ Wm}^{-1} \text{ K}^{-1}$
Specific heat capacity of water	$4.200 \text{ Jkg}^{-1} \text{ K}^{-1}$
Universal gravitational constant	$6.67 \times 10^{-11} \text{ Nm}^2 \text{ Kg}^{-2}$
Avogadro's number, NA	$6.02 \times 10^{23} \text{ mol}^{-1}$
Surface tension of water	$7.0 \times 10^{-2} \text{ Nm}^{-1}$
Density of water	1000 kgm^{-3}
Gas constant, R	$8.31 \text{ Jmol}^{-1} \text{ K}^{-1}$
Charge to mass ratio, e/m	$1.8 \times 10^{11} \text{ Ckg}^{-1}$
The constant, $1/4\pi\epsilon_0$	$9.0 \times 10^9 \text{ F}^{-1} \text{ m}$
Faraday's constant, F	$9.65 \times 10^4 \text{ Cmol}^{-1}$

Turn over

SECTION A

- 1 a) what is meant by dimensions of a physical quantity (1mks)
ii) The centripetal force required to keep a body of mass m moving in a circular path of radius r is given by $F = \frac{MV^2}{r}$, show that the formula is dimensionally consistent (4 mks)
b) Distinguish between elastic and inelastic collisions (2 mks)
ii) An object of mass m_1 moving to the right with velocity u_1 , makes a head on collision with another body of mass m_2 moving with velocity u_2 in the same direction. If v_1 and v_2 are the velocities of the two bodies respectively after collision, show that $u_1 + v_1 = v_2 + u_2$ (4mks)
c) A bullet of mass 20g is fired into a block of wood of mass 400g lying on a smooth horizontal surface. If the bullet and the wood move together with the speed of 20 m/s. calculate
i) The speed with which the bullet hits the wood (3mks)
ii) The kinetic energy lost (3 mks)
d) Define the following terms are to projectile motion
i) Time of flight (1mks)
ii) Range (1mks)
iii) Sketch a velocity time graph for a body projected vertically upwards (2mks)
2. State
a) i) the laws of motion (3mks)
ii) The law of conservation of linear momentum (1mks)
iii) Use the newton's laws to show that when two bodies collide, their momentum is conserved (4mks)
b) i) define the term impulse and derive its relation to linear momentum of the body on which it acts (3mks)
ii) Explain why long jumper bends knees (3mks)
c) A bullet of mass 40g is fired from a gun at 200 m/s and hits a block of wood of mass 2kg which is suspended by light vertical string 2m long. If the bullet gets embedded in the wooden block
i) Calculate the maximum angle the string makes with the vertical (5mks)
ii) State the factors on which the angle of swing depends (1mks)

- 3.a) i) state the laws of solid friction (3mks)
 ii) Using the molecular theory, explain the laws stated in a(i) above (3 mks)
 iii) Describe an experiment to determine the coefficient of static friction for interface between a rectangular block of wood and plane surface (4 mks)
 b) a car of mass 1000kg climbs a truck which is inclined at 30° to the horizontal. The speed of the car at the bottom of the incline is 36km/h. if the coefficient of kinetic friction is 0.3 and engine exerts a force of 4000N, how far up the incline does the car move in 5s? (5mks)
 c)i) define the term scalar quantity (1mks)
 ii) a man who can swim at 2m/s in still water wishes to swim across a river 120m wide as quickly as possible. If the river flows at 0.5m/s, find the time the man takes to cross and how far downstream he travels (4mks)

SECTION B

- 4 a)(i) Define S.H.C of a substance (01mark)
 (ii) State three advantages of the continuous flow method over the method of mixtures in the determination of S.H.C of a liquid (03marks)
 (b) In a continuous flow experiment, a steady difference of temperature of 1.50°C is maintained when the rate of liquid flow is 45gs^{-1} and the rate of electrical heating is 60.5W. On reducing the liquid flow rate to 15gs^{-1} , 36.5W is required to maintain. Calculate the;
 (i) S.H.C of the liquid (04marks)
 (ii) Rate of heat loss to the surrounding (3marks)
 (c) (i) Describe an electrical method for the determination of the S.H.C of a metal (06marks)
 (ii) State the assumptions made in the above experiment (02marks)
 (iii) Comment about the accuracy of the result of the experiment in C (i) above (01mark)

- 5 (a) (i) Define a thermometric property and give two examples (02marks)
 ii) State four qualities of a good thermometric property (02marks)
 (b) (i) With reference to the a liquid in glass thermometer, describe the steps involved in setting up a Kelvin scale of temperature (03marks)
 (ii) State two advantages and two disadvantages of constant-volume gas thermometer. (02marks)
 (c) (i) Define the triple point of water (01mark)
 (ii) Describe how you would measure the temperature of a body on thermodynamic scale using a thermo couple. (04marks)
 d) The resistance of the element of a platinum resistance thermometer is 4.0Ω at the point and 5.64Ω at the steam point. What temperature on the platinum resistance scale would correspond to a resistance of 9.48Ω (03marks)
 (e) Explain why evaporation causes cooling (3 marks)

