UACE Physics paper 1 set5 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.

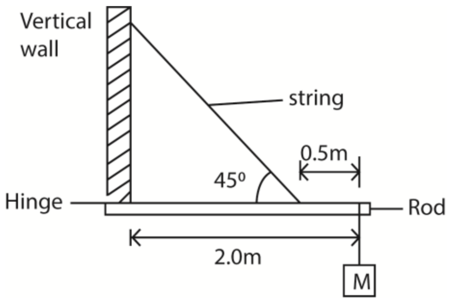
Assume where necessary

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 conservative force? (01mark)
   (ii) Give two examples of conservative forces. (01mark)
   (b) (i) State the law of conservation of mechanical energy. (01mark)
   (ii) A body of mass, m, is projected vertically upwards with speed, u. show that the low of conservation of mechanical energy is obeyed throughout its motion. (05marks)
   (iii) Sketch a graph showing variation of kinetic energy by the body with time. (01 mark)
   (c) (i) Describe an experiment to measure the coefficient of static friction. (04marks)
   (ii) State two disadvantages of friction. (01mark)
   (d) A bullet of mass 20g moving horizontally strikes and get embedded in a wooden block of mass 500g resting on a horizontal table. The block slides through a distance of 2.3m before coming to rest. If the coefficient of kinetic friction between the block and table is 0.3, calculate
   (i) friction force between the block and the table. (02marks)
   (ii) velocity of the bullet just before it strikes the block. (04marks)

2. (a) (i) State the principle of moments. (01mark)
   (ii) Define the terms centre of gravity and uniform body. (02marks)
   (b) Figure below shows a body, M of mass 20kg supported by a rod of negligible mass horizontally hinged to a vertical wall and supported by a string fixed at 0.5m from the other end of the rod.



   Calculate the
   (i) Tension in the string (03marks)
   (ii) Reaction of the hinge (03marks)
   (iii) Maximum additional mass which can be added to the mass of 20kg before the string can break given that the string cannot support a tension of more than 500N. (02marks)

   (c) (i) Define Young's modulus. (01marks)

   (ii) Explain the precautions taken in determinations of Young's modulus of a wire. (06marks)

   (iii) Explain why a piece of rubber stretches much more than a metal wire of the same length and cross section (02marks)

3. (a) State Kepler's laws of planetary motion (03marks)
   (b) (i) what is a parking orbit? (01mark)
   (ii) Derive an expression for the period, T, of a satellite in a circular orbit of radius, r, above the earth in terms of mass of earth, m, gravitational constant, G and r. (04marks)

(c) (i) A satellite of mass 200kg is launched in a circular orbit at a height of 3.59×10^7m above the earth's surface. Find the mechanical energy of the satellite. (03marks)

(ii) Explain what will happen to the satellite if its mechanical energy was reduced. (03marks)

(d) Describe laboratory method of determining the universal gravitational constant, G. (06marks)

4. (a) (i) Distinguish between surface tension and surface energy (01mark)

(ii) Show the surface energy and surface tension are numerically equal. (03marks)

(iii) Explain why water dripping out of a tap does so in spherical shapes. (03marks)

(b) Two soap bubbles of radius 2.0cm and 4.0cm respectively coalesce under isothermal conditions. If the surface tension of the soap solution is 2.5×10^{-2}Nm^{-1}, calculate the excess pressure inside the resulting soap bubble. (04marks)

(c) (i) State Bernoulli's principle (0marks)

(ii) Explain how wind at a high speed over the roof of a building can cause the roof to be ripped off the building. (03marks)

(iii) An aeroplane has a mass of 8,000kg and wing area of 8.0m^2. When moving through still air, the ratio of its velocity to that of the air above its wings is 0.25. At what velocity will the aeroplane be able to just lift off the ground? (Density of air = 1.3kgm^{-3})

SECTION B

5. (a) (i) State four desirable properties a material must have to be used as a thermometric substance. (02marks)

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

(b) With the id of diagram explain how a bolometer is used to detect thermal radiation. (06marks)

(c) Describe, with the aid of a diagram an experiment to determine specific heat of vaporization of steam using the method of mixtures. (07marks)

(d) A 600Welectricity heater is used to raise the temperature of a certain mass of water in a thermos flask from room temperature to 80^{0}C. The same temperature rise is obtained when seam from a boiler is passed into an equal mass of water at room temperature in the same time. If 16g of water were being evaporated every minute in the boiler, find the specific latent heat of vaporization of steam, assuming no heat losses. (04marks)

