UACE Physics paper 1 2009 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) Define the term impulse (01mark)
   (ii) State Newton's laws of motion (03marks)
   (b) A bullet of mass 10g travelling horizontally at a speed of 100ms^{-1} strikes a block of wood of mass 900g suspended by a light vertical string and is emended in the block which subsequently swings freely. Find the
   (i) vertical height through which the block rises. (04marks)
   (ii) Kinetic energy lost by the bullet (03marks)
   (c) Explain the terms time of flight and range as applied to projectile motion. (02marks)
   (d) A stone is projected at an angle of 200 in horizontal and just clears a wall which is 10m high and 30m from the point of projection. Find the
   (i) speed of projection. (04marks)
   (ii) Angle which the stone makes with the horizontal as it clears the wall. (03marks)
2. (a) Define the following terms
   (i) Velocity
   (ii) Moment of a force

   (b) (i) A ball is projected vertically up wards with a speed of 50ms^{-2}.on return it passes a point of projection, and falls and falls 78m below. Calculate the total time taken. (05marks)

   (ii) State energy changes that occurred during the motion of the ball in (b)(i) above. (03marks)

   (c) (i) State the conditions required for mechanical equilibrium to be attained. (02marks)

   (ii) A uniform ladder of mass 40kg length 5m, rests with its upper end against a smooth vertical wall and with its lower end at 3m from the wall on a rough ground. Find the magnitude and direction of the force exerted at the bottom of the ladder. (06marks)

   (d) State four instances where increasing friction is useful. (02marks)

3. (a) What is meant by simple harmonic motion? (01mark)
   (b) A cylindrical vessel of cross-section area A, contains air of volume V, at pressure, P, trapped by frictionless air tight piston of mass, M. the piston is pushed down and released.
   (i) If the piston oscillates with simple harmonic motion, show that its frequency, f, is given by

$$f = \frac{A}{2\pi}\sqrt{\frac{P}{MV}}$$ (06marks)

   (ii) Show that the expression for f, in (b)(i) is dimensionally correct. (03marks)

   (c) A particle executing simple harmonic motion vibrates in a straight line. Given that the speeds of the particle are 4ms^{-1} and 2ms^{-1} when the particle is 3cm and 6cm respectively from the equilibrium, calculate the

   (i) amplitude of oscillation. (03marks)

   (ii) frequency of the particle. (03marks)

(d) Give two examples of oscillatory motion which approximate to simple harmonic motion and state the assumption made in each case. (04marks)

4. (a) (i) State Archimedes' Principle. (01mark)

(ii) Use Archimedes' Principle to derive an expression for resultant force on a body of weight, W, and density, σ, totally immersed in a fluid of density, ρ. (04marks)

(b) A tube of uniform cross sectional area of $4 \times 10^{-3}m^2$ and mass 0.2kg is separately floated vertically in water of density $1.0 \times 10^{3}kgm^{-3}$ and in oil of density $8.0 \times 10^{2}kgm^{-3}$. Calculate the difference in the lengths immersed (04marks)

(c) (i) Define surface tension in terms of work (01mark)

(ii) Use the molecular theory to account for surface tension of a liquid. (04marks)

(iii) Explain the effect of increasing temperature of a liquid on its surface tension. (04marks)

(iv) Calculate the excess pressure inside a soap bubble of diameter 3.0cm if the surface tension of the soap solution is $2.5 \times 10^{-2}Nm^{-1}$. (02marks)

SECTION B

5. (a) (i) Define the term thermometric property. (01mark)
(ii) State two thermometric properties. (01mark)
(iii) With the aid of a labelled diagram, describe how the room temperature can be measured using uncalibrated resistance thermometer. (06marks)

(b) (i) Define specific heat capacity of a substance. (01mark)

(ii) Hot water at 85^0C and cold water 10^0C are ran into a bath at a rate of $3.0 \times 10^{-2}m^3min^{-1}$ and V, respectively. At the point of filling the bath, the temperature of the mixture of water 40^0C. Calculate the time taken to fill the bath is its capacity is $1.5m^3$.

