LEAVING CERTIFICATE EXAMINATION, 1966

PHYSICS—HONOURS

WEDNESDAY, 15th JUNE—MORNING, 10 to 12.30

Not more than six questions to be attempted.

1. Define momentum.
State Newton's second law of motion and show how a quantitative definition of force may be deduced from the law.
A mass of 4 lb., travelling vertically downwards at 20 ft. per sec., strikes a mass of 6 lb. which is at rest on the ground. The masses coalesce and the combined mass penetrates the ground which offers an average total resistance of 16 lb. wt. to its motion. Calculate (i) the retardation experienced by the combined mass, (ii) the distance the combined mass penetrates the ground.

(66 marks)

2. (a) Compare and contrast a liquid-in-glass thermometer, e.g. a mercury thermometer, with a gas thermometer, under the following headings: (i) scale of temperature and fixed points, (ii) temperature definition, (iii) range of temperature.
(b) State, on the basis of the kinetic theory, the relation between the mean kinetic energy of the molecules of a gas and the absolute temperature of the gas. Hence, show that $\frac{PV}{T}$ = constant.

(66 marks)

3. Show how the refraction of light may be explained in terms of (i) the corpuscular theory, (ii) the wave theory. What experimental evidence supports the explanation in (ii) ?
Describe fully an experiment to measure the refractive index of water relative to air.

(66 marks)

4. Describe an experiment to illustrate (i) the transverse nature of light waves, (ii) the interference of light waves.
What conditions must be fulfilled in order that interference of light waves may occur ?
In Young's interference experiment two narrow slits 1 mm. apart are illuminated by monochromatic light. The distance between the 1st and the 11th fringe, formed on a screen placed 50 cm. from the slits, is 0·3 cm. Calculate the wavelength of the light.

(66 marks)

OR

4. Distinguish between a real and a virtual image.
Show, by means of ray-diagrams, how a real and also a virtual image of an object may be formed by (i) a concave mirror, (ii) a convex lens.
Establish a formula for the focal length of a concave mirror in terms of u, v, where u and v represent the distances of the object and image, respectively, from the mirror.
At what distance from a concave mirror of focal length 16 cm. will (a) a real image, (b) a virtual image, be formed, the image in each case being four times the size of the object.

(66 marks)

5. How are photoelectrons produced ? Describe, with the aid of a diagram, a photoelectric cell.
What conclusions regarding the nature of light may be drawn from the photoelectric equation $h\nu = \frac{1}{2}mv^2 + w$ (where h = Planck's constant, ν = the frequency of the incident light, m and v represent the mass and velocity, respectively, of the emitted electron, w = the work function of the metal i.e. the minimum energy required to free an electron from a metal surface) ?
Calculate the maximum energy of the photoelectrons emitted from a metal surface when irradiated with ultraviolet light of wavelength 2000 Å. The work function of the metal is 2·26 eV. (Take $h = 6{\cdot}62 \times 10^{-34}$ joule-sec; $1\,eV = 1{\cdot}6 \times 10^{-19}$ joule; $1\text{Å} = 10^{-10}$ metre, velocity of light = 3×10^8 metres per sec.)

(66 marks)

OR

5. Define magnetic moment of a bar magnet.
Deduce an expression for the intensity of the magnetic field due to a short bar magnet at a point on (i) the axis of the magnet produced, (ii) the perpendicular bisector of the axis of the magnet.
Hence or otherwise, show how the inverse square law of force between magnetic poles may be verified by experiment.

(66 marks)

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6. Give an account, with the aid of a diagram, of a method of producing cathode rays. Hence, show how X-rays are produced.

Write a note on (i) the nature of X-rays, (ii) the effect of X-rays on gases.

Name three other radiations similar in nature to X-rays. Show on a diagram the position of each of these radiations, and also the position of X-rays, in the electromagnetic spectrum.

(66 marks)

OR

6. (a) Describe an experiment (e.g. Faraday's ice-pail experiment) to show that the induced charge is equal and opposite to the inducing charge.

(b) Deduce the expression $\frac{A}{4\pi d}$ (C.G.S. system) or $\frac{\varepsilon_o A}{d}$ (M.K.S. system) for the capacitance (capacity) of a parallel plate air condenser, where A is the area of the insulated plate, d is the distance between the plates, ε_o is the permittivity of free space.

A condenser consists of two parallel plates each of area 400 sq. cm. placed 1 mm. apart in air. If the difference of potential between the plates is 600 volts, find the charge on each plate.
(In the C.G.S. system 300 volts = 1 e.s.u.; in the M.K.S. system $\varepsilon_o = 8.85 \times 10^{-12}$.)

(66 marks)

7. Describe briefly a method of measuring the electrical resistance of a given piece of wire. On what factors does the resistance of the wire depend ?

Derive an expression for the resistance R which is equivalent to two resistances r_1 and r_2 connected in parallel.

A battery consists of 4 cells, each of E.M.F. 1·5 volts and each of internal resistance 0·5 ohm, joined in series. If two resistances, of 3 ohms and 6 ohms respectively, are connected in parallel to the terminals of the battery, calculate (i) the current flowing through the 3 ohms resistance, (ii) the heat developed in the 3 ohms resistance in $\frac{1}{2}$ minute.

(J = 4·2 joules per calorie)

(67 marks)

OR

7. Write a note on the nature and properties of alpha particles, protons and neutrons.

"When a radioactive isotope of phosphorus, atomic mass 32 and atomic number 15 is bombarded with neutrons it disintegrates with the emission of beta particles. The half-life period of this isotope is 14·3 days." Explain the meaning of the underlined terms in the above statement.

How may radiations emitted from radioactive substances be detected or observed ?

(67 marks)

8. Describe experiments to show (i) that a force is exerted on a current-carrying conductor in a magnetic field (ii) the production of current in a closed circuit by electromagnetic induction.

Draw a labelled diagram of a moving-coil ammeter and of an induction coil and show how the operation of either one of them is based on (i) or (ii) above.

(67 marks)

9. Describe and explain what happens when an electric current is passed through (i) a solution of copper sulphate using copper electrodes, (ii) acidulated water using platinum electrodes.

Outline how the ratio of the charge of the hydrogen ion to its mass has been measured.

Discuss the relation between the current and the potential difference between the electrodes in (i) and (ii) above.

(67 marks)

10. Write brief notes on any two of the following:-

(a) wave motion and the wave nature of sound,
(b) the dispersion of light and spectra,
(c) the measurement of alternating current,
(d) the Compton effect and pair production.

(67 marks)