HONG KONG ADVANCED LEVEL EXAMINATION
AL PHYSICS
1989 Essay Type Question

1. (a) State the main assumptions of the kinetic theory as applied to an ideal gas, briefly explaining the pressure exerted by a gas on its container (no mathematical derivation expected). (5 marks)

   (b) Point out the main observed differences in the behaviour of real gases compared with an ideal gas, giving explanations, using p-V characteristics. Comment on the differences in behaviour at high pressures and low temperatures. (7 marks)

   (c) Distinguish between the processes of evaporation and boiling for a liquid, with reference to unsaturated and saturated vapours. (4 marks)

2. (a) Discuss qualitatively the motion of a small metal ball allowed to drop downwards into a long vertical tube of liquid so that it moves along the axis of the tube (radius of tube >> radius of ball). (3 marks)

   (b) Derive Bernoulli's equation,

   $$P + h\rho g + \tfrac{1}{2}\rho v^2 = \text{a constant}$$

   for the flow of a fluid through a tube of varying cross-sectional area. Clearly explain all the physical parameters used in this equation. (6 marks)

   (c) In practice, discuss the likely sources of error in applying Bernoulli's equation to the flow of

   (i) liquids, and

   (ii) gases

   in tubes. (3 marks)

3. (a) Describe the main characteristics of light when considered as

   (i) a wave propagation, and

   (ii) moving particles.

   (5 marks)

   (b) Give a brief account of an experiment which illustrates the wave nature of light AND a second experiment which illustrates its particle nature (no mathematical derivations expected). (9 marks)

   (c) Explain how it is possible to reconcile the wave/particle nature of electrons. (2 marks)

4. (a) Give the theory of the production of an a.c. voltage by a plane coil rotating in a uniform magnetic field, identifying the maximum and zero voltages with the positions of the coil. (5 marks)

   (b) Draw a diagram of the circuit of a d.c. power pack used for generating a variable d.c. voltage from the a.c. mains, giving rough values for any inductors, capacitors and resistors used. (3 marks)

   (c) With reference to your circuit in (b), briefly explain the physical principles involved in

   (i) the transformer (working under ideal conditions),

   (ii) the full-wave rectification process, and

   (iii) the filter.

   For (iii) explain your choice of the values of any inductances, capacitances and resistances. (8 marks)

5. (a) Radioactive elements occur in nature. Summarise their unique characteristics, including how their activity decays. (4 marks)

   (b) Describe an experiment, performable in a school laboratory, to measure a radioactive half-life. (8 marks)

   (c) Explain the method of archeological dating using carbon-14. (4 marks)

6. (a) Derive, from first principles, expressions for the energies stored by

      (i) a pure capacitor of capacitance C charged by a voltage V_0, and

      (ii) a pure inductor of inductance L through which a current I_0 flows.
      (5 marks)

   (b) The charged capacitor in (a)(i) is isolated and then connected across the inductor in (a)(ii). Show that the charge on the capacitor varies with subsequent time t as $Q = Q_0 \cos \omega_0 t$, and obtain a value for ω_0. (4 marks)

   (c) Draw a phasor diagram for a series LCR circuit connected across a signal generator of voltage $V = V_0 \cos \omega t$. Derive the condition for the maximum stored energies of the inductor and the capacitor to be the same. (5 marks)

   (d) With reference to the stored energies, compare the two physical situations described in parts (b) and (c). (2 marks)

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