AN ROINN OIDEACHAIS

LEAVING CERTIFICATE EXAMINATION, 1975

PHYSICS—HIGHER LEVEL

TUESDAY, 24 JUNE—MORNING, 9.30 to 12.15

Any **six** questions to be answered.

All the questions carry the same marks.

---

1. Answer *eleven* of the following items (*a*), (*b*), (*c*), ... etc. All the items carry the same marks. *Keep your answers short.*

(*a*) What is meant by a vector quantity? Give an example.

(*b*) A particle is projected vertically upwards. What must the initial velocity of the particle be if it is to rise to a height of $2g$ metres, where g metres per second^2 is the acceleration due to gravity?

(*c*) Write down an expression for Newton's law of gravitation.

(*d*) A car of mass 1500 kg travels round a circular track at 20 m s^{-1}. If the radius of the track is 150 metres find the centripetal force.

(*e*) What is meant by an ideal (perfect) gas?

(*f*) How is temperature interpreted in terms of the kinetic theory of gases?

(*g*) Fig. I shows a ray of light travelling from air to glass. Write down the relation between the velocities v_1, v_2 and the angles i, r.

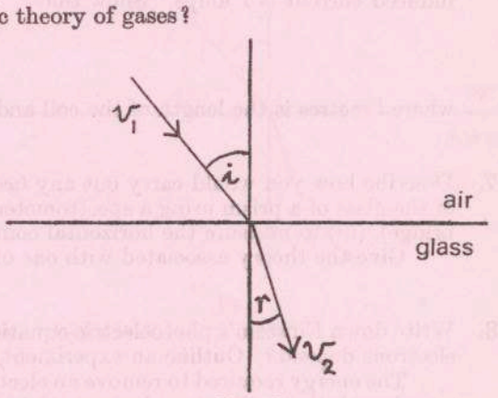

FIG. I

(*h*) In what way does the eye differ from the camera with regard to the focussing of an image?

(*i*) What is the difference between transverse and longitudinal waves?

(*j*) On what does (i) the pitch, (ii) the loudness, of a musical note depend?

(*k*) State the basic principle of moving-coil meters.

(*l*) A cell of e.m.f. 2 volts is connected across a resistor of 1·9 ohms. If the current through the resistor is 1 amp what is the internal resistance of the cell?

(*m*) Why is a potentiometer superior to a moving-coil voltmeter for measuring the e.m.f. of a cell?

(*n*) In fig. II G is a moving-coil galvanometer connected to a high resistance. What is the function of the resistance?

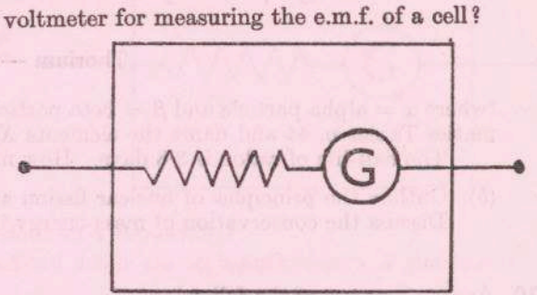

FIG. II

(*o*) When would a magnetic field not deflect an electron beam?

(*p*) What is the nature of X-rays? Give the order of magnitude of the wavelength of X-rays.

2. Define kinetic energy, work, momentum.

Show that the work done on a moving body is equal to the change in its kinetic energy.

An alpha particle of mass M_1 kg is ejected from the nucleus of an atom with a velocity of v m s^{-1}. On the assumption that the atom is initially at rest find the speed with which the resulting nucleus of mass M_2 kg recoils. If E_1 and E_2 are the kinetic energies of the alpha particle and the resulting nucleus, respectively, show that

$$\frac{E_1}{E_2} = \frac{M_2}{M_1}$$

Immediately after its ejection the alpha particle is brought to rest in a distance d metres by a constant force P newtons. Show that

$$d = \frac{M_1 v^2}{2P}$$

3. (i) Describe a method of measuring the wavelength of monochromatic light.