(c) The specific latent heat of fusion of a substance is significantly different from its specific latent heat of vaporization at the same pressure. Explain how the difference arises. (04marks)

(d) Explain in terms of specific heat capacity why water is used in a car radiator other than any other liquid. (02mark)

6. (a) (i) state Boyles law. (01mark)
(ii) Describe an experiment that can be used to verify Boyles' law. (06marks)
(b) Explain the following observations using the kinetic theory.
(i) A gas fills any container in which is it placed and exerts pressure on its walls. (03marks)
(ii) The pressure of a fixed mass of a gas rises when temperature is increased at constant volume. (02 marks)
(c) (i) What is meant by a reversible process. (01marks)
(ii) State the conditions necessary for isothermal and adiabatic processes to occur, (04marks)

(d) A mass of an ideal gas of volume 200cm^3 at 144K expands adiabatically to a temperature of 137K. Calculate its new volume. (Take γ =1.40)

7. (a) Define thermal conductivity. (01mark)

(b)(i) Explain the mechanism of thermal conduction in nonmetallic solids. (03marks)

(ii) Why are metal better thermal conductors than nonmetallic solids? (02marks)

(c) With the aid of a diagram, describe an experiment to determine the thermal conductivity of a poor conductor. (06marks)

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

(ii) Sketch curves showing the spectral distribution of energy radiated by a black body at three different temperatures. (02marks)

(iii) Describe the main features of the curves you have drawn in (d)(ii) (02marks)

(e) A small blackened solid copper sphere of radius 2cm is placed in an evacuated enclosure whose wall are kept at 100^{0}C. Find the rate at which energy must be supplied to the sphere to keep its temperature at 127^{0}C. (03marks)

SECTON C

8. (a) State four differences between cathode rays and positive rays (02marks)

(b) An electron having energy of 4.5 x 10^{3}eV moves at right angles to a uniform magnetic field of flux density 1.5 x 10^{-3}T. Find the

(i) radius of the path followed by the electron. (04marks)

(ii) period of the motion. (03marks)

(c) (i) Define the term Avogadro constant and Faraday constant (02marks)

(ii) Use the Avogadro constant and Faraday constants to calculate the charge on anion of monatomic element. (03marks)

(d) Explain the meaning of the following terms as applied to a Geiger-Muller tube.

(i) threshold potential difference (02marks)

(ii) Dead time (02marks)

(iii) A quenching agent (02marks)

9. (a) State the laws of photoelectric effect (04marks)

(b) Describe an experiment to determine the stopping potential of a metal surface. (05 marks)

(c) A 100mW beam of light of wavelength 4.0 x 10^{-7}m falls on caesium surface of a photocell.

(i) How many photons strike the caesium surface per second? (03marks)

(ii) If 65% of the photons emit photoelectrons, find the resulting photocurrent. (03marks)

(iii) Calculate the kinetic energy of each photon if the work function of caesium is 2.20eV. (03marks)

(d) Distinguish between continuous and line spectra in an X-ray tube. (02marks)

10. (a) (i) Explain the observation made in the Rutherford α-particle scattering experiment. (06marks)

(b) Distinguish between excitation and ionization energies of an atom. (02marks)

(c) Draw a labelled diagram showing the main components of an X-ray tube (03marks)

(d) An X-ray tube is operated at 50kV and 20mA. If 1% of the total energy supplied is emitted as X-radiation, calculate the

(i) maximum frequency of emitted radiation (03marks)

(ii) rate at which heat must be removed from the target in order to keep it at a steady temperature. (03marks)

(e) A beam of X-ray of wavelength 0.2nm is incident on a crystal at glancing angle 300. If the interplanar separation is 0.20nm, find the order of diffraction. (02marks)

Compiled by Dr. Bbosa Science