6. (a) Define the following

(i) Absolute zero (01marks)

(ii) Cooling correction (01marks)

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

(ii) The kinetic theory expression for the pressure, P, of ideal gas of density, ρ, and mean square speed, c^2 is $P = \rho c^2$. Use the expression to deduce Dalton's law (03marks)

(c) Explain clearly the steps taken to determine the cooling correction when measuring the specific heat capacity of a poor conductor by the method of mixtures. (07marks)

(d) The density of air at 0^{0}C and pressure of 101kPa is 1.29kgm^{-3}. Calculate pressure of 300kPa. (03marks

7. (a) Define thermal conductivity of material and state its units. (02marks)
   (b) Describe an experiment to determine the thermal conductivity of copper. (06marks)
   (c) A double glazed window has two glasses each of thickness 4.0mm separated by a layer of air of thickness 1.5mm. If the two inner air-glass surfaces have steady temperature of 20^0C and 4^0C respectively. Find the
   (i) temperatures of the outer air-glass surfaces (03marks)
   (ii) the amount of heat that flows across an area of the window of $2m^2$ in 2hours.
   [Conductivity of glass = $0.72Wm^{-1}k^{-1}$ and that of air = $0.025Wm^{-1}K^{-1}$]
   (d)(i) What is a black body? (01mark)
   (ii) Explain how a welder can protect the eyes from damage. (03marks)
   (iii) Calculate the wavelength of the radiation emitted by a black body at 6000K
   [Wen's displacement constant = 2.9×10^{-3}mK] (02marks)

SECTION C

8. (a) (i) Define Avogadro's constant and Faraday's constant. (02marks)

   (ii) Show that the charge carried by a monovalent ion is 1.6×10^{-19}C. (02marks)

   (b) With the use of a labelled diagram, describe Millikan's oil drop experiment for the determination of the charge of an electron. (07marks)

   (c) A beam of positive ions moving with velocity v enters a region of a uniform magnetic field density B with the velocity at right angles to the field B. By use of a diagram, describe the motion of ions. (03marks)

   (d) A charged oil drop of density $880kgm^{-3}$ is held stationary between two parallel plates 6.0mm apart held at a potential difference of 103V. When the electric field is switched off, the drop is observed to fall a distance of 2.0mm in 35.7s. (Viscosity of air = $1.8 \times 10^{-5}Nsm^{-2}$, Density of air = $1.29kgm^{-3}$).

   (i) Calculate the radius of the drop. (03marks)

   (ii) Estimate the number of excess electrons on the drop. (03marks)

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

   (ii) Explain briefly one application of photoelectric effect. (04marks)

   (b) In a photoelectric set up. A point source of light of power 3.2×10^{-3}W emits mono-energetic photons of energy 5.0eV. The source is located at a distance of 0.8m from the center of a stationary metallic sphere of work function 3.0eV and radius 8.0×10^{-3}m. The efficiency of photoelectron emission is one in every 10^6 incident photons.

   Calculate

   (i) Number of photoelectrons emitted per second. (04marks)
   (ii) Maximum kinetic energy in joules, the photo electrons. (02marks)

   (c) (i) State Bragg's law of X-ray diffraction (01marks)

   (ii) Show that density, ρ, of a crystal can be given by

$$\rho = \frac{M\sin^3\theta}{125N_A(n\lambda)^3}$$

where θ is the glancing angle, n, is the order of diffraction, λ is the X-ray wavelength and M is the molecular weight of the crystal. (05marks)

10. (a) With reference to a Geiger-Muller tube, define the following

(i) quenching agent (01mark)

(ii) back ground count rate (01mark)

(b) (i) With the aid of a labelled diagram, describe the operation of a Geiger-Muller (GM) tube (06marks)

(ii) Explain how the half-life of a short lived radioactive source can be obtained by use of a Geiger-Muller tube. (04marks)

(c) A radioactive isotope ${}^{32}_{15}P$ which has a half-life of 14.3days, disintegrates to form a stable product. A sample of the isotope is prepared with initial activity of 2.0 x $10^6 s^{-1}$. Calculate the

(i) the number of ${}^{32}P$ atoms present (03marks)

(ii) activity after 30days (03marks)

(iii) number of ${}^{32}P$ atoms after 30 days (02marks)

(Assume $N = N_0 e^{-\lambda t}$)

Compiled by Dr. Bbosa Science