UACE Physics paper 1 2000 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.

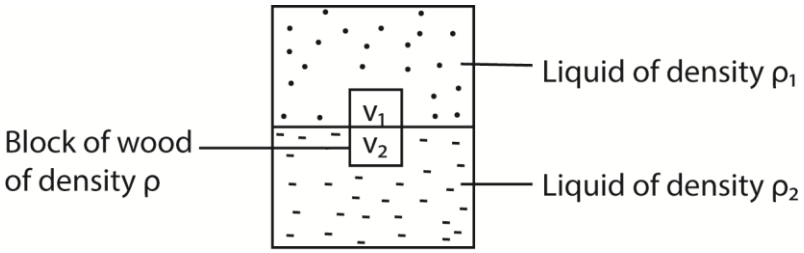
Non programmable scientific calculators may be used.

Assume where necessary

Acceleration due to gravity, g	$9.81ms^{-2}$
Electron charge, e	$1.6 x10^{-19}C$
Electron mass	$9.11 x 10^{-31}kg$
Mass of the earth	$5.97 x 10^{24}kg$
Plank's constant, h	$6.6 x 10^{-34}Js$
Stefan's-Boltzmann's constant, σ	$5.67 x 10^{-8}Wm^{-2}K^{-1}$
Radius of the earth	6.4 x 106m
Radius of the sun	$7 x 10^{8}m$
Radius of the earth's orbit about the sun	$1.5 x 10^{11}m$
Speed of light in the vacuum, c	$3.0 x 108ms^{-1}$
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	$6.67 x 10^{-11}Nm^{2}Kg^{-2}$
Avogadro's number, N_A	$6.02 x 10^{23}mol^{-1}$
Surface tension of water	$7.0 x 10^{-2}Nm^{-1}$
Density of water	$1000kgm^{-3}$
Gas constant, R	$8.31Jmol^{-1}K^{-1}$
Charge to mass ratio, e/m	$1.8 x 10^{11}Ckg^{-1}$
The constant, $\frac{1}{4\pi\varepsilon_0}$	$9.0 x 10^{9}F^{-1}m$
Faraday's constant, F	$9.65 x 10^{4}Cmol^{-1}$

SECTION A

1. (a) (i) State Newton's laws of motion (03marks)
   (ii) Define impulse and derive its relation to linear momentum of the body on which it acts. (03marks)
   (b) A body of mass m_1 and velocity, u_1 collides head on with a body of mass, m_2 having velocity, u_2 in the same direction as u_1. Use Newton's laws to show that the quantity $m_1u_1 + m_2u_2$ is conserved. (5marks)
   (c) A ball of mass 0.5kg is allowed to drop from rest, from a point a distance of 5.0m above a horizontal concrete flow. When the ball first hits the floor, it rebounds to a height of 3.0m.
   (i) What is the speed of the ball just after the first collision with the floor? (3marks)
   (ii) If the collision lasted 0.01s, find the average force which the floor exerts on the ball. (02marks)
2. (a) (i) state Archimedes' Principle. (01mark
   (ii) What is simple harmonic motion? (02marks)
   (b) A uniform cylindrical rod of length 0.08m, cross sectional area $0.02m^2$ and density $900kgm^-3$ floats vertically in a liquid of density $1000kgm^{-3}$. The rod is displaced through a distance of 0.005m and released.
   (i) Show that the rod performs simple harmonic motion. (05marks)
   (ii) Find the frequency of the resultant oscillation. (04marks)
   (iii) Find the velocity of the rod when it is a distance of 0.004m above the equilibrium position. (03marks)
   (c)



   A block of wood of density ρ floats at the interface between immiscible liquids of densities ρ_1 and ρ_2 as shown in the figure above.
   (i) Show that the ratio of volumes v_1 to v_2 of the block in the two liquids is given by $\frac{v_1}{v_2} = \frac{\rho_2 - \rho}{\rho - \rho_1}$ (04marks)
   (ii) What happens when this block of wood is replaced with a denser one? (01mark)
3. (a) Distinguish between scalar and vector quantities. Give two examples each. (03marks)
   (b) (i) Define the time of flight and range as applied to projectile motion. (02 marks)
   (ii) A projectile is fired in air with a speed u ms^{-1} at an angle θ to the horizontal. Find the time of flight of the projectile (02marks)
   (c) State the conditions for equilibrium of a rigid body under action of coplanar forces. (02marks)
   (d) A mass of 5.0kg is suspended from the end A of a uniform beam of mass 1kg and length 1.0m. The end B of the beam is hinged in a wall. The beam is kept horizontal by a rope attached to A and a point C, in the wall at a height 0.75m above B.
   (i) Draw a sketch diagram to show the forces acting on the beam. (02marks)
   (ii) Calculate the tension in the rope. (04marks)

(iii) What is the force exerted by the hinge on the beam? (05marks)

4. (a) State Kepler's laws of gravitation (03marks)

(b) (i) Show that the period of a satellite in a circular orbit of radius r about the earth is given by T = $\left(\frac{4\pi^2}{GM_s}\right)^{\frac{1}{2}} r^{\frac{3}{2}}$ where G is the universal constant and Ms is the mass of the earth. (05marks)

(ii) Explain briefly how world-wide radio or television communication can be achieved with the help of satellites. (04marks)

(c) A satellite of mass 100kg is in a circular orbit at height of 3.39 x 10^7m above the earth' surface.

