UACE Physics paper 1 2004 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) State the laws of friction (04marks)
   (b) A block of mass 5.0kg resting on the floor is given a horizontal velocity of 5.0ms^{-1} and comes to rest in a distance of 7.0m. Find the kinetic friction between the block and the floor. (04marks)
   (c) (i) State the law of conservation of linear momentum (01mark)
   (ii) What are perfectly inelastic collision? (01mark)
   (d) A car of1500kg rolls from rest down a road inclined to the horizontal at an angle 350, through 50m. The car collides with another car of identical mass at the bottom of the incline. If the two cars interlock on collision, and the coefficient of kinetic friction is 0.20, find the common velocity of the vehicles. (08marks)
   (e) Discuss briefly the energy transformation which occur in (d) above
2. (a) Define angular velocity (01mark)

   (b) A car of mass, m, travels round a circular track of radius, r, with velocity, V.

   (i) Sketch a diagram to show the forces acting on the car. (02marks)

   (ii) Show that the car does not overturn if$V^2 < \frac{arg}{2h}$, where a is the distance between the wheels, h, is the height of the centre of gravity above the ground and g is acceleration due to gravity. (05marks)

   (c) A pendulum bob of mass 0.2kg is attached to one end of an inelastic string of length 1.2m. The bob moves in a horizontal circle with the string inclined at 30^0 to the vertical. Calculate

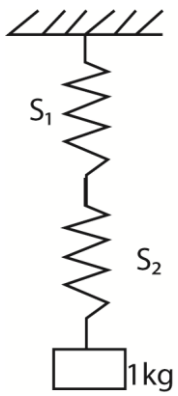
   (i) the tension in the string(02marks)

   (ii) the period of motion (04marks)

   (d) Explain and sketch the variation of acceleration due to gravity with distance from the centre of the earth (06marks)

3. (a) (i) What is meant by simple harmonic motion? (01mark)
   (ii) Show with the aid of a suitable sketch graph how kinetic energy of a mass attached at the end of an oscillating light spring changes with distance from equilibrium position. (04marks)

   (b)



A mass of 1.0kg is hang from two springs S_1 and S_2 connected in series as shown above.

The force constant of the springs are $100Nm^{-1}$ and $200Nm^{-1}$ respectively. Find

(i) The extension produced in combination. (04marks)

(ii) The frequency of oscillation of the mass if it is pulled downwards through a small distance and released. (06marks)

(c) Explain with the aid of a sketch graph, what would happen to the oscillations in (b)(ii) above if the mass was immersed in a liquid such as water. (04marks)

4. (a) (i) Define gravitational field strength. (01mark)

(ii) Draw a sketch graph to show how the gravitational field strength varies with height, h, above the earth's surface. (02marks)

(b) The period of simple pendulum is measured at different locations along a given longitude. Explain what is observed. (06marks)

(c) Derive the expression for the escape velocity of a rocket fired from earth. (03marks)

(d) The rings of the planet Saturn consist of a vast number of small particles, each in a circular orbit about the planet. Calculate the speed of the particles nearest to Saturn if its mass is 6.0×10^{26}kg (04marks)

(e) The moon moves in a circular orbit of radius 3.84×10^{8}m around the earth with a period of 2.36×10^{5}s.Calculate the gravitational field of the earth at the moon. (04marks)

SECTION B

5. (a) What is meant by:

(i) Thermometric property (01mark)

(ii) Triple point (01mark)

(b) (i) Describe the steps taken to establish a temperature scale. (05marks)

(ii) Explain why two thermometers may give different values for the same unknown temperature. (02marks)

(c) (i) Describe, with the aid of a diagram, how a constant-volume gas thermometer may be used to measure temperature. (06mrks)

(ii) State three corrections that need to be made when using the thermometer in (c)(i) above. (03marks)

(iii) State and explain the sources of inaccuracies in using mercury in glass thermometer, (02marks)

6. (a) Define thermal conductivity of a material and state its units (02marks)

(b) Describe with the aid of a diagram how the thermal conductivity of a poor conductor can be determined. (07marks)

(c) A cooking saucepan made of iron has a base area of $0.05m^2$ and thickness of 2.5mm. It has a thin layer of soot of average thickness 0.5mm on its bottom surface. Water in the saucepan is heated until it boils at 100^0C. The water boils away at a rate of 0.60kg per minute and the side of the soot nearest to the heat source is at 150^0C. Find the thermal conductivity of soot.

