P510/1

PHYSICS

PAPER 1

MOCK 2024

AUGUST

2 Hours 30 Minutes

MEBU EXAMINATIONS CONSULT

UGANDA ADVANCED CERTIFICATE OF EDUCATION

MOCK EXAMINATIONS 2024

PHYSICS

PAPER 1

2 Hours 30 Minutes

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INSTRUCTIONS TO CANDIDATES

Attempt not more than **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.
Where necessary, assume the following constants:
Acceleration due to gravity, g = 9.81 m s^{-2}
Electronic charge, e = 1.6 x 10^{-19}C
Electronic mass = 9.11 x 10^{-31}kg
Avogadro's number, NA = 6.02 × 10^{23} mol^{-1}
Mass on earth = 5.97 x 10^{24}kg
Charge to mass ratio of an election = $\mathbf{1.8\ x\ 10^{11}CKg{-}1}$
One electron volt, eV = 1.6 × 10^{-19} J
Planck's constant, h = 6.6 × 10^{-34} J s
Radius of the earth = 6.4 x 10^{6}m
Specific heat capacity of water = 4.2 × 10^{3} J kg^{-1} K^{-1}
Specific latent heat of fusion of ice = 3.36 x $10^{3}JKg^{-1}K^{-1}$
Stefan's – Boltzmann's constant, δ = 5.67 × 10^{-8} W m^{-2} K^{-4}
Speed of light in Vacuum, c = 3.0 × 10^{8} m s^{-1}
Unified mass unit, U = 1.66 × 10^{-27} kg
Universal gravitational constant, G = 6.67 x $10^{-11}NM^{2}Kg^{-2}$
Gas constant, R = $8.31Jmol^{-1}K^{-1}$

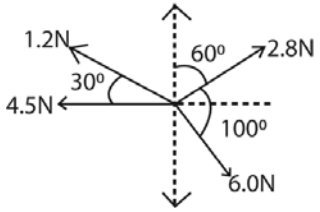
Permittivity of free space, $\in o = 8.85 \times 10^{-12} Fm^{-}$

SECTION A

1.(a)(i).Distinguish between **scalar** and **vector quantity**. (01 mark)

(ii).Give **two** examples of each type of quantity. (02marks)

(b).A body of mass **0.2 kg** at rest is acted on by four forces of **2.8 N**, **6.0 N**, **4.5 N** and **1.2 N** as shown in the figure below.



Calculate the;

(i).Resultant force on the body. (04marks)

(ii).Distance moved in 4 seconds. (02marks)

(c).State **Newton's laws of motion** and use them to derive the law of conservation of momentum. (06marks)

(d).A body of mass **800 kg** moving at **30 ms^{-1}** collides with another of mass **400 kg** moving in the same direction at **25 ms^{-1}**. The two bodies stick together after collision. Calculate the;

(i).Common velocity just after collision. (02marks)

(ii).Kinetic energy lost during collision. (03marks)

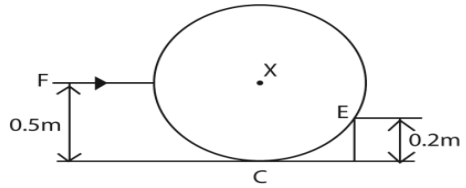
2.(a).Define **moment of force** and give its S.I units. (02marks)

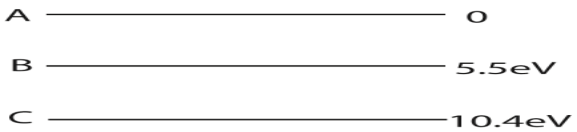
(b).Explain briefly how to locate the Centre of gravity of an irregular sheet of cardboard.

(04marks)

(c).State the conditions necessary for equilibrium of a rigid body under action of a system of forces. (02marks)

(d) A wheel of radius **0.5 m** rests on a level surface at point **C** and makes contact with edge **E** of a block height **0.2 m** as shown in the figure below.





