# MOCK EXAMINATIONS 2016

UGANDA ADVANCED CERTIFICATE OF EDUCATION
PHYSICS P510/1
TIME: 2 ½ Hours

**INSTRUCTIONS:**

*Attempt 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, g* | = | $9.81\ ms^{-2}$ |
| *Electron charge, e* | = | $1.6 \times 10^{-19}\ C$ |
| *Electron mass* | = | $9.11 \times 10^{-31}\ kg$ |
| *Density of water* | = | $1.0 \times 10^{3}\ kgm^{-3}$ |
| *Density of mercury* | = | $1.36 \times 10^{4}\ kgm^{-3}$ |
| *Planck's constant, h* | = | $6.6 \times 10^{-34}\ Js$ |
| *Stefan's-Boltzmann's constant, σ* | = | $5.67 \times 10^{-8}\ Wm^{-2}K^{-4}$ |
| *Gas constant, R* | = | $8.31\ Jmol^{-1}K^{-1}$ |
| *Wien's constant* | = | $2.9 \times 10^{-3}\ mK$ |

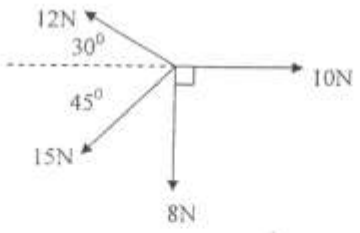
## Section A

1. (a) State **Newton's laws** of motion. (3mks)

(b) (i) Distinguish between **elastic** and **inelastic** collisions. (2mks)

(ii) A bullet of mass 50 g traveling horizontally at 100 $ms^{-1}$ embeds itself into a block of wood of mass 1kg suspended by a light vertical string 1m long. Calculate the maximum inclination of the string to the vertical after impact. (6mks)

(c) An object O of mass 5kg is acted upon by forces of 10N, 8N, 15N and 12 N as shown below:




Find the displacement of the object after 4 s. (5mks)

(d) (i) Distinguish between conservative and non-conservative forces. (2mks)

(ii) Give one example of each. (2mks)

2. (a) (i) Define the term **surface tension**. (1mk)
(ii) Derive the **dimensions** of surface tension. (2mks)

(iii) Describe the capillary tube method of measuring surface tension of a liquid. (6mks)

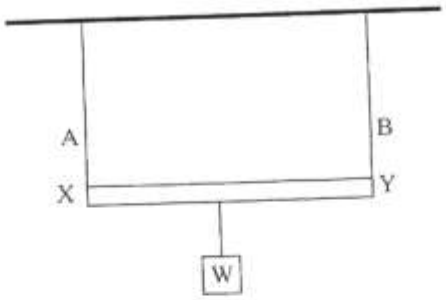
(b) Explain why a person has to blow hard to start a balloon growing. (3mks)

(c) (i) State Archimedes' principle. (1mk)
(ii) Derive an expression for the apparent weight of a body of density $d$ completely immersed in a liquid of density $p$, assuming weight of the body in air is W. (3mks)

(d) A string supports a small iron ball of mass 180 g totally immersed in a liquid of density 800 $kgm^{-3}$. Calculate the tension in the string if the density of iron is 8000 $kgm^{-3}$. (4mks)

3. (a) Define the following terms: tensile stress, tensile strain, Young's modulus. (3mks)
(b) In an experiment to determine Young's modulus of a metal, explain why:
(i) two wires of the same material are used. (2mks)
(ii) the wire are made thin and long. (2mks)

(c) A rod XY, 1.05 m long is supported at its ends by wires A and B, both of equal length as shown below.




The cross-section areas of A and B are $1mm^2$ and $2mm^2$ respectively. If Young's modulus for A is $2.4 \times 10^{11}$ $Nm^{-2}$ and for B is $1.6 \times 10^{11}$ $Nm^{-2}$, at what point along the rod should a weight W be suspended from the wire in order to produce:
(i) equal stress in A and B, (5mks)
(ii) equal strain in A and B? (4mks)

(d) (i) Sketch on the same axes the stress-strain graphs for glass and rubber. (2mks)
(ii) Explain the features of the graphs in (d) (i) above. (2mks)

4. (a) (i) Derive an expression for the speed of a body moving uniformly in a circular path. (3mks)

(ii) Explain why a force is necessary to maintain a body moving with constant speed in a circular path. (4mks)

(b) (i) Explain why it is necessary for a bicycle rider moving round a circular path leans towards the centre of the path. (4mks)

(ii) Derive an expression for the angle of inclination to the horizontal necessary for a rider moving round a circular track of radius **r** without skidding at a speed **u**, in terms of **g**, **r** and **u**. (4mks)

(c) A car travels round a bend banked at an angle of $25^0$. If the radius of curvature of the bend is 65m and the coefficient of friction between the tyres of the car and the road surface is 0.35, calculate the maximum speed at which the car negotiates the bend without skidding. (5mks)

## Section B

5. (a) (i) State the assumptions made in the derivation of the kinetic theory expression for the pressure of an ideal gas. (2mks)

(ii) Which of the assumptions made above have to be modified for real gases? (2mks)

(iii) The equation of state of one mole of a real gas is given by the expression:

$$(P + a/v^2)(v - b) = RT.$$

Account for the terms $a/v^2$ and $b$. (3mks)

(b) Calculate the root-mean-square speed of the molecules of an ideal gas at $147^0C$ given that the density of the gas at a pressure of $1.01 \times 10^5$ $Nm^{-2}$ at a temperature of $0^0C$ is 1.5 $kgm^{-3}$. (5mks)

