M.57

LEAVING CERTIFICATE EXAMINATION, 1970

PHYSICS – HONOURS

WEDNESDAY, 17th JUNE – MORNING, 9.30 to 12

Six questions to be answered.

Take the velocity of light c = 3×10^8 metres per second = 3×10^{10} cm per second.

1. Define energy. Show that when a body is falling freely under gravity the loss in potential energy is equal to the gain in kinetic energy.
A mass of 2 kg suspended vertically by a thin wire is drawn aside to a vertical height of 10 cm above its initial level. If the mass is then released find the kinetic energy, velocity and momentum of the mass at its lowest point.
If at this point the mass coalesces with a mass of 6 kg which is at rest and both move together, calculate the initial velocity of the combined masses.
(Take g = 9·8 metres per second^2 = 980 cm per second^2.)

(66 marks)

2. Describe a constant volume gas thermometer and state how temperature is defined on the scale of this type of thermometer.
"The constant volume gas thermometer is the basic thermometer from which other thermometers are calibrated." Discuss.
Use the kinetic theory to explain why the temperature of a gas rises when the gas is compressed.

(66 marks)

3. Outline a terrestrial method of measuring the velocity of light in air.
Explain why the determination of the velocity of light in air and in other media provided such significant information regarding the nature of light.
Define critical angle. Calculate the velocity of light in water given that the critical angle for water is 49°. (Take sin 49° = 0·75)

(66 marks)

4. Explain the terms dispersion of light, diffraction of light, monochromatic light.
Compare the spectral patterns obtained when a narrow beam of white light passes through (i) a prism, (ii) a diffraction grating.
Describe an experiment to measure the wavelength of monochromatic light.
Which of the following correspond to the wavelength range of visible light, of ultra-violet light, of infrared light:
$10^{-4} - 10^{-1}$ cm, $10^{-6} - 4 \times 10^{-5}$ cm, $4 \times 10^{-5} - 7 \times 10^{-5}$ cm ?

(66 marks)

5. What is a photon ? Write down the relation between the frequency of the light radiation falling on the surface of a metal, the energy of the ejected photoelectrons and the work function of the metal (i.e. the minimum energy required to release an electron from the surface).
How does (i) the energy, (ii) the rate of emission, of photoelectrons depend on the wavelength and intensity of the incident light ?
Light of wavelength 2000Å falls on the surface of a metal. If the work function of the metal is 4·00 electron-volts calculate the retarding potential difference required to stop the emission of photoelectrons.
(Take h = $6{\cdot}6 \times 10^{-34}$ joule second = $6{\cdot}6 \times 10^{-27}$ erg second; 1Å = 10^{-10} metre = 10^{-8} cm;
1 electron-volt = $1{\cdot}6 \times 10^{-19}$ joule = $1{\cdot}6 \times 10^{-12}$ erg)

(66 marks)

6. Describe briefly (a) an experiment to show that a current-carrying conductor experiences a force in a magnetic field, (b) an experiment to show the production of an induced current by electromagnetic induction.
Draw a clearly labelled diagram (i) of a moving-coil galvanometer, (ii) of a simple alternating current generator.
Why is the scale in (i) uniform (linear) ? How may the e.m.f. in (ii) be increased ?

(66 marks)

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7. Describe (i) an experiment to compare the magnetic moments of two bar magnets, (ii) an experiment to measure the internal resistance of a cell.
Give the theory underlying the experiment in (i) or (ii).

(67 marks)

8. Give a concise account, with the aid of a diagram, of the production of X-rays. In what way do X-rays differ in origin from the optical spectra of the elements ?
Compare X-rays with gamma rays. Discuss the ionisation of gases by these radiations and state how it may be demonstrated. What limits the penetrating power of these radiations ?

(67 marks)

9. What are protons, neutrons, alpha particles ? Indicate how they may be used as bombarding agents for the transmutation of elements and comment on their relative suitability.
How was the neutron discovered ?
The following nuclear reaction illustrates the neutron bombardment of a heavy nucleus, uranium; two of the fragment nuclei produced in the reaction being xenon and strontium:

$$_{92}U^{235} + {}_{0}n^{1} = {}_{54}Xe^{140} + {}_{38}Sr^{94} + 2{}_{0}n^{1} + \text{energy}$$

Discuss the nature and significance of this reaction and state how the energy released may be estimated by applying the principle of mass-energy conservation.

(67 marks)

$C = \frac{Q}{Vol.}$

10. Answer any two of the following:

(a) Define capacitance.
A parallel-plate air capacitor (condenser) consists of two square plates of side 10 cm and 4 mm apart. Calculate the energy of the capacitor when the difference of potential between the plates is 200 volts. [In the c.g.s. system take 300 volts = 1 e.s.u., in the M.K.S. system take ϵ_0 (permittivity of free space) = 9×10^{-12} farad per metre].

(b) State Ohm's law.
Why is it incorrect to use a moving coil voltmeter when verifying this law and what instrument should be used instead ?
Mention some conducting media which do not obey Ohm's law.

(c) Compare sound and light with regard to transmission, reflection and refraction.

(d) What is meant by saying force is a vector ?
Define moment of a force, equilibrium. State the conditions of equilibrium of a rigid body under the action of coplanar forces.

(67 marks)