UACE Physics paper 1 set 8 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 Hooke's law. (01mark)
   (b) A copper wire is stretched until it breaks.
   (i) Sketch a stress- strain graph for the wire and explain the main features of the graph. (04marks)
   (ii) Explain what happens to the energy used to stretch the wire at each stage. (04marks)
   (iii)Derive the expression for the work done to stretch a spring of force constant, k, by a distance, 2. (03marks)
   (c)(i) Define Young's Modulus. (01mark)
   (ii) Two identical steel bars A and B of radius2.0mm are suspended from the ceiling. A mass of 2.0kg is attached to the free end of bar A. Calculate the temperature to which B should be raised so that the bars are again equal in length.
   [Young's Modulus of steel = $1.0 \times 10^{11} Nm^{-2}$)
   [Linear expansivity of steal = $1.2 \times 10^{-5} K^{-1}$] (05mark)
   (d) Why does an iron roof make cracking sound at night? (02marks)
2. (a) Define the following terms as applied to oscillatory motion
   (i) Amplitude (01mark)
   (ii) Period (01mark)

   (b) State four characteristics of simple harmonic motion. (02marks)

   (c) A mass, m is suspended from a rigid support by a straight string of length L. the mass is pulled aside so that the string makes an angle, θ, with the vertical and then released.

   (i) Show that the mass executes simple harmonic motion with a period T =$2\pi\sqrt{\frac{L}{g}}$.

   (ii) Explain why this mass comes to a stop after a short time. (02marks)

   (d) A piston in a car engine performs a simple harmonic motion of frequency 12.5Hz. If the mass of the piston is 0.50kg and its amplitude of vibration is 45mm, find the maximum force on the piston. (03marks)

   (e) Describe an experiment to determine the acceleration due to gravity, g, using a spiral spring, of known constant. (06marks)

3. (a) Explain what is meant by centripetal force. (02marks)
   (b)(i) Derive an expression for centripetal force acting on a body of mass, M, moving in a circular path of radius, r. (06marks)
   (ii) A body moving in a circular path of radius 0.5m makes 40 revolutions per second. Find the centripetal force if the mass is 1kg (03marks)
   (c) Explain the following
   (i) A mass attached to a string rotating at constant speed in a horizontal circle will fly off at a tangent of the string breaks. (02marks)
   (ii) A cosmonaut in a satellite which is in a free circular orbit around the earth experiences the sensation of weightlessness even though there is influence of gravitational field on earth. (03marks)

(d) (i) Derive an expression for maximum horizontal distance travelled by a projectile in terms of the initial speed, u, and the angle of projection, θ, to the horizontal. (02marks)

(ii) Sketch a graph to show the relationship between kinetic energy and height above the ground in a projectile. (02marks)

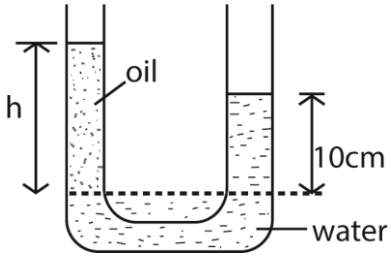
4. (a)(i) What is meant by the following terms, steady flow and viscosity? (02marks)

(ii) Explain the effect of increase in temperature on viscosity of a liquid. (03marks)

(b) (i) Show that the pressure, P, exerted at a depth, h, below the free surface of a liquid of density, ρ, is given by P =hρg. (03marks)

(ii) Define relative density. (01mark)

(iii) A U-tube whose ends are open to atmosphere, contains water and oil as shown in the figure below



Given the density of oil is 300kgm-3, find the value of h.