(c) The density of an ideal gas is 1.60 $kgm^{-3}$ at $27^0C$ and $1.01 \times 10^5$ $Nm^{-2}$ pressure and its specific heat capacity at constant volume, $c_v$ is 312 $Jkg^{-1}K^{-1}$. Find the ratio of the specific heat capacity at constant pressure $c_p$ to that at constant volume. (4mks)

(d) Explain, with the aid of a volume against temperature sketch graph, what happens to a gas cooled at constant pressure from room temperature to zero kelvin. (4mks)

6. (a) (i) Define thermal conductivity. (1mk)

(ii) Explain the mechanism of heat transfer by conduction in solids. (3mks)

(b) A flat horizontal rectangular roof 12m by 10 m rests on vertical walls 4m high. The walls and roof are 25cm thick and are made of a material of thermal conductivity 0.25 $Wm^{-1}K^{-1}$. The doors and windows cover an area of $16m^2$ and are made of glass of thickness 5mm and thermal conductivity 1.2 $Wm^{-1}K^{-1}$. If the room is maintained at a constant temperature above that of its surroundings, calculate the percentage heat loss by conduction through the windows and doors. (6mks)

(c) (i) Sketch graphs showing the distribution of energy in the spectrum of a black body radiation at three different temperatures. (3mks)

(ii) Use the graphs above to explain the colour changes which occur when a piece of iron is heated from cold to its melting point. (3mks)

(d) A metal sphere with a black surface and radius 30 mm is cooled to $-73^0$C and placed inside an enclosure at a temperature of $27^0$C. Calculate the initial rate of rise of temperature of the sphere, assuming the sphere is a black body. Take density of the metal to be 800 $kgm^{-3}$, specific heat capacity of the metal to be 400$Jkg^{-1}K^{-1}$. (4mks)

7. (a) (i) State the desirable properties a material must have to be used as a thermometric property. (2mks)

(ii) Explain why a constant-volume gas thermometer is used to calibrate other thermometers. (2mks)

(b) Describe, with the aid of a labeled diagram, how an optical pyrometer can be used to measure high temperatures. (6mks)

(c) What is meant by the following terms:

(i) heat capacity, (1mk)

(ii) latent heat? (1mk)

(d) 50g of ice at $0^0$C is added to 200 g of water initially at $70^0$C in a vacuum flask. When all the ice has melted, the temperature of the flask and its contents drops to $40^0$C. On adding a further 80 g of ice, the temperature of the whole becomes $10^0$C when all the ice has melted.

(i) Calculate the specific latent heat of fusion of ice. (7mks)

(ii) State the assumption made in the calculation above. (1mk)

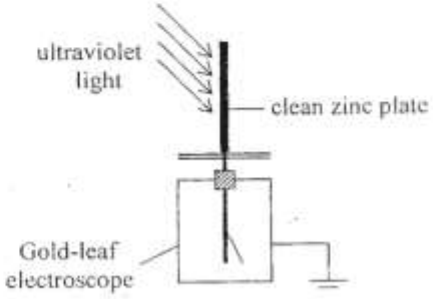
## Section C

8. (a) What is meant by the terms:

(i) **work function.** (1mk)

(ii) an **electron volt**? (1mk)

(b) A freshly cleaned zinc plate placed on the cap of a gold-leaf electroscope is irradiated with ultraviolet light as shown below.



Explain what is observed when the gold-leaf electroscope is:
(i) negatively charged. (3mks)
(ii) positively charged. (3mks)

(c) A metal of work function 3.0 eV is irradiated with light of unknown frequency. The maximum velocity of the photoelectrons is $1.14 \times 10^6$ $ms^{-1}$. Calculate the maximum wavelength of the incident radiation. (3mks)

(d) Explain the physical processes that account for the occurrence of the following features of the x-ray radiation:
(i) continuous spectrum. (2mks)
(ii) characteristic lines. (2mks)

(e) Explain briefly one:
(i) use of x-rays in medicine. (2mks)
(ii) application of optical absorption line spectra. (3mks)

9. (a) (i) With the aid of a labeled diagram, describe the structure and mode of operation of a diffusion-type cloud chamber. (6mks)

(ii) Explain the effect of reducing pressure in the cloud chamber on the length of tracks by alpha particles. (3mks)

(iii) A uniform magnetic field of flux density $2.0 \times 10^2$T is applied on a cloud chamber. Alpha particles emitted from a radioactive source in the chamber describe a circular path of radius 50.0cm. Calculate the energy with which the alpha particles are emitted in **Mev**. (4mks)

(b) State the reason for each of the following features of a particular form of the Geiger-Muller tube:
(i) a thin wire anode. (1mk)
(ii) a thin mica window. (1mk)

(c) (i) Draw a labeled sketch graph showing how the number of pulses per second varies when the applied voltage is increased from zero. (2mks)

(ii) Explain the main features of the sketch above. (3mks)

10. (a) Define the terms:
(i) half-life. (1mk)
(ii) decay constant. (1mk)
(iii) an isotope. (1mk)

(b) (i) Derive the relationship between half-life and decay constant. (3mks)

(ii) The half-life of polonium-30 is 2.5 minutes. Calculate the mass of polonium-30 which has an activity of $1.0 \times 10^{15}$ disintegrations per second. (4mks)

(c) (i) Explain briefly is meant by **mass defect** in nuclear physics? (2mks)

(ii) Calculate the binding energy per nucleon of helium $^{4}_{2}$**He** nucleus.

Take mass of a proton = 1.0073 U
Mass of a neutron = 1.0087 U
Mass of helium nucleus = 4.0015 U
(1 U = 931 Mev) (4mks)

(d) State **one similarity** and **one difference** between:
(i) cathode rays and β – particles. (2mks)
(ii) nuclear fusion and fission. (2mks)

***The End***