(ii) A beam of monochromatic light of wavelength 500 nm (1 nm $= 10^{-9}$ m) is incident normally on a diffraction grating that has 6000 lines per cm. A screen is placed 0·4 m from the grating. Find the distance of the second order image from the central image. (Take $\tan\theta = \sin\theta$).

(iii) Distinguish between continuous, band and line spectra. Explain the origin of line spectra in terms of atomic structure.

4. Describe an experiment to measure the focal length of a convex lens.
Show, by means of a ray diagram, the optical arrangement of a compound microscope and clearly indicate how the final image is formed.
Give an account of a terrestrial method of measuring the velocity of light.

5. (*a*) Describe briefly Faraday's ice-pail experiments. What conclusions may be drawn from these experiments?

(*b*) Establish the expression $\frac{\epsilon_0 A}{d}$ for the capacitance of a parallel plate air capacitor where A is the area of either plate, d is the distance between the plates and ϵ_0 is the permittivity of a vacuum (or air).
Comment on the passage of a.c. through capacitors.

6. State the laws of electromagnetic induction.
Describe (i) the transformer, (ii) the induction coil. Indicate how the principle of electromagnetic induction is illustrated in the operation of (i) *or* (ii).
A bar magnet is approaching a coil along a line through the centre and perpendicular to the plane of the coil. The force on the magnet due to the coil is F newtons when the velocity of the magnet is v m s^{-1} and the induced current is I amps. Show that

$$F = \frac{I^2 r l}{v}$$

where l metres is the length of the coil and r ohms is the resistance of the coil per metre.

7. Describe how you would carry out any *two* of the following experiments: (i) to measure the refractive index of the glass of a prism using a spectrometer, (ii) to compare two resistances using a Wheatstone bridge (metre bridge), (iii) to measure the horizontal component of the earth's magnetic flux density.
Give the theory associated with *one* of the experiments you have described.

8. Write down Einstein's photoelectric equation. On what does (i) the energy, (ii) the rate of emission, of photoelectrons depend? Outline an experiment in support of your answer in (i) *or* (ii).
The energy required to remove an electron from a certain metal is $3{\cdot}6 \times 10^{-19}$ joules. What is the shortest wavelength that will cause electrons to be emitted from the metal?

(Take Planck's constant, $h = 6{\cdot}6 \times 10^{-34}$ J s; velocity of light, $c = 3{\cdot}0 \times 10^{8}$ m s^{-1}).

In what way does the Compton effect resemble the photoelectric effect? What deduction may be drawn from these phenomena regarding the nature of light?

9. (*a*) What is meant by (i) radioactivity, (ii) half-life?
The following represents part of the natural radioactive disintegration of Thorium ($^{232}_{90}$Th):

$$\text{Thorium} \xrightarrow{\alpha} X \xrightarrow{\beta} Y \xrightarrow{\beta} Z \xrightarrow{\alpha} W$$

(where α = alpha particle and β = beta particle). Refer to the Periodic Table of the elements in the Mathematics Tables p. 44 and name the elements X, Y, Z, W.
The half-life of radon is 3·8 days. How much of a radon sample would remain after 19·0 days?

(*b*) Outline the principles of nuclear fission and nuclear fusion.
Discuss the conservation of mass-energy in nuclear reactions.

10. Answer any *two* of the following.

(*a*) Compare concisely the constant volume gas thermometer, the platinum resistance thermometer and the thermocouple under the following headings: (i) thermometric property involved, (ii) advantages, (iii) disadvantages.

(*b*) Describe an experiment to show that a material medium is necessary for the transmission of sound.
If the velocity of sound in a gas is expressed by $\sqrt{\frac{\gamma p}{\rho}}$ where p = pressure, ρ = density, γ = constant, show that its velocity is dependent on temperature and independent of variations in pressure.

(*c*) Describe, with the aid of a diagram, how a thermionic diode functions. Show how the diode may be used to rectify alternating current.

(*d*) Give an account of an experiment to measure the specific charge (the ratio of the charge to the mass) of the hydrogen ion.