UACE Physics paper 1 2006 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	$9.11 \times 10^{-31}kg$
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

1. (a)(i) What is meant by uniformly accelerated motion? (01marks)
   (ii) Sketch the speed against time graph for a uniformly accelerated body. (01mark)
   (iii) Derive the expression: $S = ut + \frac{1}{2} at^2$, for the distance, S, moved by a body which is initially travelling with speed u and is uniformly accelerated for time t.

   (b) A projectile is fired horizontally from the top of a cliff 250m high. The projectile lands 1.414×10^3m from the bottom of the cliff. Find the

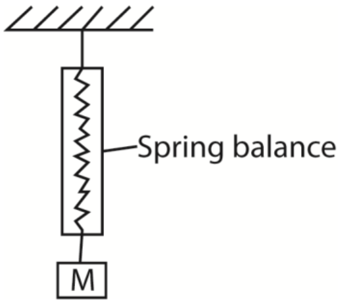
   (i) initial speed of the projectile. (05marks)

   (ii) velocity of the projectile just before it hits the ground. (05marks)

   (c) Describe an experiment to determine the centre of gravity of a plane sheet of material having irregular shape (04marks)

2. (a) (i) Define force and power. (02marks)
   (ii) Explain why more energy is required to push a wheel barrow uphill than on a level ground. (03mark)

   (b)



   A mass, M, is suspended from a spring balance as shown in the figure above. Explain what happens to the reading of the spring balance when the setup is raised slowly to a very high height above the ground. (02marks)

   (c) (i) State the work-energy theorem (01mark)

   (ii) A bullet of mass 0.1kgmoving horizontally with a speed of $420ms^{-1}$ strikes a block of mass 2.0kg at rest on a smooth table and becomes embedded in it. Find the kinetic energy lost if they move together. (04marks)

   (d) State the condition for equilibrium of a rigid body under the action of coplanar forces. (02marks)

   (e) A 3m long ladder rests at an angle 600 to the horizontal against a smooth vertical wall on a rough ground. The ladder weighs 5kg and its centre of gravity is one- third from the bottom of the ladder.

   (i) Draw a sketch diagram to show the forces acting on the ladder. (02marks)

   (ii) Find the reaction of the ground on the ladder (04marks)

3. (a) (i) Define stress and strain (02marks)
   (ii) Determine the dimensions of Young's modulus. (03marks)

(b) Sketch a graph of stress versus strain for a ductile material and explain its features. (06marks)

(c) A steel wire of cross section area $1mm^2$ is cooled from a temperature of 60^0C to 15^0C. Find the:

(i) strain (02marks)

(ii) force needed to prevent it from contracting. (03marks)

[Young's Modulus= $2.0 \times 10^{11}Pa$, Coefficient of linear expansion of steel = $1.1 \times 10^{-5}K^{-1}$]

(d) Explain the energy changes which occur during plastic deformation (04marks)

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

(ii) Describe an experiment to determine the relative density of an irregular solid which floats in water

(iii) A block of wood floats at an interface between water and oil with 0.25 of its volume submerged in oil. If the density of the wood is $7.3 \times 10^2kgm^{-2}$, find the density of oil. (04marks)

(b) (i) State Bernoulli's Principle. (04marks)

(ii) Explain the origin of the lift force on the wings of an aeroplane at take-off. (04marks)

(c) Water flowing in a pipe on the ground with a velocity of $8ms^{-1}$ and at gauge pressure of 2.0×10^3Pa is pumped into a water tank 10m above the ground. The water enters the tank at a pressure of 1.0×10^5Pa. Calculate the velocity with which the water enters the tank. (03marks)

(d) Describe how terminal velocity can be measured. (04marks)

SECTION B

5. (a) Define saturated vapour pressure (S.V.P) (01mark)

(b) Use the kinetic theory of matter to explain the following observations

(i) saturated vapour pressure of a liquid increases with temperature. (03marks)

(ii) saturated vapour pressure is not affected by decrease in volume at constant temperature. (03marks)

(c) Describe how saturated vapour pressure of a liquid at various temperatures can be determined. (07marks)

(d) (i) State Dalton's law of partial pressures (01mark)

