UACE Physics paper 1 set 10 Time 2½ marks

Instructions the candidates:

Answer **five** questions, including at least **one**, but **not more than two** from each sections **A, Band C**.

Any additional question(s) answered will not be marked.

Non programmable scientific calculators may be used.

Assume where necessary

Acceleration due to gravity, g	$9.81ms^{-2}$
Electron charge, e	$1.6 \times 10^{-19}C$
Electron mass	$9.11 \times 10^{-31}kg$
Mass of the earth	$5.97 \times 10^{24}kg$
Plank's constant, h	$6.6 \times 10^{-34}Js$
Stefan's-Boltzmann's constant, σ	$5.67 \times 10^{-8}Wm^{-2}K^{-1}$
Radius of the earth	6.4 x 106m
Radius of the sun	$7 \times 10^{8}m$
Radius of the earth's orbit about the sun	$1.5 \times 10^{11}m$
Speed of light in the vacuum, c	$3.0 \times 108ms^{-1}$
Thermal conductivity of copper	$390Wm^{-1}K^{-1}$
Thermal conductivity of aluminium	$210Wm^{-1}K^{-1}$
Specific heat capacity of water	$4.200Jkg^{-1}K^{-1}$
Universal gravitational constant	$6.67 \times 10^{-11}Nm^{2}Kg^{-2}$
Avogadro's number, N_A	$6.02 \times 10^{23}mol^{-1}$
Surface tension of water	$7.0 \times 10^{-2}Nm^{-1}$
Density of water	$1000kgm^{-3}$
Gas constant, R	$8.31Jmol^{-1}K^{-1}$
Charge to mass ratio, e/m	$1.8 \times 10^{11}Ckg^{-1}$
The constant, $\frac{1}{4\pi\varepsilon_0}$	$9.0 \times 10^{9}F^{-1}m$
Faraday's constant, F	$9.65 \times 10^{4}Cmol^{-1}$

SECTION A

(i))

1. (a) (i) State the law of conservation of linear momentum. (01mark)
   (ii) Use Newton's law to derive the law in (a) (i) (04marks)

   (b) Distinguish between elastic an inelastic collision (01mark)

   (c) An object X of mass M, moving with a velocity of $10ms^{-1}$ collides with a stationary object Y of equal mass. After collision, X moves with a speed u at an angle 30^0 to the initial direction, while Y, moves with a speed V at angle 90^0 to the new direction of X.

   (i) Calculate the speeds U and V (05marks)

   (ii) Determine whether the collision is elastic or not. (03marks)

   (d) (i) Define uniform acceleration. (01mark)

   (ii) With the aid of a velocity-time graph, describe the motion of a body projected vertically upwards. (03marks)

   (iii) Calculate the range of a projectile which is fired at an angle of 45^0 to the horizontal with a speed of $20ms^{-1}$. (02marks)

2. (a)(i) State Archimedes' principle. (01mark)
   (ii) A solid weighs 20.0g in air, 15.0g in water and 16.0g in a liquid, R. Find the density of R (03marks)
   (b) (i) What is meant by simple harmonic motion? (01 mark)
   (ii) Distinguish between damped and forced oscillations (02marks)
   (c) A cylinder of length, L, and cross section area A and density σ floats in a liquid of density, ρ. The cylinder is pushed down slightly and released.
   (i) show that it performs simple harmonic motion. (05marks)
   (ii) Derive the expression for period of the oscillation. (02marks)
   (d) A spring of force constant $40Nm^{-1}$ is suspended vertically. A mass of 0.1kg suspended from the spring is pulled down a distance of 5mm and released. Find the
   (i) period of the oscillation (02marks)
   (ii) maximum acceleration of the mass (02marks)
   (iii) net force acting on the mass when it is 2mm below the centre of oscillation. (02marks)

3. (a) Define viscosity of a fluid (01mark)
   (b) (i) Derive an expression for terminal velocity attained by a sphere of density, σ, and radius, a, falling through a fluid of density, ρ and viscosity, η. (05marks)
   (ii) Explain the variation of viscosity of a liquid with temperature. (02marks)
   (c) (i) State the laws of friction. (02marks)
   (ii) With the aid of a well labelled diagram, describe an experiment to determine the coefficient of kinetic friction between two surfaces. (05marks)
   (d) A body slides down a rough plane inclined at 30^0 to horizontal. If the coefficient of kinetic friction between the body and the plane is 0.4, find the velocity after it has travelled 6m along the plane. (05marks)

4. (a) (i) Describe the terms tensile stress and kinetic strain as applied to a stretched wire. (02marks)
   (ii) Distinguish between elastic limit and proportional limit. (02marks)
   (b) With the aid of a labelled diagram, describe an experiment to investigate the relationship between tensile stress and tensile strains of a steel wire. (07marks)
   (c)(i) A load of 60N is applied to a steel wire of length 2.5m and cross sectional area of $0.22mm^2$. If Young's Modulus for steel is 210GPa, find the expansion produced. (03marks)
   (ii) If the temperature rise of 1K causes a fractional increase of 0.001%, find the change in length of a steel wire of length 2.5 when the temperature increases by 4K. (03marks)
   (d) The velocity, V, of a wave in a material of Young's Modulus, E and density, ρ, is given by $V = \sqrt{\frac{E}{\rho}}$. Show that the relationship is dimensionally correct. (03marks)

SECTION B

5. (a) (i) Define the term specific heat capacity and internal energy and state their units. (03marks)
   (ii) Why is the distinction between specific heat capacity at constant pressure and that at constant volume important for gases, but less important for solids and liquids? (04marks)

