UACE Physics paper 1 set 1 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

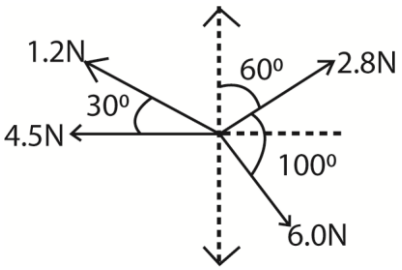
Acceleration due to gravity, g	$9.81ms^{-2}$
Electron charge, e	$1.6 x10^{-19}C$
Electron mass	$9.11 x 10^{-31}kg$
Mass of the earth	$5.97 x 10^{24}kg$
Plank's constant, h	$6.6 x 10^{-34}Js$
Stefan's-Boltzmann's constant, σ	$5.67 x 10^{-8}Wm^{-2}K^{-1}$
Radius of the earth	6.4 x 106m
Radius of the sun	$7 x 10^{8}m$
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) Distinguish between scalar and vector quantity. (01 mark)

   (ii) Give two examples of each type of quantity. (02marks)

   (b) A body of mass 0.2kg at rest is acted on by four forces of 2.8N, 6.0N, 4.5N and 1.2N as shown in the figure below.



   Calculate

   (i) Resultant force on the body (04marks)
   (ii) Distance moved in 4s (02marks)

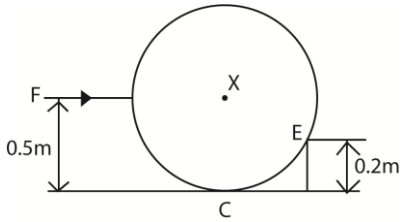
   (c) State Newton's law of motion and use them to derive the law of conservation of momentum. (06marks)

   (d) A body of mass 800kg moving at $30ms^{-1}$ collides with another of mass 400kg moving in the same direction at $25ms^{-1}$. The two bodies stick together after collision. Calculate the

   (i) common velocity just after collision (02marks)

   (ii) kinetic energy lost during collision (03marks)

2. (a) Define moment of force and give its SI unit. (02marks)
   (b) Explain briefly how to locate the centre of gravity of an irregular sheet of cardboard. (04marks)
   (c) State the conditions necessary for equilibrium of a rigid body under action of a system of forces. (02marks)
   (d) A wheel of radius 0.5m rests on a level surface at point C and makes contact with edge E of a block height 0.2m as shown in the figure below.



   A force F is applied horizontally through the axle of the wheel at X to just move the wheel over the block. If the weight of the wheel is 180N, find the

   (i) Force exerted at point E (02marks)
   (ii) Force F (04marks)

   (e) State the laws of friction and explain each of them (06marks)

3. (a) Define the following as applied to circular motion:
   (i) Centripetal acceleration (01mark)
   (ii) Period (01mark)

   (b) (i) Explain why a cyclist bends inward while going round a curved path. (03marks)

   (ii) Show that if θ is the angle of inclination of the cyclist to the vertical and μ is the coefficient of limiting friction between the ground and the bicycle tyres, then for safe riding $\tan\theta \leq \mu$. (04marks)

   (iii) A body of mass 1.5kg moves once round a circular path to cover 44.0cm in 5s. Calculate the centripetal force acting on the body. (04marks)

   (c) Define simple harmonic motion (01mark)

   (d) A body executes simple harmonic motion with amplitude A and angular velocity, ω.

   (i) Write down the equation for velocity of the body at a displacement x from the mean position (01mark)

   (ii) Sketch the velocity-displacement graph for the body in (d)(i) for $\omega < 1$. (02marks

   (iii) If the body moves with amplitude 14.142 cm, at what distance from the mean position will be kinetic energy equal to potential energy? (03marks)
4. (a) State and illustrate Archimedes' principle. (05marks)
   (b)(i) State the law of flotation (01 marks)
   (ii) Describe an experiment to verify the law in (b)(i). (05marks)
   (c) (i) Write Bernoulli's equation and define each term in the equation. (02marks)
   (ii) Explain the origin of lift force on the wings of a plane. (03marks)

   (iii) Air flows over the upper surfaces of the wings of an aeroplane at a speed of $120ms^{-1}$, and past the lower surface of the wings at $110ms^{-1}$.Calclate the lift force on the aeroplane if it has a total wing area of $20m^2$. Density of air = $1.29kgm^{-3}$)

SECTION B

5. (a) (i) State any three properties of ultraviolet radiation.(03marks)
   (ii) What is a black body? (01mark)
   (b) A cylindrical metal rod with a well- insulated curved surface has one end blackened and then exposed to thermal radiation from a body at a temperature 500K. If the equilibrium temperature of the blackened end is 400K and the length of the rod is 10cm, calculate the temperature of the other end. [Thermal conductivity of the metal = $500Wm^{-1}K^{-1}$] (04marks)
   (c) (i) Describe Electrical method of determining the specific heat capacity of a good conducting solid. (06marks)
   (ii) Give two reasons why the value obtained using the method in (c)(i) may not be accurate. (02marks)
   (d) Explain why cloudy nights are warmer than cloudless ones.
6. (a)(i) What is meant by a reversible process? (02marks)

