P510/1

PHYSICS

PAPER 1

July / August 2023

2 ½ Hours

KABALE DISTRICT JOINT MOCK EXAMINATIONS 2023

UGANDA ADVANCED CERTIFICATE OF EDUCATION

PHYSICS

P510/1

PAPER 1

TIME: 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.

Assume where necessary;

❖ Acceleration due to gravity, g	$= 9.81 ms^{-2}$
❖ Electron charge, e	$= 1.6 \times 10^{-19} C$
❖ Electron mass	$= 9.11 \times 10^{-31} kg$
❖ Linear expansivity of steel	$= 1.6 \times 10^{-7} K^{-1}$
❖ Thermal conductivity of iron	$= 661 Nm^{-1} K^{-1}$
❖ Specific latent heat of vaporization of water	$= 2.26 \times 10^{6} Jkg^{-1}$
❖ Density of copper	$= 8900 kgm^{-3}$
❖ Specific heat capacity of copper	$= 390 Jkg^{-1} k^{-1}$
❖ Mass of a carbon atom	$= 2.0 \times 10^{-26} kg$
❖ Planks constant	$= 6.6 \times 10^{-34} Js$
❖ Speed of light in vacuum	$= 3.0 \times 10^{8}$
❖ Stefan – Boltzmann's constant, δ	$= 5.67 \times 10^{-8} Wm^{-2} K^{-4}$
❖ Wien's displacement constant	$= 2.90 \times 10^{-3} mk$
❖ Gas constant, R	$= 8.31 Jmol^{-1} k^{-1}$
❖ One electron volt	$= 1.6 \times 10^{-19} J$

Turn Over

SECTION A

1) a) What is meant by dimensions of a physical quantity **(01 Mark)**

b) The maximum power, P, developed by a wind turbine depends on the speed (v) of air, density (ρ) of air and radius (r) of its blades.

i. Using dimensions, derive an expression for P in terms of v, ρ, and r. (take $k = \frac{\pi}{2}$) **(05 Marks)**

ii. Given that during operation, the blades of a certain wind turbine sweep an area of $1400m^2$, determine the maximum power the turbine can develop when air of density $1.29kgm^{-3}$ moving at a speed of $15ms^{-1}$ operates this turbine. **(03 Marks)**

iii. State one reason why the power developed by the turbine is less than the value in (ii) above. **(01 Mark)**

c) (i) Define the terms time of flight and range as applied to projectile motion. **(02 Marks)**

(ii) Show that when a projectile is fined at a speed u at an angle of θ to the horizontal, its range is given by $R = \frac{u^2 \, Sin2\theta}{g}$ **(04 Marks)**

(iii) A missile is launched with a velocity of $1800ms^{-1}$ at an angle of 60^0 to the horizontal. Determine the speed of the projectile at a height of 32km when ascending. **(04 Marks)**

2) a) (i) Define simple harmonic motion **(01 Mark)**

(ii) Show that the principle of conservation of mechanical energy applies to an oscillating bob of a simple pendulum **(05 Marks)**

b) Figure 1 shows a block of mass 100g resting on a smooth horizontal surface attached to two springs A and B of force constants $60Nm^{-1}$ and $100Nm^{-1}$ respectively.

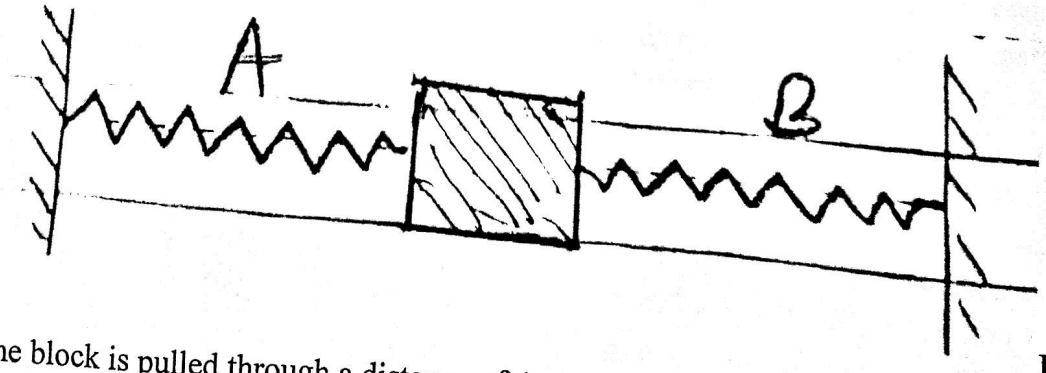

Fig 1

The block is pulled through a distance of 4cm to the right and released.

i. Show that the mass oscillates with simple harmonic motion and find the frequency of the resulting oscillations **(06 Marks)**

ii. Find the speed of the block when it is 3cm from the end point of the oscillation. **(03 Marks)**

iii. c) i) State Newton's law of universal gravitation. **(01 Mark)**

ii) Use the law in c (i) to derive the dimensions of the universal gravitational constant. **(03 Marks)**

iii) State Kepler's first law of planetary motion **(01 Mark)**

3) a) Define coefficient of viscosity and state its dimensions **(02 Marks)**

b) (i) Describe briefly an experiment to measure viscosity of motor oil of known density. **(06 Marks)**