Calculate the wavelength of the radiation emitted when electron makes a transition from level **A** to level **C**. (03marks)

10.(a) What is meant by the following as applied to radioactivity?

(i).**Activity.** (01marks)

(ii).**Half-life** of a radioactive material. (01marks)

(b).Using the radioactive decay law $\mathbf{N = N_0 e^{-\lambda t}}$, show that the half-life $T_{\frac{1}{2}} = \frac{0.693}{\lambda}$. (02marks)

(c).With the aid of a labelled diagram, describe the action of an **ionization chamber**. (05marks)

(d).What is meant by **unified atomic unit** and **electron volt**? (02marks)

(e).(i)The nucleus Bi-212 decays by alpha emission as follows:

$$^{212}_{83}Bi \rightarrow {}^{208}_{81}Tl + {}^{4}_{2}He$$

Calculate the energy released by **2 g** of $^{212}_{83}Bi$. (05marks)

(ii).Explain **two** uses of radioactive isotopes. (04marks)

END

A force **F** is applied horizontally through the axle of the wheel at **X** to just move the wheel over the block. If the weight of the wheel is **180 N**, find the;

(i).Force exerted at point **E** (02marks)

(ii).Force **F**. (04marks)

(e)State the **laws of friction** and explain each of them. (06marks)

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

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

(ii).**Period**. (01mark)

(b)(i).Explain why a cyclist bends inwards while going around a curved path. (03marks)

(ii).Show that if **θ** is the angle of inclination of the cyclist to the vertical and **μ** is the coefficient of limiting friction between the ground and the bicycle tyres, then for safe riding $\tan \theta \leq \mu$. (04marks)

(iii).A body of mass **1.5 kg** moves once round a circular path to cover **44.0 cm** in **5 s**. Calculate the centripetal force acting on the body. (04marks)

(c).Define **simple harmonic motion**. (01mark)

(d).A body executes simple harmonic motion with amplitude **A** and angular velocity, **ω**.

(i).Write down the equation for velocity of the body at a displacement **x** from the mean position. (01mark)

(ii) Sketch the velocity-displacement graph for the body in (d) (i) for $\omega < 1$. (02marks)

(iii) If the body moves with amplitude **14.142 cm**, at what distance from the mean position will its kinetic energy equal to potential energy? (03marks)

4.(a).State and illustrate **Archimedes' principle**. (05marks)

(b)(i).State the **law of floatation**. (01 marks)

(ii).Describe an experiment to verify the law in (b) (i) above. (05marks)

(c) (i).Write **Bernoulli's equation** and define each term in the equation. (02marks)

(ii).Explain the origin of lift force on the wings of a plane. (03marks)

(iii).Air flows over the upper surfaces of the wings of an aeroplane at a speed of **120 ms^{-1}**, and past the lower surface of the wings at **110 ms^{-1}**.Calclate the lift force on the aeroplane if it has a total wing area of **20 m^2**. (**Density of air = 1.29 kgm^{-3}**) (04 marks)

SECTION B

5.(a)(i).State any **three** properties of ultraviolet radiations. (03marks)

(ii).What is **a black body**? (01mark)

(b).A cylindrical metal rod with a well- insulated curved surface has one end blackened and then exposed to thermal radiation from a body at a temperature of **500 K**. If the equilibrium temperature of the blackened end is **400 K** and the length of the rod is **10 cm**, calculate the temperature of the other end. [Thermal conductivity of the metal = **500 $Wm^{-1}K^{-1}$**] (04marks)

(c)(i).Describe the Electrical method of determining the specific heat capacity of a good conducting solid. (06marks)

(ii).Give **two** reasons why the value obtained using the method in (c) (i) above may not be accurate. (02marks)

(d).Explain why cloudy nights are warmer than cloudless ones. (04 marks)

6.(a)(i).What is meant by a **reversible process**? (02marks)

(ii).Distinguish between a **saturated vapour** and **unsaturated vapour**. (02marks)

