P510/1

PHYSICS 1

$2^1/_2$hours

UGANDA ADVANCED CERTIFICATE OF EDUCATION
RESOURCEFUL EXAMS 2022
PHYSICS 1
2 hours 30 minutes

Instructions to candidates:

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

Acceleration due to gravity, (g)	$= 9.81ms^{-2}$
Electronic charge, (e)	$= 1.6x10^{-19}C$
Electron mass	$= 9.11x10^{-31}kg$
Mass of the earth,	$= 5.97x10^{24}kg$
Plank's constant, (h)	$= 6.6x10^{-34}Js$
Stefan's constant, (σ)	$= 5.67x10^{-8}Wm^{-2}K^{-4}$
Radius of earth	$= 6.4x10^{6}m$
Radius of the sun	$= 7.0x10^{8}m$
Radius of earth 's orbit about the sun	$= 1.5x10^{11}m$
Speed of light in a vacuum (C)	$= 3.0x10^{8}ms^{-1}$
Specific latent of fusion of ice (L_f)	$= 3.36x10^{5}Jkg^{-1}$
Specific heat capacity of water (c)	$= 4200Jkg^{-1}K^{-1}$
Universal Gravitation constant, (G)	$= 6.67x10^{-11}Nm^{2}kg^{-2}$
Avogadro's number, (N_A)	$= 6.02x10^{23}mol^{-1}$
Density of water, (ρ)	$= 1000kgm^{-3}$
Gas constant , R	$= 8.31\ Jmol^{-1}K^{-1}$
Surface tension of water (γ)	$= 7.0x10^{-2}Nm^{-1}$
Charge to mass ration, (e/m)	$= 1.8x10^{11}Ckg^{-1}$

Section A

1. (a) (i) What is a trajectory? (01mark)

(ii) Show that the trajectory of a projectile is a parabola. (03marks)

(b) (i) What is **time of flight** and **range** as applied to a projectile? (02marks)

(ii) A ball is projected with a velocity of $28ms^{-1}$, the range of the ball on the horizontal plane is 64m. Find the two possible angles of projection. (05marks)

(c) (i) State the laws of friction. (03marks)

(ii) Explain the origin of friction using molecular theory (03marks)

(d) Describe an experiment to measure the coefficient of static friction between two solid surfaces. (03marks)

2. (a) (i) Define angular velocity (01mark)

(ii) Derive an expression for the acceleration of a body moving in a circle of radius, r meters at a uniform speed, v ms^{-1}. (04marks)

(b) (i) Define uniform acceleration and state its units. (02marks)

(ii) Explain why a body moving in a circular path with uniform speed has an acceleration. (03marks)

(c) (i) State Newton's law of gravitation. (01mark)

(ii) Describe an experiment to determine the gravitational constant G. (06marks)

(d) (i) What is meant by a parking orbit of an earth satellite?. (01marks)

(ii) Calculate the period of a satellite which is 100km above the surface of the earth. (05marks)

3. (a) What is meant by Young's modulus of a material (1 mark)

(b) With the aid of a labeled diagram, describe an experiment to determine young's modulus of a metal wire (06marks)

(c) Explain why the following precautions are taken during an experiment to determine young's modulus of a metal wire.

(i) Two long, thin wires of the same material are suspended from a common support (2 marks)

(ii) The readings of the Vernier are also taken when the loads are gradually removed in steps. (01mark)

(c) (i) Derive an expression for the potential energy stored in a stretched wire.

(04marks)

(ii) A steel wire of diameter 1mm and length 1.0m is stretched by a force of 50N, calculate the potential energy stored in the wire. ((young's modulus for steel = 2x10^{11}Nm^{-2}) (03marks)

(iii) The wire is further stretched to breaking, Explain where the stored energy goes. (03marks)

4. (a) Define the term simple harmonic motion. (01mark)

(b) Sketch the following graphs for a body performing S.H.M

(i) Velocity against displacement. (02marks)

(ii) Acceleration against displacement (02marks)

(c) A column of liquid of density ρ and total length h in a U-tube of uniform cross sectional area A is depressed by blowing gently down that side. Show that the levels of liquid will oscillate about the equilibrium positions with S.H.M. (05marks)

(d) Define surface tension. (01mark)

(e) Derive the expression for the excess pressure inside a soap bubble of radius r (04marks)

(f) A U-tube with limbs of diameters 5.0mm and 2.0mm contains water of surface tension $7.0x10^{-2}Nm^{-1}$ and zero angle of contact. Find the difference in the levels. (05marks)

Section B

5. (a) (i) With reference to a constant-volume gas thermometer define temperature on the Celsius scale (02marks)

(ii) With the aid of a labelled diagram, describe how you can determine the temperature of hot milk using a constant volume gas thermometer. (06marks)

(b) A constant volume thermometer was used to measure temperature when the atmospheric pressure was 760mmHg. The following values were obtained

	Reading in the closed limb (mmHg)	**Reading in the open limb (mmHg)**
Bulb in ice	126	**112**
Bulb in steam	126	**390**
Bulb at room temperature	126	**157**

(i) Determine the pressure of the gas thermometer at the fixed point. (03marks)

(ii) Calculate the room temperature (03marks)

(c) (i) Define specific heat capacity of a substance and state its S.I unit. (02marks)

(ii) Explain why at the same temperature a solid cools faster than a liquid. (02marks)

(iii) Explain the advantage of a high specific heat capacity of water. (02marks)

6. (a) (i) The pressure, P, of an ideal gas is given by $\boldsymbol{P = \frac{1}{3}\rho\overline{C^2}}$, where ρ is the density of the ideal gas and $\overline{C^2}$ it's mean square speed. State the assumptions made in deriving this expression. (02marks)

