AN ROINN OIDEACHAIS

LEAVING CERTIFICATE EXAMINATION, 1977

PHYSICS—HIGHER LEVEL

WEDNESDAY, 22 JUNE—MORNING, 9.30 to 12.15

Any **six** questions to be answered.
All 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) A body starts from rest with an acceleration of 20 m s^{-2}. How far will it have moved after 5 seconds?

(b) What is the horizontal component of a force of 20 newtons acting at 60° to the horizontal?

(c) If a simple pendulum is moved from the surface of the earth to the surface of the moon, how will its periodic time (T) be affected?

(d) Write an expression for the pressure of a gas in terms of the density of the gas and the mean square velocity of the molecules.

(e) An object is placed 0·2 m from a concave mirror of focal length 0·1 m. At what distance from the mirror will the image be formed?

(f) Parallel rays of red light (A) and violet light (B) strike the convex lens L as shown in Fig. I. Suggest a reason why the rays for the two colours pass through slightly different focal points P and Q.

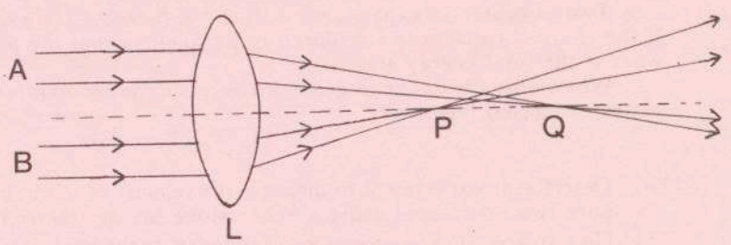

Fig. I

(g) What conclusion regarding the nature of light can be drawn from the fact that light can be polarised?

(h) If f is the frequency of the fundamental note of a pipe open at both ends, what is the frequency of the fundamental note of a pipe of the same dimensions closed at one end?

(i) What is meant by simple harmonic motion (S.H.M.)?

(j) Write down Coulomb's law of force between electric charges.

(k) Fig. II shows a balanced potentiometer circuit. Assuming that the battery B falls in potential, in what direction should the contact X be moved in order to restore the balance?

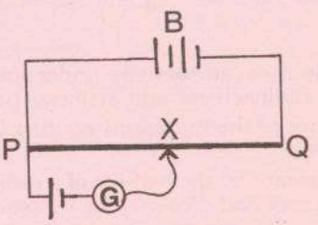

Fig. II

(l) What is the magnifying power of the telescope in normal (infinite) adjustment, if the focal lengths of the objective and eye-piece are 0·5 m and 0·02 m respectively?

(m) What is the basic principle of moving-coil meters?

(n) In the photoelectric effect what is the relation between the number of electrons emitted per second and the intensity of the light used?

(o) Why are *two* photons produced in the annihilation of a positron and an electron?

(p) Identify the isotopes X and Y in the following nuclear reaction:

$$^{19}_{9}F + {}^{4}_{2}He \rightarrow X \rightarrow Y + {}^{1}_{0}n$$

(Refer to the Periodic Table of the elements on page 44 of the Mathematics Tables.)

2. State Newton's law of gravitation.
Describe a method of measuring G, the gravitational constant.
What is meant by centripetal force?
Assuming that the mass of the earth is 81 times that of the moon, determine the relationship between the periodic times of two satellites, one orbiting the earth and the other orbiting the moon when the radii of the circular orbits are the same.

3. *(a)* What is meant by specific heat capacity?
Describe how you would measure the specific heat capacity of a metal.
A liquid flows through a pipe heated by a 630 watt electric heater. The steady temperature difference between the liquid entering and leaving the pipe is 15°C when there is a constant flow of $1{\cdot}0 \times 10^{-5}$ m^3 per second. Calculate the specific heat capacity of the liquid. (Take the density of the liquid = 800 kg m^{-3}).

(b) Outline how a thermistor *or* a thermocouple may be used to measure temperature and indicate any *one* of its limitations in respect of temperature measurement.

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4. *(a)* State the laws of refraction of light. Define critical angle.
A point source of light is placed 0·7 m below the surface of a pond. Find the area of the circle at the surface through which light can pass, given that the refractive index of water is 4/3. (Take $\pi = 22/7$).
(b) Describe an experiment to measure the wavelength of monochromatic light.
Show that the wavelength of electromagnetic waves in a medium of refractive index μ is given by λ/μ where λ is the wavelength in air (or vacuum).

5. State the laws of electromagnetic induction.
Outline how the operation of an alternating current generator is governed by these laws.
A magnetic field which has a flux density of 4 Wb m^{-2} within a given region and zero flux density outside the region acts at right angles to the plane of a rectangular coil *abcd*, where $ab = 0{\cdot}02$ m and $bc = 0{\cdot}10$ m. The coil is moving with a constant speed of 2 m s^{-1} in a direction parallel to *bc*. What are the effects (if any) on the moving coil
(i) when it is wholly within the region of the magnetic field,
(ii) when it is leaving the region of the magnetic field?
Calculate the work done in removing the coil completely from the magnetic field in a direction parallel to *bc* if the resistance of the coil is 10 ohms and the induced e.m.f. is 0·16 volts.

6. Derive 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 the permittivity of vacuum (or air).
Two capacitors of capacitance $8\mu F$ and $4\mu F$ respectively are connected, each in turn, across a 60V supply. If the charged capacitors are placed in parallel, so that the plates with like charges are connected together, what is the total energy stored?
Why would the total energy stored be less if the capacitors were placed in parallel with oppositely charged plates connected together?

7. *(a)* Describe an experiment to measure the velocity of sound in a gas other than air *or* an experiment to compare two resistances using a Wheatstone bridge (metre bridge).
(b) Give an account of an experiment to measure the horizontal component of the earth's magnetic flux density and give the theory associated with the experiment.

8. *(a)* Explain the terms (i) space charge, (ii) saturation, in relation to thermionic emission.
Why is a high vacuum container necessary for the proper operation of a thermionic diode?
(b) Outline briefly an experiment in support of the wave nature of electrons.
Calculate the wavelength of electrons of energy 5 eV. Take $h = 6{\cdot}6 \times 10^{-34}$ J s, the mass of the electron $= 9{\cdot}0 \times 10^{-31}$ kg and the electron charge $= 1{\cdot}6 \times 10^{-19}$ C.

9. Give an account of radioactivity under the following headings:
(i) natural radioactivity and artificial (induced) radioactivity,
(ii) the nature of the radiations emitted from radioactive substances and the methods of detection of these radiations.
What is meant by the half-life of a radioactive isotope? Describe how the half-life of a radioactive isotope, of relatively short half-life, may be measured experimentally.

10. Answer any *two* of the following.
(a) Describe, by means of a ray-diagram, the optical system of a compound microscope. State the cause of spherical aberration and indicate how it may be corrected.
(b) "Visible and invisible light, X-rays, gamma rays, arise from energy changes in atoms". Discuss this statement.
(c) Outline the principles of nuclear fission and fusion. Comment on their relative merits as sources of energy.
(d) Give an account of an experiment to measure the specific charge, e/m, (ratio of charge to mass) of the electron.