(ii) Explain using kinetic theory, the effect of increasing temperature on viscosity of a liquid. **(03 Marks)**

c) (i) Define the term surface tension in terms of surface energy. **(01 Mark)**

(ii) Explain the origin of surface tension **(04 Marks)**

(iii) Mercury is poured into a glass – U – tube with vertical limbs of diameters 2mm and 12mm respectively. If the angle of contact between mercury and glass is 140^0 and the surface tension of mercury is $0.52Nm^{-1}$, calculate the difference in the levels of mercury in the two limbs. **(03 Marks)**

d) What is meant by the term up thrust? **(01 Mark)**

4) a) Define the following terms as applied to elasticity;

i) Elastic limit **(01 Mark)**

ii) Young's modulus **(01 Mark)**

b) i) Describe an experiment to determine young's modulus for a steel wire. **(06 Marks)**

ii) Sketch a graph of extension against weight and briefly explain the features of the graph. **(03 Marks)**

c) A steel rod of length 0.65m and cross-sectional area $2.5 \times 10^{-5}m^2$ at 100^0c is clamped so that when it cools it is unable to contract. Find the tension in the rod when it is cooled to 20^0c. **(04 Marks)**

d) i) What is meant by the term perfectly plastic material? **(01 Mark)**

ii) Distinguish between fatigue fracture and creep. **(02 Marks)**

iii) Explain briefly the term work hardening **(02 Marks)**

SECTION B

5) a) (i) Define the term thermometric property. **(01 Mark)**

(ii) State any four characteristics of a good thermometric property. **(02 Marks)**

(iii) The resistance R, of platinum wire at a temperature θ as measured by mercury – in – glass thermometer is given by;

$R\theta = R0\ (1 + b\theta + a\theta^2)$ where $b = 3.8 \times 10^{-3}K^{-1}$ and $a = -5.6 \times 10^{-7}K^{-2}$.

Calculate the temperature of platinum thermometer corresponding to 200^0c on glass scale. **(04 Marks)**

(iv) State one reason why the two thermometers do not give the same temperature. **(01 Mark)**

b) (i) State any two ways in which heat losses are minimized in calorimetry experiments. **(02 Marks)**

(ii) Describe an experiment to determine the specific latent heat of vaporization of water by method of mixtures. **(06 Marks)**

c) Explain why the specific heat of vaporization is greater than that of fusion. **(04 Marks)**

6) a) (i) What is meant by the terms coefficient of thermal conduction and temperature gradient? **(02 Marks)**

(ii) Describe an experiment to determine the coefficient of thermal conduction of a plastic material. **(06 Marks)**

(iii) A cooking saucepan made of iron has a base area $0.05m^2$ and thickness of 2.5mm. It has a thin layer of 500t of average thickness 0.5mm on its bottom surface. Water in the saucepan is heated until it boils at 100^0c, $10gs^{-1}$ of water boils away and the side of the 800t nearest to the heat source is at 150^0c. Find the thermal conductivity of 800t. **(04 Marks)**

b) (i) State Stefan's law black body radiation. **(01 Mark)**

(ii) What is meant by the term relative intensity of radiations? **(01 Mark)**

(iii) Sketch a graph to show how relative intensity of radiation varies with wave length for three different temperatures **(02 Marks)**

c) A copper sphere with a black body surface and radius 30mm is cooled to -73^0c and placed inside an enclosure at a temperature of 27^0c. Calculate the initial rate of temperature rise of the sphere.

7) a) (i) State Charles' law **(04 Marks)**

(ii) Show that the ideal gas equation is consistent with Charles' law. **(01 Mark)** **(05 Marks)**

b) (i) State the assumptions made in the derivation of the ideal gas equation that do not apply to real gases **(02 Marks)**

(ii) For the Vander Waal's gas equation:

$\left(P + \frac{a}{V^2}\right)(v - b) =$ Constant, account for the terms "$\frac{a}{V^2}$" and "b". **(04 Marks)**

c) (i) What is meant by the term saturated vapour pressure? **(01 Mark)**

(ii) Explain the effect of volume change on saturated vapour pressure. **(04 Marks)**

(iii) Represent the effect for b) (ii) on a sketch graph for saturated vapour. **(03 Mark)**

SECTION C

8) a) (i) Distinguish between cathode rays and positive rays **(02 Marks)**

(ii) An electron gun operating at 3.0×10^3 V is used to project electrons into a space between two oppositely charged parallel plates of length 10cm and 5cm apart. Calculate the vertical deflection of an electron as it emerges from the region between the charged plates when the potential difference is 1.0×10^3V. **(05 Marks)**