   (b) Explain why the temperature of a liquid does not change when the liquid is boiling? (02marks)

   (c) One kilogram of water is converted to steam at a temperature of 100^0C and a pressure of 1.0×10^5Pa. If the density of steam is $0.58kgm^{-3}$ and specific heat of vaporization of water is $2.3 \times 10^6Jkg^{-1}$, calculate the

   (i) external work done (04marks)

   (ii) internal energy (03marks)

   (d) Explain why the specific latent heat of fusion and specific latent heat of vaporization of a substance at the same pressure are different. (04marks)

6. (a) (i) Explain the difference between isothermal and adiabatic expansion of a gas. (02marks)
   (ii) Using same axes and point, sketch graphs of pressure versus volume for fixed mass of a gas undergoing isothermal and adiabatic changes. (03marks)
   (b) Show that work, W, done by a gas which expands reversibly from V_0 to V_1 is given by $W = \int_{V_0}^{V_1} \rho dv$ (04marks)
   (c) (i) State two differences between real and ideal gases (02marks)
   (ii) Draw a labelled diagram showing P-V isothermals for a real gas above and below the critical temperature. (03marks)
   (d) Ten moles of a gas, initially at 27^0C are heated at constant pressure of 1.01×10^5Pa and volume increased from $0.25m^3$ to $0.375m^3$. Calculate the increase in internal energy. [Assume $C_p = 28.5Jmol^{-1}K^{-1}$] (06marks)

7. (a) What is meant by the following?
   (i) Conduction
   (ii) Convection
   (iii) Greenhouse effect (06marks)

   (b) One end of a long copper bar is heated in a steam chest and the other end is kept cool by current of circulating water. Explain with the aid of sketch graphs, the variation of temperature along the bar, when steady state has been attained if the bar is

   (i) lagged (02marks)

   (ii) exposed to the surrounding (02marks)

   (c) (i) What is meant by a black body? (01mark)

   (ii) Describe how a black body can be approximated in practice. (04marks)

   (d) (i) State Prevost's theory of heat exchange. (01mark)

   (ii) Sketch the variation with wavelength of the intensity of radiation emitted by a black body at two different temperatures. (01mark)

   (e) A cube of side 1.0cm has a grey surface that emits 50% of the radiation emitted by a black body at the same temperature. If the cube's temperature is 700^0C, calculate the power radiated by the cube. (03marks)

SECTION C

8. (a) (i) With the aid of a labelled diagram, describe what is observed when a high tension voltage is applied across a gas tube in which pressure is gradually reduced to vary low value. (05marks)

   (ii) Give two applications of discharge tubes. (01mark)

(b) Describe Thomson's experiment to determine the specific charge of an electron. (06marks)

(c) In a Millikan's experiment, a charged oil drop of radius 9.2×10^{-7}m and density 800kgm-3 is held stationary in an electric field of intensity 4.0×10^4Vm^{-1}.

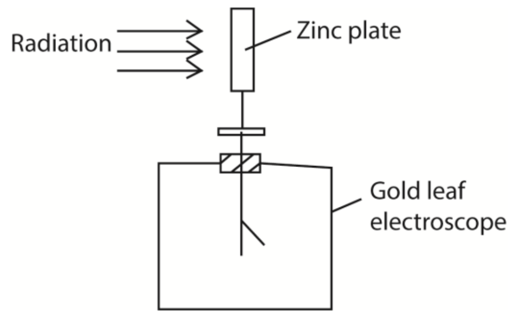
(i) How many electron charges are on the drop? (04marks)

(ii) Find the electric field intensity that can be applied vertically to move the drop with velocity 0.005ms-1 upwards.

[Density of air = 1.29kgm^{-3}, coefficient of viscosity of air = 1.8×10^{-5}Nsm^{-1}]

9. (a) Explain what is meant by photoelectric effect. (02marks)

(b)



Ultraviolet and infrared radiations are directed in turns on to a zinc plate which is attached to a gold leaf electroscope as shown in the figure above

Explain that happens when

(i) Ultraviolet radiation falls on the zinc plate (02marks)
(ii) Infrared falls on the zinc plate. (01mark)
(iii) The intensity of each radiation is increased. (02marks)

(c) An X-ray of wavelength 10^{-10}m is required for the study of its diffraction in a crystal. Find the least accelerating voltage to be applied on an X-ray tube in order to produce these X-rays. (04marks)

(d) Sodium has a work function of 2.0eV and is illuminated by radiation of wavelength 150nm. Calculate the maximum speed of the emitted electrons. (04marks)

(e) With the aid of a well labelled diagram, describe how stopping potential of a metal can be measured. (05marks)

10. (a) (i) What is meant by mass defect? (01marks)

(ii) Sketch a graph showing how binding energy per nucleon varies with mass number and explain its features. (03marks)

(iii) Find the binding energy per nucleon of $^{56}_{26}Fe$ given that

Mass of 1 proton = 1.007825u

Mass of 1neutron = 1.008665u

[1u = 931MeV) (03marks)

(b) With the aid of a diagram, explain how an ionization chamber works (06marks)

(c) (i) Show that an alpha particle collides head on with an atom of atomic number, Z, the closest distance of approach to the nucleus X_0 is given by

$$X_0 = \frac{ze^2}{\pi\varepsilon_0 mv^2}$$

Where

e is electronic charge

ε_0 is permittivity of fee space

m is mass of alpha particle

v is initial speed of alpha particle (04marks)

(ii) In a head on collision between an alpha particle and a gold nucleus, the minimum distance of approach is 5 x 10-14m. Calculate the energy of alpha particle (in MeV)

[Atomic number of gold= 79]

Compiled by Dr. Bbosa Science