[Thermal conductivity of iron = 66$Wm^{-1}K^{-1}$and specific latent heat of vaporization =2200kJ/kg)

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

(ii) Sketch the spherical distribution of black body radiation for three different temperatures and describe their main features. (04marks)

7. (a) Derive the expression P = $\frac{1}{3}\rho\overline{c^2}$ for the pressure, P, of an ideal gas of density ρ and mean square speed, $\overline{c^2}$. State any assumptions made (07marks)

(b) A gas is confined in a container of volume 0.1m^3 at a pressure of 1.0 x 10^5Nm^{-2} and temperature of 300K. If the gas is assumed to be ideal, calculate the density of the gas. (The relative molecular mass of the gas is 32) (05marks)

(c) What is meant by

(i) isothermal change

(ii) adiabatic change (02marks)

(d) A gas at a pressure of 1.0 x 10^6Pa is compressed adiabatically to half its volume and then allowed to expand isothermally to its original volume. Calculate the final pressure of the gas.

[Assume the ratio of the principal specific heat capacities $^{C_p}/_{C_v}, \gamma = 1.4$] (06marks)

SECTION C

8. (a) (i) Describe with the aid of a labelled diagram the main features of a cathode ray oscilloscope (C.R.O) (08marks)

(ii) State two uses of C.R.O (01mark)

(iii) The gain control of a C.R.O is set on 0.5Vcm^{-1} and an alternating voltage produces a vertical trace of 2.0cm long with the time base off. Find the root mean value of the applied voltage. (02marks)

(b) a beam of electrons is accelerated through a potential difference of 2000V and is directed mid-way between two horizontal plates of length 5.0cm and separation of 2.0cm. The potential difference across the plates is 80V.

(i) Calculate the speed of the electron as they enter the region between the plates. (03marks)

(ii) Explain the motion of the electrons between the plates. (02marks)

(iii) find the speed of electrons as they emerge from the region between the plates. (04marks)

9. (a) Explain the term stopping potential as applied to photo electric effect. (02marks)

(b) Explain how intensity and penetrating power of X-rays from X-ray tube would be affected by changing:

(i) the filament current (02marks)

(ii) the high tension potential difference across the tube (02marks)

(c) When a p.d of 60kV is applied across an X-ray tube, a current of 30mA flows. The anode is cooled by water flowing at a rate of 0.060kgs^{-1}. If 99% of the power supplied is converted into heat at the anode, calculate the rate at which the temperature of the water rises. {Specific heat capacity of water = 4.2 x $10^3Jkg^{-1}K^{-1}$] (05marks)

(d) (i) Derive Bragg's law of X-ray diffraction. (05marks)

(ii) Calculate the atomic spacing of sodium chloride if the relative atomic mass of sodium is 23.0 and that of chlorine is 35.5.
[Density of sodium chloride = 2.18 x 10^{3}kgm^{-3}] (04marks)

10. (a) (i) Explain briefly the mechanism of thermionic emission. (02marks)
(ii) Draw a labelled diagram of the circuit used to determine the anode current and anode voltage characteristics of a thermionic diode. (02marks)
(iii) Sketch the characteristic expected in (a) (ii) at constant filament current, and account for its special features. (04marks)
(b) Describe, with the aid of a labelled diagram, the structure and action of a diffusion cloud chamber (06marks)
(c) (i) Define radioactivity and half-life of a radioactive substance (02marks)
(ii) A radioactive isotope of strontium of mass 5.0μg has a half-life of 28years. Find the mass of the isotope left after 14 years. (04marks)

Compiled by Dr. Bbosa Science