P510/1
**PHYSICS**
PAPER 1
**July/august 2022**
2½ HOURS

*Physics for togetherness*

**JOINT INTERNAL MOCK EXAMINATIONS 2022**
**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**.
Non – programmable scientific calculators may be used.

**Assume where necessary:**

| | | |
|---|---|---|
| Acceleration due to gravity | $\boldsymbol{g}$ | $= 9.81ms^{-2}$ |
| Electron charge | $\boldsymbol{e}$ | $= 1.6 \times 10^{-19}C$ |
| Election mass | | $= 9.11 \times 10^{-31}kg$ |
| Mass of earth | | $= 5.97 \times 10^{24}kg$ |
| Planck's constant | $\boldsymbol{h}$ | $= 6.6 \times 10^{-34}Js$ |
| Stefan's – Boltzmann's constant, **σ** | | $= 5.67 \times 10^{-8}K^{-4}$ |
| Radius of 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 vacuum | $\boldsymbol{c}$ | $= 3.0 \times 10^{8}ms^{-1}$ |
| Thermal conductivity of Copper | | $= 390Wm^{-1}k^{-1}$ |
| Specific heat capacity water | | $= 4200Jkg^{-1}K^{-1}$ |
| Universal gravitational constant, $\boldsymbol{G}$ | | $= 6.67 \times 10^{-11}Nm^{2}kg^{-2}$ |
| Avogadro's number, | $\boldsymbol{NA}$ | $= 6.02 \times 10^{23}mol^{-1}$ |
| Density of water | | $= 1{,}000kgm^{-3}$ |
| Gas constant, | $\boldsymbol{R}$ | $= 8.31J\ mol^{-1}K^{-1}$ |
| Specific heat capacity of copper | | $= 400Jkg^{-1}K^{-1}$ |

## SECTION A

1. (a) Define the following terms:
   (i) uniform acceleration (01mark)
   (ii) angular velocity (01mark)

   (b) (i) What is meant by a banked track? (01mark)
   (ii) Derive an expression for the angle of banking, $\theta$ for a car of mass, $m$, moving at speed, $v$, round a banked track of radius, $r$. (03marks)

   (c) A bob of mass, $m$, is tied to an inelastic thread of length, $l$, and whirled with constant speed in a vertical circle
   (i) With the aid of a sketch diagram, explain the variation of tension in the string along the circle. (04marks)

   (ii) If the string breaks at one point along the circle, state the most likely position and explain the subsequent motion of the bob. (01mark)

   (d) Describe the action of a centrifuge. (03marks)

   (e) A car travels round a bend banked at an angle of $22.6^o$. If the radius of curvature of the bend is $62.5m$ and the co – efficient of friction between the tyres of the car and the road surface is $0.3$, calculate the maximum speed at which the car negotiates the bend without skidding. (06marks)

2. (a) (i) What is meant by simple harmonic motion? (01mark)
   (ii) State two practical examples of simple harmonic motion. (01mark)
   (iii) Using graphical illustrations, distinguish between under damped and critically damped oscillations. (04marks)

   (b) (i) Describe an experiment to measure acceleration due to gravity using a spiral string. (06marks)
   (ii) State two limitations to the accuracy of the value obtained in b(i).(02marks)

   (c) (i) State Archimedes' principle. (01mark)
   (ii) A cube of rubber of volume $1 \times 10^{-1}m^3$ floats with half of it volume submerged in a liquid of density $1200kgm^{-3}$. Find the depth of which the cube will be submerged in a liquid of density $1000kgm^{-3}$. (03marks)

(d) Explain why velocity of a liquid at wide part of tube is less than that at a narrow part. (02marks)

3. (a) (i) Distinguish between conservative and non – conservative forces. (02marks)

(ii) Show that the sum of kinetic energy and potential energy is constant for a body falling vertically downwards from a point above the grounds (04marks)

(b) A truck of mass $1500kg$ is moving at $20ms^{-1}$ down a plane inclined at $30^o$ to the horizontal. The truck collides with another truck of mass $200kg$ moving into the same direction with a velocity of $15ms^{-1}$. If the trucks stick together after collision, find:

(i) the velocity of the trucks immediately after collision. (03marks)

(ii) the velocity of the trucks 6s after collision given that the co – efficient of kinetic friction is 0.20. (03marks)

(c) State the conditions for equilibrium of a rigid body under the action of coplanar Forces. (02marks)

(d) A 3m long ladder rests at an angle of $60^o$ to the horizontal against a smooth vertical wall on a rough ground. The ladder weighs 5kg and its centre of gravity is one third from the bottom of the ladder.