(c) A metal ball of diameter 10mm is timed as it falls through oil at a steady speed. It takes 0.5s to fall through a vertical distance of 0.3m. Assuming that the density of metal is 7500kgm^{-3} and that of oil is 900kgm^{-3}, find

(i) the weight of the ball (02marks)

(ii) the up thrust on the ball (02marks)

(iii) the coefficient of viscosity of the oil (03marks)

[Assume the viscous force = $6\pi\eta r v_0$ where η is the coefficient of viscosity, r is the radius of the ball, v_0 is the terminal velocity]

SECTION B

5. (a)(i) Define the terms specific heat capacity and specific latent heat of fusion (02marks)

(ii) Explain the changes that take place in the molecular structure of substances during fusion and evaporation (04marks)

(b) With the aid of a labelled diagram describe an experiment to determine the specific heat capacity of a liquid using the continuous flow method. (08marks)

(c) Steam at 100^{0}C is passed into a copper calorimeter of mass 150g containing 340g of water at 15^{0}C. This is done until the temperature of the calorimeter and its content is 71^{0}C. If the mass of the calorimeter and its content is found to be 525g, calculate the specific latent heat of vaporization of water. (06marks)

6. (a) (i) Define saturated vapour pressure. (01mark)

(ii) Describe with the aid of a diagram, how saturated vapour pressure of a liquid can be determined at a given temperature. (06marks)

(b) Use the kinetic theory 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 pressure. (03marks)

(c) When hydrogen gas is collected over water, the pressure in the tube at 15^0C and 75^0C are 65.5cm and 105.6cm of mercury respectively. If the saturated vapour pressure at 15^0C is 1.42cm of mercury, find its value at 75^0C (04marks)

(d) Explain why the molar heat capacity of an ideal gas at constant pressure differs from the molar heat capacity at constant volume (03marks)

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

(ii) Compare the mechanism of heat transfer in poor conductor and good conductor. (05marks)

(b) Describe, with the aid of a diagram how you would measure the thermal conductivity of a poor conductor, stating the necessary precautions (08marks)

(c) A cylindrical iron vessel with a base of diameter 15cm and thickness 0.30cm has its base coated with a thin film of soot of thickness 0.10cm. It is then filled with water at 100^0C and placed on a large block of ice at 0^0C. Calculate the initial rate at which the ice will melt (06marks) (thermal conductivity of soot=0.12$Wm^{-1}K^{-1}$

SECTION C

8. (a) (i) What are cathode rays?

(ii) With the aid of a diagram, describe an experiment to show that cathode rays travel in straight line (04mrks)

(b) A beam of electrons is accelerated through a potential difference of 500V. The beam enters midway between two similar parallel plates of length 10cm and are 3cm apart. If the potential difference across the plates is 600V, find the velocity of an electron as it leaves the region between the plates. (08marks)

(c) State the laws of photoelectric emission (04marks)

(d) Explain how line emission spectra are produced. (03marks)

9. (a) (i) what is meant by terms: radioactive decay, half-life and decay constant? (03marks)

(ii) show that the half-life, $t_{\frac{1}{2}}$ of a radioactive isotope is given by $t_{1/2} = \frac{0.693}{\lambda}$ where λ is the decay constant

(Assume the decay law $N = N_0e^{-\lambda t}$)

(b) With the aid of a labelled diagram, describe the structure and action of a cloud chamber (05marks)

(c) A radioactive isotope $^{99}_{43}X$ decays by emission of a gamma ray. The half-life of the isotope is 360minutes. What is the activity of 1mg of the isotope? (06marks)

(d) Explain the term avalanche as applied to an ionization chamber. (03marks)

10. (a) Define the terms below as applied to a triode

(i) space charge (01mark)

(ii) Amplification factor (01mark)

(i) Mutual conductance (01mark)

(b) With the aid of a labelled diagram explain full wave rectification. (07marks)

(c) Derive an expression for the amplification factor, μ, in terms of anode resistance, R_a and mutual conductance, g_m, for a triode valve. (03marks)

(d) A triode with mutual conductance $3mAV^{-1}$ and anode resistance of $10k\Omega$ is connected to a load resistance of $20k\Omega$, Calculate the amplitude of output signal, if the input signal is 25mV. (04marks)

(e) (i) Sketch the output characteristics of a transistor. (02marks)

(ii) Identify on the sketch in (e)(i), the region over which the transistor can be used as amplifier. (01).

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