P510/1

PHYSICS 1

$2\frac{1}{2}$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) State Newton's laws of motion. (03marks)

(ii) Use Newton's laws of motion to show that linear momentum is conserved when two particles moving in a straight line collide. (04marks)

(b) Ball P, Q and R of masses m_1, m_2 and m_3 lie on a smooth horizontal surface in a straight line. The balls are initially at rest. Ball P is projected with a velocity u_1 towards Q and makes an elastic collision with Q. if Q makes a perfectly in elastic collision with R, show that R moves with a velocity.

$$v_2 = \frac{2\,m_1 m_2 u_1}{(m_1+m_2)(m_2+m_3)}$$ (06marks)

(c) (i) Define the term impulse of a force. (01marks)

(ii) Explain why a longer jumper must land on sand. (03marks)

(d) Explain what is meant by the term weightlessness. (03marks)

2. (a) (i) What is meant by a couple in mechanics. (01mark)

(ii) State the condition for equilibrium of coplanar forces. (02marks)

(b) One end of a uniform plank of length 4m and weight 100N is hinged to a vertical wall. An inelastic rope, tied to the other end of the plank, is fixed at a point 4m above the hinge so that the plank is horizontal. A weight of 300N is suspended from the plank at a distance of 3m form the hinge. Find the:

(i) tension in the rope (03marks)

(ii) reaction of the wall on the plank (03marks)

(c) Describe an experiment to study the elastic properties of a steel wire. (06marks)

(d) A cylindrical steel rod of length 1.20m and cross-sectional area 1.8cm^2 is fixed between two rigid supports at a temperature of 10℃. The temperature of the rod is raised to 60℃. Given that the coefficient of linear expansivity of steel is= $1.2x10^{-5}K^{-1}$ and young's modulus for steel as $2.0x10^{11}Nm^{-2}$

(i) Derive the expression of the force exerted on the rigid supports. (03marks)

(ii) Calculate the value of the force exerted. (02marks)

3. (a) (i) Define simple harmonic motion. (01mark)

(ii) State two properties of simple harmonic motion. (01mark)

(iii) Give two practical example of simple harmonic motion (01marks)

(b) A body of mass 200g s executing S.H.M with amplitude of 20mm. The maximum force which acts upon it is 0.064N. calculate

(i) its maximum velocity (03marks)

(ii) its period of oscillation (02marks)

(c) With the aid of sketch graphs, explain what is meant by critically damped, over damped and under damped oscillations. (06marks)

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

(ii) Derive an expression for the period of a planet moving in a circular orbit about the sun in terms of the radius of the orbit. (03marks)

4. (a) What is meant by the following terms

(i) Velocity gradient (01mark)

(ii) Viscosity (01mark)

(b) (i) What are the origins of viscosity in gases (02marks)

(ii) Explain the effect of temperature on viscosity of a gas. (02marks)

(c) Describe an experiment to measure the coefficient of viscosity of water using Poiseulle's formula. (06marks)

(e) Derive an expression for the terminal velocity of a steel-ball bearing of radius r and density ρ falling through a liquid of density σ and coefficient of viscosity η. (05marks)

(f) Explain with the aid of a diagram why air flow cover the on wings of an air craft at take-off causes a lift. (03marks)

Section B

5. (a) (i) What is meant by a cooling correction (01mark)

(ii) Explain clearly the steps taken to determine the cooling correction when measuring the specific heat capacity of a poor conductor by method of mixtures (07marks)

(b) (i) What are fixed points (01mark)

(ii) Describe how you can measure the temperature of a body on a celcius scale using mercury in glass thermometer (04marks)

(d) The temperature θ°C of a liquid is determined using a constant pressure gas thermometer with the following measurements $V_0 = 4.00m^3,\ V_{100} = 5.50m^3, V_\theta = 4.25m^3$.
Determine the temperature θ°C of a liquid (03marks)

(e) (i) State two advantages and disadvantages using gas thermometer. (02marks)

(ii) Explain why temperature values for two different thermometers used to measure a body's temperature may differ. (02marks)

6. (a) (i) Define the term **specific heat capacity** of a substance and state its units. (02marks)

(ii) Describe an experiment to measure specific heat capacity of a metal using electrical method. (06marks)

