HONG KONG ADVANCED LEVEL EXAMINATION
AL PHYSICS
1983 Essay Type Question

1. (a) Explain why the speed of travel of a gas odour (smell) across a room is very slow compared with the actual speeds of the gas molecules.

   (b) Briefly describe an experimental arrangement for measuring the rate of diffusion of bromine.

   (c) Given a knowledge of the r.m.s. molecular speed and the known rate of diffusion of bromine, show that it is possible to obtain estimates of

      (i) the mean free path of the molecules (random walk statistical rule to be assumed), and

      (ii) the size of the molecules, taking into consideration a typical volume change from liquid to gas.

   (d) Briefly explain how the separation of the ^{235}U and ^{238}U isotopes of uranium may be accomplished.

2. Describe briefly the methods adopted in the measurement of

   (a) a steady magnetic field using a Hall probe, and

   (b) an alternating magnetic field using a search coil.

   Compare the different physical mechanisms in these tow methods and derive any necessary mathematical expressions.

   Comment briefly on the main factors that might affect the accuracy of the measurements.

3. (a) Explain qualitatively, in terms of energy, what is meant by ‘force vibrations’ (oscillations) and ‘resonance’ in physical systems.

   (b) Give one example each of ‘resonance’ for the following types of system:

   (i) mechanical,

   (ii) acoustical,

   (iii) electrical, and

   (iv) atomic.

   For each of the examples you have chosen, explain clearly and concisely the factors affecting the resonant frequency and the sharpness of the frequency response. Mathematical derivations are not expected.

4. (a) By considering one practical example of each of the following phenomena:

   (i) the refraction of light, and

   (ii) the interference of light,

   show how these phenomena can be explained by assuming that light possesses a wavelike nature.

   (Note: No mathematical derivations are needed for (ii).)

   (b) Under certain experimental conditions, it is found necessary to assume that light possesses a particle-type, rather than a wave-like nature. Briefly describe such an experiment and explain how the results lead to this conclusion.

   (c) In some cases, wave-like properties have been observed for matter: such as in the diffraction of moving electrons. How may the wave and particle theories be reconciled in this particular case?

5. Describe the working principles of a moving coil type of

   (a) microphone, and

   (b) loudspeaker.

   For each example explain, with the aid of a diagram, the basic construction. You should indicate on your diagrams the directions of the corresponding sound vibrations and the flow of electric currents at a particular instant. Briefly suggest possible reasons for the reproduced sounds being different from the original sounds when such devices are used.

6. (a) A battery of e.m.f. E and negligible internal resistance is connected in series with a resistor of resistance R, a capacitor of capacitance C and an open switch. After the switch is closed, derive expressions for

      (i) the total work done in charging up the capacitor, and

      (ii) the total energy dissipated in the resistor, using the expression for instantaneous Joule heating.

      Discuss these results in relation to the total energy delivered by the battery.

   (b) The battery is now replaced by an a.c. source of voltage $E = E_0 \sin \omega t$, ω being the angular frequency and t the time. With the switch closed, and making the assumption that $\omega CR << 1$, determine expressions for the current I, and the power P delivered to the circuit at any instant. Sketch the time variations of E, I and P. Comment on the result for P.

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