(ii) Distinguish between a saturated vapour and unsaturated vapour. (02marks)

(iii) Explain why evaporation causes cooling(03marks)

(b) Describe an experiment to determine the temperature dependence of saturated vapour pressure of water. (07marks)

(c) (i) State Dalton's law of partial pressures. (07marks)

(ii) A sealed container has liquid water, water vapour and air all at 27^0C. The total pressure inside the container is 69cmHg. When the temperature is raised to 85^0C, the total pressure changes to 96cmHg. If the saturated vapour pressure of water at 27^0C is 5cmHg and water vapour remains saturated, calculate the saturated vapour pressure of water at 85^0C. (05marks)

7. (a) Define the following:

(i) Thermal conductivity. (01marks)

(ii) Specific latent heat of vaporization. (01mark)

(b) A boiler with a base made of rod steel 15cm thick, rests on a hot stove. The area of the bottom of the boiler is 1.5×10^3 cm^2. The water inside the boiler is at 100^0C. If 750g of water is evaporated every 5 minutes, find the temperature of the surface of the boiler in contact with the stove. [Thermal conductivity of steel = 50.2Wm^{-1}K^{-1}, specific latent heat of vaporization of water = 2.26×10^6Jkg^{-1}]

(c) Hot water in a metal tank is kept constant at 65^0C by an immersion heater in the water. The tank has lagging all around it of thickness 20mm and thermal conductivity0.04Wm^{-1}K^{-1} and its surface area is 0.5m^2. The heat lost per second by the lagging is 0.8W per degree excess above the surroundings. Calculate the power of immersion heater if the temperature of the surroundings is 15^0C. (05marks)

(d)(i) Define thermometric property (01mark)

(ii) Define how a liquid-in-glass thermometer can be used to measure temperature in degrees Celsius. (04marks)

(iii) A thermometer is constructed with a liquid which expands according to relation. $V_t = V_0(1 + \alpha t + \beta t^2)$. Where V_t is the volume at t^0C and V_0 is the volume at 0^0C on the scale of the gas thermometer and α and β are constants.
Given that $\alpha = 1000\beta$, what will the liquid thermometer read when the gas thermometer reads 50^0C.

SECTION C

8. (a) (i) What are cathode rays? (01marks)

(ii) State two properties of cathode rays (01mark)

(iii) Explain two disadvantages of using the discharge tube in producing cathode rays. (02marks)

(b) With the aid of a diagram, describe Millikan's experiment to determine the charge on an oil drop (07marks)

(c) A beam of electrons is accelerated through a potential difference of 1.98kV and directed mid-way between two horizontal plates of length 4.8cm and separated by a distance of 2.0cm. the potential difference applied across the plates is 80.0V.

(i) Calculate the speed of the electrons 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)(i) what is meant by thermionic emission? (01marks)

(ii) Describe how full-wave rectification of a.c can be achieved using four semiconductor diodes. (04marks)

(b) (i) Draw a labelled diagram to show the main parts of a cathode ray oscilloscope (C.R.O) (03marks)

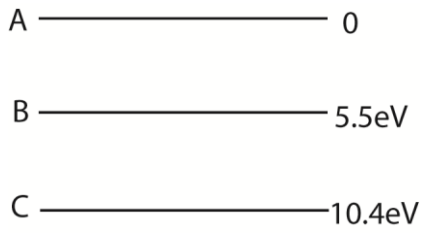
(ii) Describe how a C.R.O can be used as an a.c voltmeter. (02marks)

(c) (i) an electron of charge –e and mass m moves in circular orbit round a central hydrogen nucleus of charge +e. Derive an expression for total energy of electron in an orbit of radius r. (05 marks)

(ii) Why is this energy always negative (01marks)

(d) (i) what is meant by excitation potential of an atom? (01marks)

(ii) Some of the energy levels in mercury spectrum are shown in the figure below.



Calculate the wavelength of the radiation emitted when electron makes a transition from level A to level C. (03marks)

10. (a) What is meant by the following as applied to radioactivity?

(i) Activity (01marks)

(ii) Half-life of a radioactive material (01marks)

(b) Using the radioactive decay law $N = N_0 e^{-\lambda t}$, show that the half-life $T_{\frac{1}{2}} = \frac{1}{\lambda}$ (02marks)

(c) With the aid of a labelled diagram, describe the action of an ionization chamber. (05marks)

(d) What is meant by unified atomic unit and electron volt. (02marks)

(e) (i) The nucleus $^{212}_{83}Bi$ decays by alpha emission as follows

$$^{212}_{83}Bi \rightarrow {}^{208}_{81}Tl + {}^{4}_{2}He$$

Calculate the energy released by 2g of $^{212}_{83}Bi$. (05marks)

(ii) Explain two uses of radioactive isotopes. (04marks)