(iii) Explain the motion of electrons between the plates in a (ii) above **(02 Marks)**

b) (i) State any two uses of a cathode ray oscilloscope (C.R.O) **(02 Marks)**

(ii) A C.R.O has its Y-sensitivity set at $6Vcm^{-1}$. Sinusoidal input voltage is suitably applied to give a steady P.d. The time base switched on so that the electron beam takes 0.01s to traverse the screen. If the trace seen has a peak –to-peak height of 4cm and contains two complete cycles, determine the root mean square value of the input voltage and the frequency of the signal. **(05 Marks)**

c) A beam of singly ionized carbon atoms pass un deflected through a region of crossed magnetic and electric fields of 0.10T and $10KVm^{-1}$ respectively. When it enters a region of uniform magnetic field, it is deflected through an arc of radius 80cm. Calculate the magnetic flunk density of this magnetic field. **(04 Marks)**

9) a) What is meant by the following term?

i) Radioactive decay **(01 Mark)**

ii) Decay constant **(01 Mark)**

b) Show that the half-life of a radioisotope is given by the expression; $T\frac{1}{2} = \frac{0.693}{\lambda}$

where λ is the decay constant **(03 Marks)**

c) A radioisotope $^{99}_{46}Y$ decays by emission of a gamma ray. The half-life of the isotope is 6 hours. Calculate the activity of 5mg of the isotope **(05 Marks)**

d) With the aid of a labelled diagram, describe the structure and mode of operation of a Wilson cloud chamber **(05 Marks)**

e) The diagram in figure 2 shows some energy levels of the hydrogen atom.

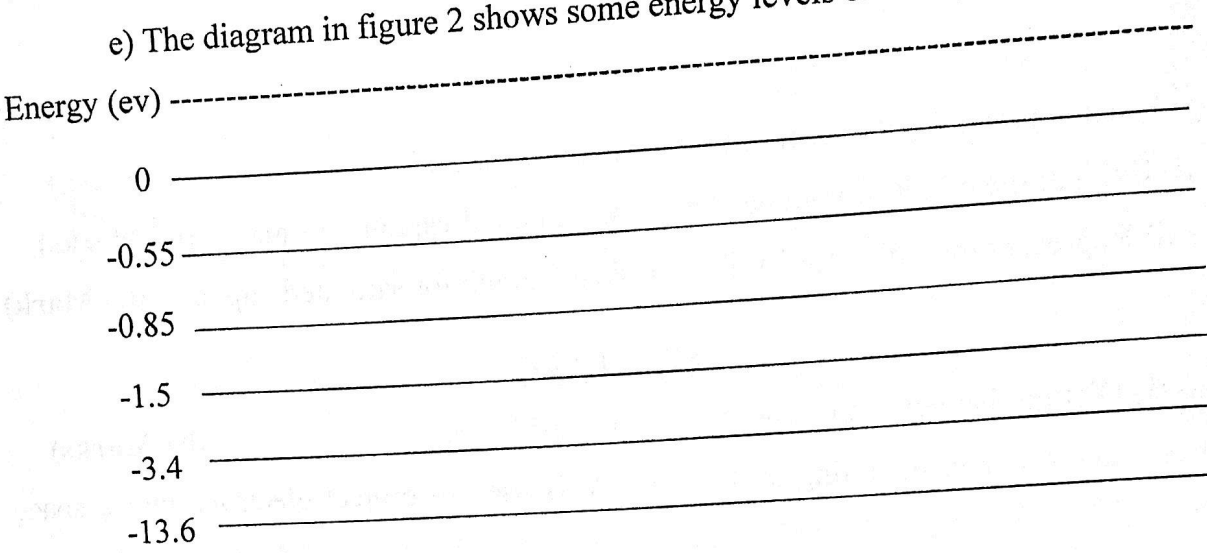

Fig 2

(i) Redraw the diagram above and indicate the emission of the visible spectrum, infrared rays and ultraviolet light **(03 Marks)**

(ii) Calculate the speed of an electron which would just ionize the hydrogen atom. **(02 Marks)**

10) a) (i) State any two processes of ejecting electrons from a metal surface. **(02 Marks)**

(ii) Describe a simple experiment to demonstrate photo electric emission. **(04 Marks)**

b) When light of wave length 450nm falls on a certain metal surface, it ejects photo electrons with maximum velocity of $6.0 \times 10^5 ms^{-1}$. Calculate the;

i) Work function of the metal surface

ii) Threshold frequency of the metal surface **(05 Marks)**

c) (i) State Bragg's law of x-ray diffraction **(01 Mark)**

(ii) A beam of x-rays of frequency 3.56×10^{18} Hz is incident on a potassium chloride (KCl) crystal and the first order Bragg's reflection occurs at $7^0 41^1$. The density of KCl is $1.98 \times 10^3 kgm^{-3}$ and its molecular mass is 74.5. Calculate the value of Avogadro's number. **(05 Marks)**

d) State three health hazards of X-rays **(03 Marks)**

END