(i) Find the mechanical energy of the satellite (04marks)

(ii) Explain what would happen if the mechanical energy was decreased. (04marks)

SECTION B

5. (a)(i) Describe Searle's method of determining the thermal conductivity of a good conductor of heat. (07marks)

(ii) Why is the method in (a)(i) best suited for a good conductor of heat? (02marks)

(b) The two ends of a metal bar of length 1.0m are perfectly lagged up to 20cm from either end. The ends of the bar maintained at 100^0C and 0^0C respectively.

(i) Sketch a graph of temperature versus distance of a bar. (02marks)

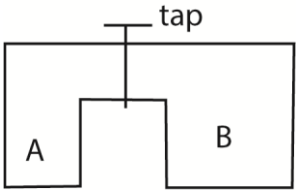
(ii)Explain the features of the graph in (b)(i)(03marks)

(c) The external wall of a house consists of two layers of brick separated by an air cavity. The outer face of the wall is at a temperature of 45^0C while the inside of the house is at 20^0C. If the thickness of each brick layer is 15cm and of air cavity is 5cm, calculate the temperatures of the walls in contact with air in the cavity. (06marks)

6. (a) (i) State Boyles law. (01mark)

(ii) What is meant by partial pressure of a gas (01 mark)

(iii)



Two cylinders A and B of volumes V and 3V respectively are separately filled with a gas. The cylinders are connected as shown above with the tap closed. The pressures of A and B are P and 4P respectively. When the tap is opened the common pressure becomes 60Pa. Assuming isothermal conditions find the value of P. (04marks)

(b) (i) State three differences between ideal and real gases. (03marks)

(ii)Sketch a pressure versus volume curve for a real gas undergoing compression below its critical temperature. (01mark)

(iii)Explain the main features of the curve in (b)(ii) above (03marks)

(c) Two similar cylinders P and Q contain different gases at the same pressure. When gas is released from P the pressure remains constant for some time before it starts dropping.

When gas is released from Q the pressure continuously drops. Explain the observation above. (05marks)

(d) Using the expression for the kinetic pressure of an ideal gas, deduce the ideal gas equation of $\frac{1}{2}mc^{\overline{2}} = \frac{3}{2}K_BT$ (02marks)

7. (a)(i) State the desirable properties of a material must have to be used as thermometric substance, (02marks)

(ii) Explain why scales of temperature based on different thermometric properties may not agree.(01marks)

(b) (i) Draw a labelled diagram to show a simple constant volume gas thermometer. (03marks)

(ii) Describe how a simple constant volume gas thermometer cab be used to establish a Celsius scale of temperature. (05marks)

(iii) State the advantages and disadvantages of mercury in glass thermometer and constant-volume gas thermometer. (03marks)

(c) The resistance of the element of platinum resistance thermometer is 4.00Ω at ice point and 5.46Ω at steam point. What is the temperature on the platinum resistance scale would correspond to a resistance of 9.84Ω.(03marks)

(d) The mean kinetic energy of one mole of helium gas at room temperature is 3.74 x 10^3J. Calculate room temperature.

SECTION C

8. (a) State the laws of pho electric emission. (04marks)

(b) (i) Describe an experiment Plank's constant. (05marks)

(ii) Violet light wavelength 0.4μm is incident on a metal surface of threshold wavelength 0.65μm. Find the maximum speed of emitted electrons

(i) Explain why light whose frequency is less than the threshold frequency cannot cause photo emission. (02marks)

(c) (i) What are X-rays? (01marks)

(ii) Explain how the intensity and penetrating power of X-rays produced by an X-ray tune can be varied. (04marks)

9. (a)(i) Define the terms half-life and decay constant as applied to radioactivity. (02marks)

(ii) State relationship between half-life and decay constant. (01mark)

(b) The radioisotope ^{60}Co decays by emission of a β-particle and γ-rays. Its half-life is 5.3years.

(i) find the activity of a source containing 0.10g of ^{60}Co. (04marks)

(ii) In which ways do γ-rays differ from β-particles (03marks)

(c) (i) What is meant by mass defect in nuclear physics? (01mark)

(ii) Calculate the mass defect for $^{59}_{26}Fe$, given the following information

Mass of $^{59}_{26}Fe$ nucleus = 58.93488u

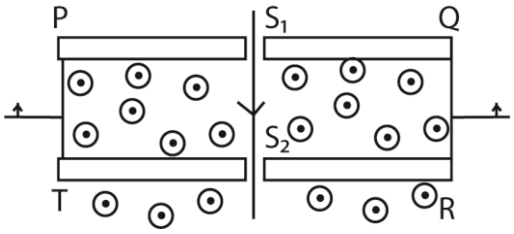
Mass of a proton = 1.00728u

Mass of neutron = 1.00867u (04marks)

(d) Describe the structure and action of ionization chamber. (05marks)

10. (a) What is meant by specific charge of an ion? (01mark)

(b)



Positive ions of the same charge are directed through slit S_1 into a region PQRT as shown in the figure above. There is a uniform electric field of intensity $300NC^{-1}$ between the plate PT and QR. A uniform magnetic field of flux density 0.6T is directed perpendicularly out of the paper as shown above.

(i) Calculate the velocity of the ions which go through slit S_2. (03marks)

(ii) Describe the motion of ions in the region TR. (3marks)

(c) When fast moving electrons strike a metal target in X-ray tube, two type of X-ray spectra are produced

(i) Draw a sketch graph of intensity against wavelength of the X-rays (02marks)

(ii) Account for the occurrence of the two types of spectra (05marks)

(d) Outline the experimental evidences for the quantum theory of matter. (06marks)

Compiled by Dr. Bbosa Science