(c) (i) A copper block of mass 250g is heated to a temperature of 145°C and then dropped into a copper calorimeter of mass 250g which contains 2500m^3 of oil at 20°C. Given that the final temperature of the mixture recorded was 30°C, calculate the specific heat capacity of copper. (density of oil = 800 kgm^{-3}, S.H.C of oil = 2000 $J\ kg^{-1}\ K^{-1}$). (04marks)

(ii) Explain how the accuracy of the value of the specific heat capacity obtained by method of mixtures can be increased (02marks)

(b) Explain the significance of latent heat in regulation of body temperature (3marks)

(d) (i) State **Wien's displacement law** of black body radiations (01mark)

(ii) Explain why the centre of fire is white (02marks)

7. (a) (i) Thermal conductivity of copper is 390 $Wm^{-1}K^{-1}$. What is meant by this statement?. (01mark)

(ii) State any two factors on which the rate of flow of heat through a solid conductor material depends. (02marks)

(b) (i) Explain the mechanism of heat transfer in a poor conductor of heat. (03marks)

(ii) Describe an experiment to measure the thermal conductivity of wood. (07marks)

(c) (i) State **Stefan's law** of black body radiation (01mark)

(ii) The average distance of Jupiter from the sun is about 5.2 times that of the earth from the sun. If the sun radiates as black body at 5900K and is 1.5x10^{11}m from the earth. Calculate the surface temperature of Jupiter. (06marks)

Section C

8. **(a)** (i) With the aid of a labelled diagram, describe the production of cathode rays using a cathode ray tube (04mark)

(ii) Explain the modifications that can be done in the cathode ray tube to enable the production of x-rays (03marks)

(b) (i) State Bragg's law of x-ray diffraction, hence derive it (05marks)

(ii) A beam of X-rays of wavelength 0.3nm is incident on a crystal, and gives a first order maximum when the glancing angle is 9.0°. Find the atomic spacing. (03marks)

(c) Define the following terms as applied to photo electric emission.

(i) Stopping potential. (01mark)

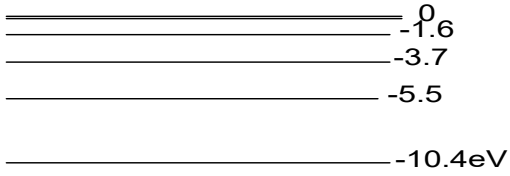
(ii) threshold frequency (01mark)

(d) If a sodium surface with work function of $2.4eV$ is illuminated with a beam of monochromatic ultraviolet light with wavelength of 200nm, what will be the maximum velocity with which electrons can be emitted (03marks)

9. (a) (i) What is **Rutherford's model** of the atom? (02marks)

(ii) Explain what is observed when abeam of alpha particles are directed onto a thin gold foil. (06marks)

(b) The diagram shows energy levels of mercury



(i) Explain how emission line spectra is produced, when a mercury vapour atom is supplied with energy. (03marks)

(ii) What is the ionization energy in Joule of mercury vapour atom in the ground state (02marks)

(iii) If mercury vapour atom in a ground state has a collision with an electron of energy 6.6eV. What is likely to happen to the mercury atom. (03marks)

(c) Explain how Bohr's model of an atom addresses the two main failures of Rutherford's model (04marks)

10. (a) What is meant by the terms

(i) Positive rays (01mark)

(ii) Isotopes (01mark)

(b) With the aid of a well labelled diagram describe the operation of a Bain Bridge mass spectrometer in determining the specific charge of an ion (06marks)

(c) In a Bain bridge mass spectrometer a beam of positive ions is accelerated through a p.d of 1000V into a region of uniform magnetic field of flux density of 0.20T. In the magnetic field, the beam moves in a circular path of radius 25mm. Show that the charge to mass ratio of the ion has a value of $8.0x10^7 Ckg^{-1}$. (04marks)

(d) (i) What is a time base as applied to a Cathode ray tube, C.R.O. (01mark)

(ii) Sketch a graph showing a.c voltage input on a C.R.O with time when the time base is on. (02marks)

(e) A CRO has its y-sensitivity set to 20Vcm^{-1}, a sinusoidal input voltage is suitably applied to give a steady 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. Find the

(i) r.m.s value of the input voltage [02marks]

(ii) frequency of the input signal [02marks]

END