P510/1
PHYSICS
PAPER 1
August 2023
2¼ hrs

UNNASE MOCK EXAMINATIONS

UGANDA ADVANCED CERTIFICATE OF EDUCATION

PHYSICS

PAPER 1

2 Hours 30 Minutes

INSTRUCTIONS TO CANDIDATES

- Attempt **five** questions including at least **one** but not more than **two** from each of the sections **A**, **B** and **C** and where necessary take;

Where necessary, assume the following constants:

- Acceleration due to gravity, g = $9.81\ m\ s^{-2}$
- Avogadro's number, N_A = $6.02 \times 10^{23}\ mol^{-1}$
- Density of water, = $1000\ kg\ m^{-3}$
- Electroniccharge, e = $1.6 \times 10^{-19}\ C$
- Electronic mass = $9.11 \times 10^{-31}\ kg$
- Gas constant, R = $8.31\ J\ mol^{-1}\ K^{-1}$
- One electron volt, eV = $1.6 \times 10^{-19}\ J$
- Plank's constant, h = $6.63 \times 10^{-34}\ J\ s$
- Specific heat capacity of water = $4.2 \times 10^{3}\ J\ kg^{-1}\ K^{-1}$
- Speed of light in Vacuum, c = $3.0 \times 10^{8}\ m\ s^{-1}$
- Stefan's – Boltzmann's constant, δ = $5.67 \times 10^{-8}\ W\ m^{-2}\ K^{-4}$
- Surface tension of water = $7.0 \times 10^{-2}\ N\ m^{-1}$
- Unified mass unit, U = $1.66 \times 10^{-27}\ kg$
- Universal gravitational constant, G = $6.67 \times 10^{-11}\ N\ m^{2}\ kg^{-2}$

SECTION A:

1. (a) (i)State **Newton's law** of gravitation. (01 mark)

(ii)Explain why the force of attraction between twobodies in ordinary life is not noticeable. (03 marks)

(b) (i) A communication satellite is in a circular orbit at heighth, above the earth's surface. Show that the period of itsmotion is $T = \frac{2}{R_e}(h + R_e)^{\frac{3}{2}}$, where R_e is the radius of the earth. (05 marks)

(ii) A satellite of mass 500kg is in a circular orbit at a height $3.6x10^7$m above the earth's surface. Find the kinetic energy of the satellite. (05 marks)

(c) Describe how gravitational constant can be determined experimentally. (06marks)

2. (a) (i) Define **upthrust.** (01 mark)

(ii) Use Archimedes' principle to derive an expression for the resultant force on a body of weight W and density σ totally immersed in a fluid of density,ρ. (04 marks)

(b) A piece of metal of mass $2.6 x10^{-2}$kg is attached to a block of wax of mass $1.0x10^{-4}$kg and density $200kgm^{-3}$, when the two are immersed in water they float with wax just submerged. Find the density of the metal. (04 marks)

(c) (i) Define **fluid element.** (01 mark)

(ii) Describe a simple experiment to demonstrate turbulent and laminar flow. (05 marks)

(d) Explain the following

(i) effect of temperature on viscosity in liquids. (02 marks)

(ii) why a person has to blow hard to start a balloon growing.

(03 marks)

3. (a) Define the terms;

(i) **Linear momentum**.

(01 mark)

(ii) **Impulse**.