(iii).Explain why evaporation causes cooling. (03marks)

(b).Describe an experiment to determine the temperature dependence of saturated vapour pressure of water. (07marks)

(c)(i).State **Dalton's law of partial pressures**. (07marks)

(ii).A sealed container has liquid water, water vapour and air all at **27**°C. The total pressure inside the container is **69 cmHg**. When the temperature is raised to **85**°C, the total pressure changes to **96 cmHg**. If the saturated vapour pressure of water at **27**°C is **5 cmHg** and water vapour remains saturated, calculate the saturated vapour pressure of water at **85**°C. (05marks)

7.(a).Define the following:

(i).**Thermal conductivity**. (01marks)

(ii).**Specific latent heat of vaporization**. (01mark)

(b).A boiler with a base made of rod steel **15 cm** thick, rests on a hot stove. The area of the bottom of the boiler is **1.5 x 10^3 cm^2**. The water inside the boiler is at **100**°C. If **750 g** of water is evaporated every **5 minutes**, find the temperature of the surface of the boiler in contact with the stove.

[Thermal conductivity of steel = **50.2 $Wm^{-1}K^{-1}$**, specific latent heat of vaporization of water = **2.26 x 10^6 Jkg^{-1}**] (04 marks)

(c) Hot water in a metal tank is kept constant at **65**°C by an immersion heater in the water. The tank has a lagging all around it of thickness **20 mm** and thermal conductivity **0.04 $Wm^{-1}K^{-1}$** and its surface area is **0.5 m^2**. The heat lost per second by the lagging is **0.8 W per degree** excess above the surroundings. Calculate the power of the immersion heater if the temperature of the surroundings is **15**°C. (05marks)

(d)(i).Define a **thermometric property.** (01mark)

(ii).Define how a liquid-in-glass thermometer can be used to measure temperature in degrees Celsius. (04marks)

(iii) A thermometer is constructed with a liquid which expands according to relation. $V_t = V_0(1 + \alpha t + \beta t^2)$, where $\mathbf{V_t}$ is the volume at **t**°C and $\mathbf{V_0}$ is the volume at **0**°C on the scale of the gas thermometer and $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ are constants. Given that $\boldsymbol{\alpha = 1000\beta}$, what will the liquid thermometer read when the gas thermometer reads **50**°C? (04 marks)

SECTION C

8.(a)(i).What are **cathode rays**? (01marks)

(ii).State **two** properties of cathode rays. (01mark)

(iii).Explain **two** disadvantages of using the discharge tube in producing cathode rays. (02marks)

(b).With the aid of a diagram, describe Millikan's experiment to determine the charge on an oil drop (07marks)

(c).A beam of electrons is accelerated through a potential difference of **1.98 kV** and directed mid-way between two horizontal plates of length **4.8 cm** and separated by a distance of **2.0 cm**. The potential difference applied across the plates is **80.0 V**.

(i).Calculate the speed of the electrons as they enter the region between the plates. (03marks)

(ii).Explain the motion of the electrons between the plates. (02marks)

(iii).Find the speed of electrons as they emerge from the region between the plates. (04marks)

9.(a)(i).What is meant by **thermionic emission**? (01marks)

(ii).Describe how **full-wave rectification** of a.c can be achieved using four semiconductor diodes. (04marks)

(b)(i).Draw a labelled diagram to show the main parts of a Cathode Ray Oscilloscope. (C.R.O). (03marks)

(ii).Describe how a C.R.O can be used as an a.c voltmeter. (02marks)

(c)(i)An electron of charge, $-e$ and mass $\boldsymbol{m}$ moves in circular orbit round a central hydrogen nucleus of charge $+\boldsymbol{e}$. Derive an expression for total energy of electron in an orbit of radius $\boldsymbol{r}$. (05 marks)

(ii).Why is this energy always negative? (01marks)

(d)(i).What is meant by **excitation potential** of an atom? (01marks)

(ii).Some of the energy levels in mercury spectrum are shown in the figure below.