(ii) A horizontal tube of uniform bore, closed at one end, has some air trapped by a small quantity of water. The length of the enclosed air column is 20cm at 12^0C.
Find stating any assumptions made, the length of air column when the temperature is raised to 38^0C.
[S.V.P of water at 12^0C and 38^0C are 10.5mmHg and 49.5mmHg respectively.
Atmospheric pressure = 75cmHG] (05marks)

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

(ii) State three advantages of the continuous flow method over the method of mixtures in determination of the specific heat capacity of a liquid. (03marks)

(b) In a continuous flow experiment, a steady difference of temperature of 1.5^0C is maintained when the rate of liquid flow is $4.5gs^{-1}$ and the rate of electrical heating is 60.5W. On reducing the liquid flow rate to $1.5gs^{-1}$, 36.5W is required to maintain the same temperature difference.

Calculate the

(i) Specific heat capacity of the liquid. (04marks)

(ii) Rate of heat loss to the surroundings (03marks)

(c) (i) Describe an electrical method for determination of the specific heat capacity of a metal. (06marks)

(ii) State the assumptions made in the above experiment. (02marks)

(iii) Comment about the accuracy of the results of the experiment in (c)(i) above. (01marks)

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

(ii) Explain the mechanism of heat transfer in metals (03marks)

(b) Two brick walls each of thickness 10cm are separated by an air-gap of thickness 10cm. the outer faces of the brick walls are maintained at 20^0C and 5^0C respectively.

(i) Calculate the temperatures of the inner surfaces of the walls. (06marks)

(ii) Compare the rate of heat loss through the layer of air with that through a single brick wall. (03marks)

[Thermal conductivity of air is $0.02Wm^{-1}K^{-1}$, and that of bricks is $0.6Wm^{-1}K^{-1}$]

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

(ii) The average distance of Pluto from the sun is about 40 times that of the Earth from the sun. If the sun radiated as a black body at 600K, and is 1.5×10^{11}m from the Earth, Calculate the temperature of Pluto. (06marks)

SECTION C

8. (a) (i) What is a photon? (01mark)

(ii) Explain, using quantum theory, the experimental observation on the photoelectric effect. (06marks)

(iii) when light of wavelength 150nm falls on a certain metal, electrons of maximum kinetic energy 0.76eV are emitted. Find the threshold frequency for the metal. (04marks)

(b) Explain, using suitable sketch graph, how X-ray spectrum in an X-ray tube are formed. (06marks)

(c) A beam of X-rays of wavelength 8.42×10^{-11}m is incident on a sodium chloride crystal of interplanar separation 2.82×10^{-10}m. Calculate the first order of diffraction angle. (03marks)

9. (a) (i) A beam of electrons, having a common velocity, enters a uniform magnetic field in a direction normal to the field. Describe and explain the subsequent path of the electrons (04marks)

(ii) Explain whether a similar path would be followed if a uniform electric field were substituted for magnetic field (01mark)

(b) Describe an experiment to measure the ratio of the charge to mass of an electron (07marks)

(c) Electrodes are mounted at opposite ends of low pressure discharge tube and a potential difference of 1.20kV applied between them. Assuming the electrons are accelerated from rest, calculate the maximum velocity which they could acquire. [Specific electron charge =- 1.76×10^{11} Ckg^{-1}) (02marks)

(d) (i) Give an account of the stages observed when an electric discharge passes through a gas at pressure varying from atmospheric to about 0.01mmHg as air is pumped out when the p.d across the tube is maintained at extra high tension. (05marks)

(ii) State two disadvantages of discharge tubes when used to study cathode rays. (01mark)

10. (a) (i) What is meant by half-life of a radioactive material? (01mark)

(ii) Given the radioactive law, $N_t = N_0 e^{-\lambda t}$, obtain the relationship between λ and half-life $T_{\frac{1}{2}}$ (02marks)

(iii) What are radioisotopes? (01mark)

(iv) The radioisotope $^{90}_{38}Sr$ decays by emission of β-particles. The half-life of the radioisotope is 28.8years. Determine the activity of 1g of the isotope (05marks)

(b) (i) With aid of a diagram describe the structure and action of Geiger-Muller tube. (06marks)

(ii) Sketch the current –voltage characteristic of the Geiger- Muller tube and explain its main features. (03marks)

(iii) Identify, giving reasons, the suitable range in (b) (ii) of operation of the tube (02marks)

Compiled by Dr. Bbosa Science