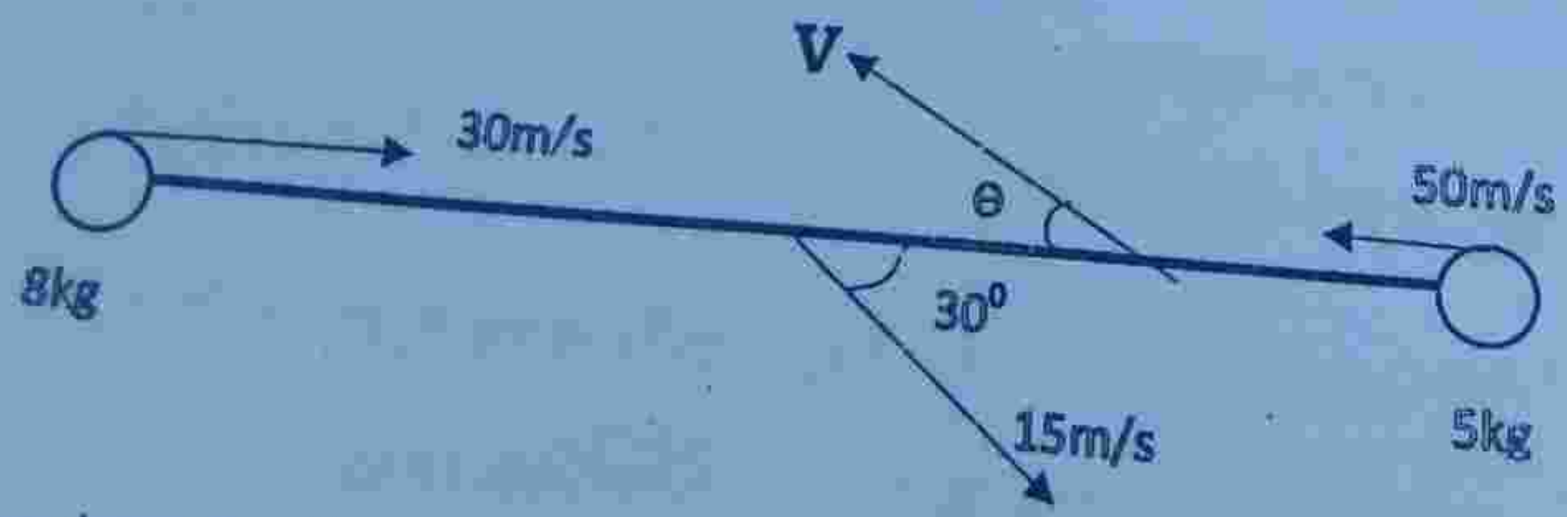
(01 mark)

(b) Two balls A and B of mass M_1, and M_2 initially approaching each other with velocities U_1 and U_2 respectively had a head on collision. If A continued in its original direction with a velocity of V_1 while B reversed its direction with a velocity V_2. Show that $U_1 + U_2 = V_2 - V_1$ if the collision was perfectly elastic. (06 marks)

(c) When a basketball player leaps high for the ball, he suddenly sets an upward momentum. How do you reconcile this observation with the law of conservation of linear momentum?

(05 marks)

(d)



The two balls shown above collide and bounce off each other as shown.

Find the final velocity of the 5kg ball after collision and deduce whether collision is perfectly elastic or perfectly inelastic.

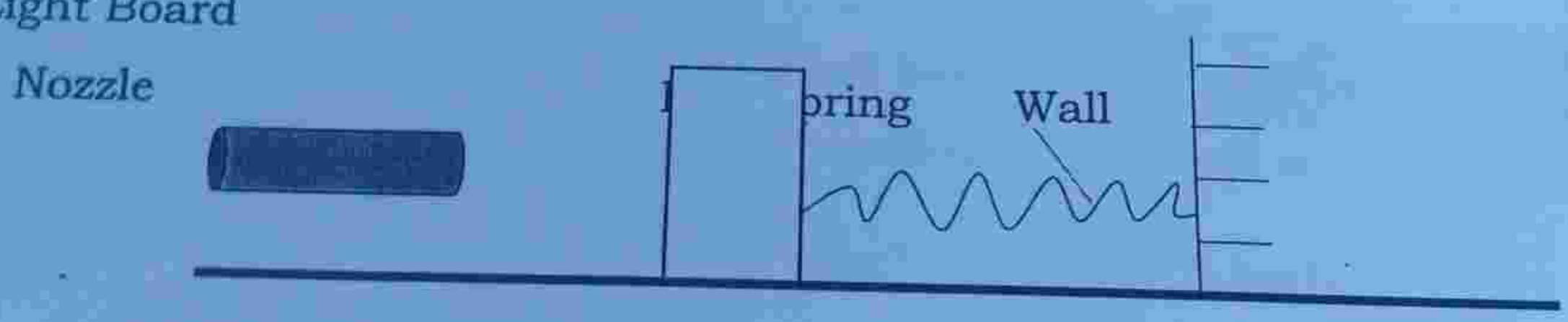
(07 marks)

4. (a) (i) Define a **megawatt**. (01 mark)

(ii) A wind turbine made of a blade of radius **R** is driven by wind of a speed **U**, if the density of air, ρ. Derive an expression for the maximum power **P** which can be developed by the turbine in terms of ρ, **R** and **U**.