Turn over

- 6 (a) (i) Define **thermal conductivity** (01marks)
 (ii) Compare the mechanism of heat transfer in **poor** and **good solid** conductors (05marks)
 (b) Describe, with the aid of a diagram how you would measure the thermal conductivity of a poor conductor, stating the necessary precautions. (08marks)
 (c) A cylindrical iron vessel with a base of diameter 15cm and thickness 0.30cm has its base coated with a thin film of soot of thickness 0.1cm. It is then filled with water at 100°C and placed on a large block of ice at 0°C . Calculate the initial rate at which the ice will melt. [The conductivity of soot = $0.12 \text{ Wm}^{-1}\text{K}^{-1}$ conductivity of iron = $75 \text{ Wm}^{-1}\text{K}^{-1}$] (06 marks)

SECTION C

- 7 a) What is meant by?
 i) Half-life of a radioactive element (1mark)
 ii) Decay constant (1mark)
 iii) Radioactivity (1mark)
 b) An atom ^{222}Ra emits an alpha-particle of energy 5.3MeV. Given that the half-life ^{222}Ra is 3.8 days, use the decay law to calculate the
 i) Decay constant (2 marks)
 ii) Amount of energy released by $3.0 \times 10^{-9} \text{ kg}$ after 3.8 days (4 marks)
 c) Describe with the aid of a labeled diagram the structure and action of ionization chamber (5 marks)
 d) Define the term binding energy (1 mark)
 (ii) Sketch a graph showing the variation of binding energy per nucleon with mass number (2 marks)
 iii) Use the sketch graph you have drawn in d(ii) to explain how energy is released during fission and fusion (3 marks)
- 8 (a) What is **photo electric emission** (01marks)
 (b) (i) Describe a simple experiment to demonstrate photo electric effect (05marks)
 (iii) When a clean surface of metal in a vacuum is irradiated with light of wavelength $5.5 \times 10^{-7} \text{ m}$, electrons just emerge from the surface. However when light of wavelength $5.0 \times 10^{-7} \text{ m}$ is incident on the metal surface, electrons are emitted each with energy $3.62 \times 10^{-20} \text{ J}$. Find the value of Planck's constant (4 marks)
- c) An electron of charge, e and mass, m , is emitted from a hot cathode and then accelerated by an electric field towards the anode. If the potential difference between the cathode and anode is V , show that the speed of the electron, U , is given by $U = \sqrt{\left(\frac{2eV}{m}\right)}$ (4 Marks)
- d) An electron starts from rest and moves in an electric field intensity of $2.4 \times 10^3 \text{ Vm}^{-1}$. Find the;
 (i) Force on the electron (02marks)
 (ii) Acceleration of the electron (02marks)
 (iii) Velocity acquired in moving through a of 90V (02 marks)

9. a) Distinguish between unified atomic mass unit and mass defect (2 mark)
 b)(i) Distinguish between nuclear fission and nuclear fusion (2 marks)
 ii) State the condition necessary for each of the nuclear reactions in b (i) to occur (2 marks)
 c) With the aid of a labeled diagram, describe the operation of a diffusion cloud chamber (6 marks)

d) A typical nuclear reaction is given by ${}^{235}_{92}\text{U} + {}^1_0\text{n} \rightarrow {}^{95}_{42}\text{Mo} + {}^{139}_{57}\text{La} + 2{}^1_0\text{n} + 7{}^0_{-1}\text{e}$
 Calculate the total energy released by 1g of uranium (6 marks)

$$\text{mass of } {}^1_0\text{n} = 1.009\text{U}$$

$${}^0_{-1}\text{e} = 0.00055\text{U}$$

$${}^{95}_{42}\text{Mo} = 94.906\text{U}$$

$${}^{139}_{57}\text{La} = 138.906\text{U}$$

$${}^{235}_{92}\text{U} = 235.044\text{U}$$

$$1\text{U} = 1.66 \times 10^{-27}\text{kg}$$

- e) State **four** differences between cathode rays and positive rays (2marks)

10. (a) What are isotopes [01marks]
 (b) With the aid of a diagram, describe the operation of Bain bridge spectrometer in determining the specific charge of ions. [06marks]
 c) In a Bain bridge mass spectrometer singly ionized atoms of ${}^{35}\text{Cl}$, ${}^{37}\text{Cl}$ pass into the deflection chamber with a velocity of 10^5 ms^{-1} . If the flux density of the magnetic field in the deflecting chamber is 0.08T, calculate the difference in the radii of the path of the ion. (4marks)
 d) (i) State the laws of photo electric emission (04marks)
 (ii) Write down Einstein's equation for photoelectric emission (01marks)
 (iii) Ultra-violet light of wavelength $3.3 \times 10^{-8}\text{m}$ is incident on a metal. Given that the work function of the metal is 3.5eV, calculate the maximum velocity of the liberated electron (4 marks)

END

MERYY CHRISTMAS AND HAPPY NEW YEAR 2025