(i) Draw a sketch diagram to show the forces acting on the ladder. (02marks)

(ii) Find the reaction of the ground on the ladder. (04marks)

4. (a) (i) Sketch using the same axes, the stress – strain curves for a glass wire, a metal wire and a rubber band. (03marks)

(ii) Discuss briefly the main features of the curves. (06marks)

(b) Describe the energy transformations that take place during elastic and plastic deformations. (04marks)

(c) (i) Explain the origin of surface tension. (03marks)

(ii) Describe an experiment to determine surface tension of a liquid by capillarity method. (05marks)

(iii) Explain why one needs to blow hard to start a balloon growing. (02marks)

## SECTION B

5. (a) (i) Define specific latent heat of vaporization. (01mark)

(ii) Describe an electric method for the determination of the specific latent heat of vaporization of water. (05marks)

(iii) State two advantages of using the method in (a) (ii) above. (02marks)

(b) Explain why the specific latent heat of fusion and specific latent heat of vaporization of a substance at the same pressure are different. (04marks)

(c) When water was passed through a continuous flow calorimeter the rise in temperature was from $16.0^oC$ to $20.0^oC$, the mass of water flowing was $100g$ in one minute, the potential difference across the heating coil was $20V$ and the current was 1.5A. Another liquid at $16.0^oC$ was then passed through the calorimeter and got the same change in temperature and potential difference was changed to $13V$, the current to 1.2A and the rate of flow to 120g in one minute. Calculate the specific heat capacity of the liquid. (05marks)

(d) Using the expression for the kinetic pressure of an ideal gas, deduce the ideal gas equation if $\frac{1}{2}mc^{-2} = \frac{3}{2}K_BT$. (03mks)

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

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

(b) A copper kettle containing 1.00kg of water has a base of thickness 2.0mm and area $3.0 \times 10^{-2}m^2$. Calculate:

(i) the steady difference in temperature between the inner and outer surfaces of the base which must be maintained so that the temperature of the water rises at a rate of $0.25Ks^{-1}$. (03marks)

(ii) the specific latent heat of vaporization of water. If it is allowed to boil under the same conditions for $120s$ and the mass of water remaining $0.94kg$. (03marks)

(iii) Describe an experiment to determine the thermal conductivity of rubber. (06marks)

(c) (i) Define a perfect black body. (01mark)

(ii) 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. (03marks)

7. (a) (i) What is meant by a thermometric property? (01mark)

(ii) State the qualities that make a particular property suitable for use in a practical thermometer. (02marks)

(b) Describe with the aid of a diagram how a platinum resistance thermometer can be used to determine the room temperature. (05marks)

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

(i) saturated vapor pressure of a liquid increases with temperature. (03marks)

(ii) saturated vapor pressure is not affected by a decrease in volume at constant temperature. (03marks)

(d) Explain why it is possible to make water boil below its normal boiling point. (02marks)

(e) Two cylinders $P$ and $Q$ each of volume $1.5l$ are joined in the middle by a closed tap $T$, and placed in a constant temperature both at $60^oC$. $P$ contains a vacuum while $Q$ contains air and saturated water vapour. The total pressure in $Q$ is $200mmHg$. When $T$ is opened, equilibrium is reached with the water vapor remaining saturated. If the final pressure in the cylinders is $150mmHg$. Calculate the saturation pressure of water at $60^oC$. (04marks)

## SECTION C

8. (a) (i) What is meant by the terms; radioactive decay, half-life and decay constant? (03marks)

(ii) Show that the half life $T_{\frac{1}{2}}$ of a radio isotope is given by: $T_{\frac{1}{2}} = \frac{0.693}{\lambda}$, where $\lambda$ is decay constant.
(Assume the decay law $N = N_o e^{-\lambda t}$) (03marks)

(b) (i) With the aid of a labelled diagram, describe the structure and action of Diffusion cloud chamber. (05marks)

(ii) Sketch the curve of ionization current against applied p.d and explain it's main features. (04marks)

(c) During the fusion of Uranium, $U - 235, 200MeV$ of energy is released. Calculate the energy in Joules released when $1.5kg$ of Uranium takes part in a bomb explosion. (03marks)

(d) Explain the application of carbon – 14 in carbon dating. (03marks)

9. (a) (i) What are cathode rays? (01mark)

(ii) With the aid of a diagram, describe an experiment to show that cathode rays travel in a straight line. (04marks)

(b) A beam of electrons is accelerated through a potential difference of $400V$. The beam enters mid-way between two similar parallel plates of length $10cm$ and are $3cm$ apart. If the potential difference across the plates is $600V$, find:

(i) the deflection of the electrons as they emerge out of the field. (03marks)

(ii) the velocity of an electron as it leaves the region between the plates. (04marks)

(c) (i) Explain the emission of x – ray characteristic spectra. (03marks)

(ii) Briefly explain the x – ray diffraction by a crystal. (03marks)

(iii) Under what conditions does x – ray diffraction occur? (02marks)

10. (a) State the laws of the photo electric effect. (02marks)

(b) Describe the Millikan's oil experiment (08marks)

(c) In a Millikan's oil drop experiment the plates were $1.2cm$ apart. With no electric field present, a drop of oil of mass $6.0 \times 10^{-16}kg$ fell with a steady velocity of $3.3 \times 10^{-5}ms^{-1}$, with a potential difference of $450V$ applied across the plates the drop rose with same velocity. Neglecting upthrust due to air, calculate the number of electron charges on the drop. (07marks)

(d) Sketch the current – potential difference characteristics of a thermionic diode for two difference operating temperatures and explain their main features. (05marks)

**END**