(03 marks)

(b) A light horizontal spring of force constant $512Nm^{-1}$ has one of its ends fixed on a light vertical wall and its free end has a light vertical board fitted on it as shown.



When water flows through the horizontal nozzle of cross-sectional area $4cm^2$and strikes throughthe light board the spring is compressed by 5cm. If the nozzle is coaxial with the spring, find the velocity with which the water jets off the nozzle.

(04 marks)

(c) (i) State characteristics of a SHM. (02 marks)

(ii) Sketch a graph showing the variation of kinetic energy and potential energy against displacement of a body executing SHM.

(03 marks)

(d) Describe with the aid of a diagram an experiment to determine acceleration due to gravity using a spring of unkown force constant.

(07 marks)

SECTION B:

5. (a) Define the following

(i) **melting point.** (01 mark)

(ii) **specific latent heat.** (01 mark)

(b) Use kinetic theory of matter to explain physical processes involved during melting.

(04 marks)

(c) A mass of a hot liquid of specific heat capacity $1200JKg^{-1}k^{-1}$ is confined in a thin walled vessel of negligible heat capacity and allowed to cool freely. It is then found that the liquid cools at a rate of $2.9^{o}C$ per minute just before solidification and complete solidification takes 40 minutes subsequently cooling proceeds at a rate of $3.1^{o}C$ per minute immediately after complete solidification.

(i) Sketch a temperature time graph and explain its main features.

(03 marks)

(ii) Find the specific latent heat of fusion of the liquid and the specific heat capacity of the solid formed.

(04 marks)

(d) Describe with the aid of a labelled diagram an experiment to determine specific latent heat of evaporation of a liquid using electrical method. (07 marks)

6. (a) (i) Define **Isothermal** and **adiabatic** change of a gas.(02 marks)

(ii) Give**two** examples of Isothermal change of a gas. (02 marks)

(iii) Explain briefly how you would achieve isothermal and adiabatic change of a gas. (04 marks)

(b) (i) State **Dalton's law** of partial pressures. (01 mark)

(ii) Derive the expression $P = \frac{1}{3}\rho\bar{c^2}$ for an ideal gas. (06 marks)

(c) One kilo mole of an ideal gas initially at 25°C. It undergoes a reversibleadiabatic expansion to twice its volume, followed by a reversible isothermal compression to its original volume.

(i) Sketch a P-V diagram to show the process. (01 mark)

(ii) Calculate the final temperature of the gasgiven that $C_v = \frac{5}{2}R$ (04 marks)

7. (a) (i) What is **temperature gradient**. (01 mark)

(b) (i) Explain why insulators are poor conductors of heat compared to metals. (03 marks)

(ii) In an experiment to determine thermal conductivity of a good conductor,explain the design of the specimen. (03 marks)

(c) (i) State **Prevost's theorem** for heat exchange. (01 mark)

the aid of a labeled diagram, describe how the ether thermoscope works. (06 marks)

(d) The ratio of the distance of the earth from the Sun to that of Venus from the Sun is 1:0.72. Assuming they all radiate heat as a black body, calculate the approximate mean temperature of Venus if that of the earth is 15^0c by radiation. (06 marks)

SECTION C:

8. (a) (i) Define **threshold wavelength**. (01 mark)

(ii) Explain briefly how the kinetic energy of the electrons emitted from a metal surface depends on the frequency of the incident radiation. (03 marks)

(b) (i) Sketch a graph of kinetic energy against frequency of incident radiation on a metal. (02 marks)

(ii) Use the above sketch graph to describe how **Planck's constant** can be got. (02 marks)

(c) (i) Define **time base**. (01 mark)

(ii) Describe with the aid of a labeled diagram how a CRO can be used to trace a wave form. (06 marks)

(d) 5.0 V R.m.s, 50Hz voltage is obtained from a transformer connected to the main supply and is fed to the y – plate of a CRO. If the y-sensitivity is set at 10 Vcm^{-1} and the time base is 10 $mscm^{-1}$. What will be the total peak–to–peak height of the

trace and the number of cycles of the voltage if the trace is 40cm wide? (05 marks)

9. (a) Define the following terms as used in radioactivity decay.