(ii) Calculate the root mean square speed of the molecules of an ideal gas at 27°C given that the density of the gas at a pressure of 2.45 x 10^5Nm^{-2} and a temperature of -23°C is 1.2kgm^{-3}. (05marks)

(ii) Explain why oxygen and nitrogen are the gasses are the most abundant in the atmosphere close to the earth surface (02marks)

(b) (i) Which of the above assumptions in a(i) above have to be modified for real gases?. State the modification (03marks)

(ii) Sketch the pressure- volume curve of a real gas at temperatures above and below the critical temperature (02marks)

(c) (i) Explain why the molar heat capacity at constant pressure, C_P an ideal gas differ from the molar heat capacity at constant volume, C_v (02marks)

(ii) Derive the relationship $C_P - C_v = R$, where R is universal gas constant (4 marks)

7. (a) What is thermal radiation (01mark)

(b) Describe an experiment to detect infra red radiations using an ether thermoscope (04marks)

(c) Draw spectral curves for a black body radiation showing variation of relative intensity against wavelength at three different temperatures (03marks)

(d) **(i)** Define the coefficient of thermal conductivity and determine its dimensions (02marks)

(ii) The bottom of a cylindrical metallic saucepan of radius 5cm and thickness 1.5cm rests on a hot stove. The water inside the saucepan is at 100°C. If 500g of water is evaporate every hour, find the temperature of the surface of the saucepan in

contact with the stove (thermal conductivity of the metal $= 386Wm^{-1}K^{-1}$, specific latent heat of vapouriastion of water$= 2.25x10^{6}JKg^{-1}$) (04marks)

(e) (i) Distinguish between **saturated** vapour and **unsaturated** vapour (02marks)

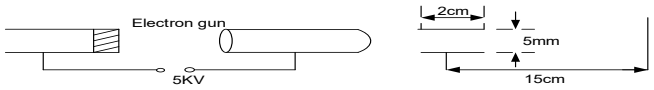
(ii) Explain the effect of attitude on the boiling point of water (02marks)

Section C

8. (a) (i) State the difference between cathode rays and positive rays (02marks)

(ii) With the aid of a diagram describe the structure and mode of operation of a cathode ray oscilloscope. (05marks)

(b) Calculate the deflection sensitivity (deflection of spot in mm per volt potential difference) of the cathode ray tube from the following data.



Electrons are accelerated by a potential difference of 5kV between the cathode and anode. [length of deflection plates =2cm, separation of deflector plates =5mm, distance of mid point of deflector plates from screen =15cm] (05marks)

(c) (i) What are x-rays (01mark)

(ii) Explain the emission of x-ray white spectrum in an x-ray tube (03marks)

(d) An x-ray tube operates at 15kV and current through it is 1mA. Calculate the;

(i) number of electrons striking the anode per second (02marks)

(ii) speed of the electrons on striking the anode. (02marks)

9. (a) What is meant by the terms as applied to a nucleus of an atom

(i) Mass defect (01mark)

(ii) Binding energy (01mark)

(b) (i) Sketch a graph showing how binding energy per nucleon varies with mass number (02mark)

(ii) Explain the main features of the graph (02marks)

(c) Given the mass of the nucleus of the isotope $^{235}_{92}\boldsymbol{U} = 390.295x10^{-27}kg$,

$mass\ of\ neutron = 1.675x10^{-27}kg$, $mass\ of\ proton = 1.672x10^{-27}kg$

$1u = 1.66x10^{-27}kg$

Find the binding energy per nucleon. **An(1700MeV)** (03marks)

(d) The isotope $^{238}_{92}U$ emits an alpha particle to form an isotope of thorium (Th) while the isotope $^{235}_{92}U$ when bombarded by a neutron, forms $^{139}_{57}La$, $^{95}_{42}Mo$, two neutrons and seven electrons

i) Write the nuclear equations for the reactions of $^{238}_{92}U$ and $^{235}_{92}U$ (2 marks)

ii) How does the reaction of $^{235}_{92}U$ differ from that of $^{238}_{92}U$ (3 marks)

(b) (i) What are radioisotopes (1 mark)

(ii) With the aid of a labelled diagram describe how a cloud chamber can be used to detect ionizing radiations. (05 marks)

10. (a) (i) What is meant by **half- life** . (01mark)

(ii) Show that the half life $t_{1/2}$ of a radio isotope is given by $t_{1/2} = \frac{\log_e 2}{\lambda}$

Where λ is the decay constant [assume the activity law $N = N_o e^{-\lambda t}$]

[03 marks]

(b) A point source of alpha particles containing 5.0 g of $^{222}_{86}Rn$ is mounted 20cm in front of a G.M.T. and a count rate of 90counts per second is recorded. If the entrance window of the G.M tube has an area of $10\pi cm^2$ Calculate,

(i) The number of $^{222}_{86}Rn$ atoms disintegrations per second [03 marks]

(ii) The half-life of $^{222}_{86}Rn$ [03 marks]

(c) Describe how the age of old wood can be determined by carbon dating (04marks)

(d) (i) State Rutherford's model of the atom (01mark)

(ii) Show that when an alpha particle collides head on with an atom of atomic number 79. The closest distance of approach to the nucleus, b_0 is given by $b_0 = \frac{39.5e^2}{\pi\varepsilon_0 E}$

Where e is the electronic charge ε_0 is the permittivity of free space, E is the kinetic energy of the alpha particle (04marks)

(iii) What is the significance of the value of b_0 **in d(ii) above** (01mark)

END