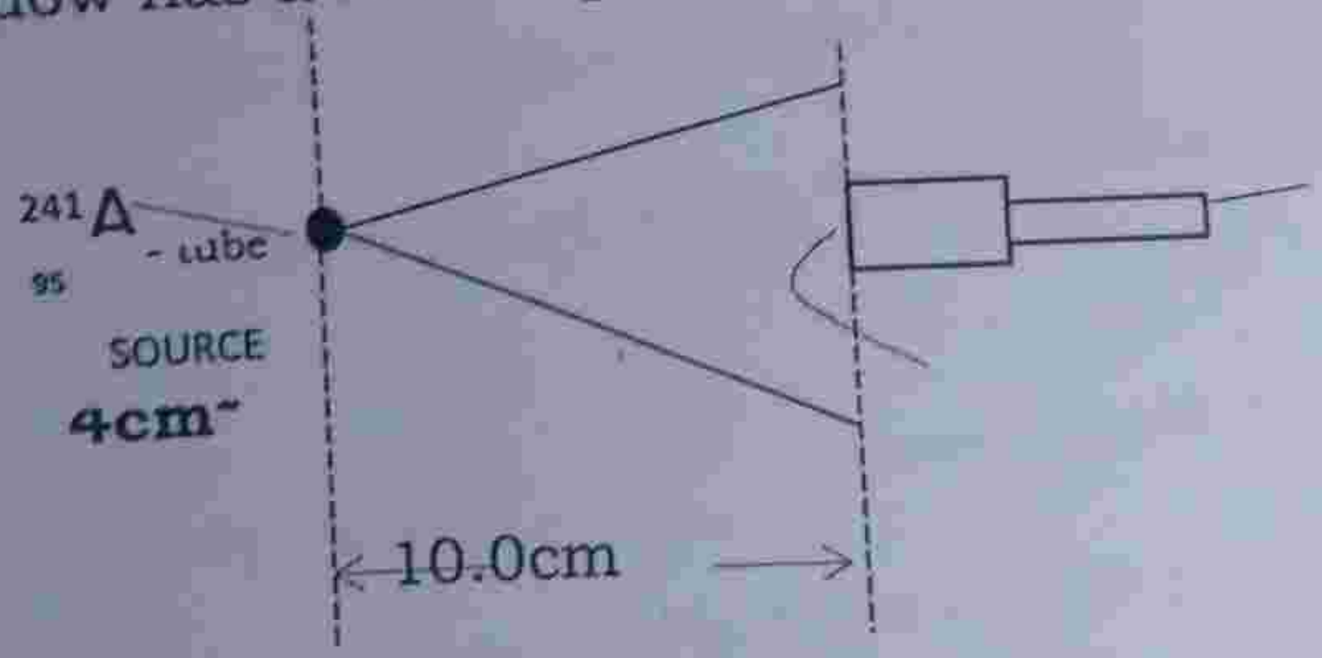
(i) **Dead time**. (02 mark)

(ii) **Recovery time**. (01 mark)

(b) (i) With the aid of a labeled diagram, describe how the expansion Wilson chamber is used to detect radiation. (06 marks)

(ii) Explain the effect of reducing pressure in expansion Wilson's chamber on the length of the tracks formed. (03 marks)

(c) A point source of alpha particles and a tiny mass of nuclide $^{241}_{95}Am$ is mounted 10.0cm in front of a G-M–tube whose mica window has a receiving area of $40cm^2$.



A pilemeter connected to the G-M tube records 4.8×10^4 counts per minute. If the number of $^{241}_{95}$Am atoms in the sample are 5.2×10^{15} atoms, calculate the;

(i) number of disintegration per second within the source.

(04mark

(ii) half – life of $^{241}_{95}A$.

(04 marks)

10. (a) (i) Define a **transistor**. (01 mark)

(ii) Explain briefly how P-type and N-type semi-conductors are obtained. (03 marks)

(b) (i) State **Bragg's law**. (01 mark)

(ii) State the conditions for x-ray diffraction to occur.

(02 marks)

(iii) Derive the **Bragg's law** of x-ray diffraction. (04 marks)

(c) In the production of x-rays in an x-ray tube,

(i) describe the energy changes that occur when the tube is in operation. (02 marks)

(ii) Explain how the intensity of the x-rays can be increased.

(02 marks)

(d) With the aid of a labeled diagram, describe how the specific charge of an electron is measured using a fine beam method.

(05 marks)

END