AN ROINN OIDEACHAIS

LEAVING CERTIFICATE EXAMINATION, 1979

PHYSICS—HIGHER LEVEL

MONDAY, 25 JUNE—MORNING, 9.30 to 12.30

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) Define the unit of force i.e. the newton.

   (b) The motion of a body in a straight line is represented by the equation $x = 4t + 3t^2$, where x is the displacement of the body in metres and t is the time in seconds. What is (i) the initial velocity, (ii) the acceleration, of the body?

   (c) Calculate the work done when a mass of 5 kg is raised from the ground to a height of 2 metres. (Take $g = 9{\cdot}8\ \text{m s}^{-2}$)

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

   (e) Fig. I illustrates a plane-polarised electromagnetic wave moving to the right with velocity c. The complete arrows represent the electric field intensity (E) at a particular instant. What do the broken arrows represent?

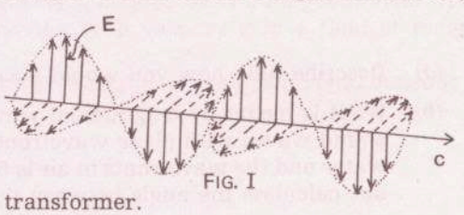


FIG. I

   (f) Mention two ways in which energy may be lost in a transformer.

   (g) How are the frequencies of spectrum lines related to energy levels in atoms?

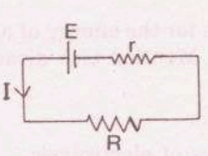
   (h) Explain the term potential gradient.

   (i) If an electric current is passed through a coil which is wound round an initially non-magnetised piece of iron, the iron becomes magnetised. When the current, however, is reduced to zero, the iron still shows some magnetism. What name is given to this effect?

   (j) What is meant by chromatic aberration?

   (k) When operating a simple dynamo by hand, how would you detect (without the use of an ammeter) that the current drawn from the dynamo increased?

   (l) Derive an expression for the internal resistance r ohms of a cell of e.m.f. E volts which is driving a current of I amperes through a circuit of total external resistance R ohms (see diagram).



   (m) Write down the orders of magnitude of wavelengths in the X-ray and visible regions of the electromagnetic spectrum.

   (n) On what does the wavelength of the X-radiation depend in an X-ray tube?

   (o) What is meant by nuclear fission?

   (p) In pair production, calculate the kinetic energy of the electron and of the positron produced from a γ-ray of energy 1·34 MeV. (Take the mass-energy equivalent of the electron and the positron each to be 0·51 MeV)

2. *(a)* State the law of conservation of momentum.
   A mass of 2 kg moving with constant velocity collides with a mass of 3 kg which is initially at rest. After the collision the two masses coalesce and move off together. Calculate the ratio of the final kinetic energy to the total initial kinetic energy. Explain why this ratio has a value less than one.

   (b) State Newton's law of gravitation.
   Assuming that the moon circles the earth in an orbit of radius d, show that the periodic time of the moon may be expressed as $2\pi \frac{d}{r}\sqrt{\frac{d}{g}}$ where r is the radius of the earth and g is the acceleration due to gravity on the surface of the earth.

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3. *(a)* Define specific heat capacity.
A 550 W electric heater was used to heat 2 kg of water. The temperature was measured at various times and the results are shown in the following table.

Time (minutes)	0	2	5	7	10	12	14	16	19	21
Temperature (K)	279	287	299	307	319	327	334	342	354	362

Plot a graph using the above experimental data with time as the horizontal axis. From your graph, calculate as accurately as you can, the specific heat capacity of water. (Assume that there is no loss of liquid and that there is no loss of heat to the surroundings.)

(b) Outline how a thermocouple may be used to measure temperature.
The graph in Fig. II shows how the e.m.f. of a thermocouple varies with temperature. It is based on observations made when the warmer junction was placed firstly in an ice-water mixture and then in boiling water. Calculate the temperature of the cold junction.

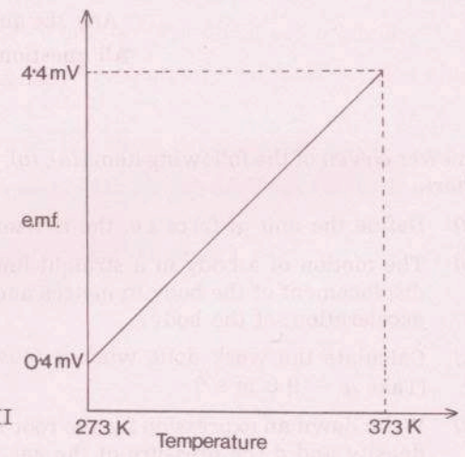

Fig. II

4. *(a)* Describe fully how you would accurately measure the focal length of a convex lens.

(b) What is meant by longitudinal waves? State the laws of refraction.
Sound waves with plane wavefronts enter sea-water from air. The angle between the surface of the water and the wavefronts in air is 6° 12′. If the wavelength of sound in sea-water is 4·75 times that in air, calculate the angle between the surface and the wavefronts in the sea-water.

5. *(a)* For what purpose is an electroscope used?
Explain the following.
(i) The case of an electroscope should always incorporate some metal in its structure in order to function more satisfactorily.
(ii) When a battery is used to charge an electroscope, the battery should be of high voltage rather than low voltage.

(b) Define capacitance.
Derive an expression for the energy of a charged capacitor in terms of its capacitance and the potential difference across it. Mention two disadvantages of using charged capacitors as sources of energy.

6. *(a)* State Faraday's laws of electrolysis.
Calculate the time it would take to plate an object of total surface area $1{\cdot}4 \times 10^{-3}$ m^2 with a layer of silver 4×10^{-3} m thick by means of a current of 2·1 amperes. (The density and electrochemical equivalent of silver are $10{\cdot}5 \times 10^{3}$ kg m^{-3} and $1{\cdot}12 \times 10^{-6}$ kg C^{-1} respectively.)

(b) State the laws of electromagnetic induction.
Fig III shows a metal ring (M) moving with constant velocity towards a solenoid (S) which is stationary. The ring is arranged so that its centre moves along the axis (A) of the solenoid. The diameter of the ring is less than that of the solenoid.
Discuss the magnitude and direction of the current in the ring as it approaches, passes within, and leaves the solenoid when (i) a d.c. voltage, (ii) an a.c. voltage, is applied to the terminals (T) of the solenoid.

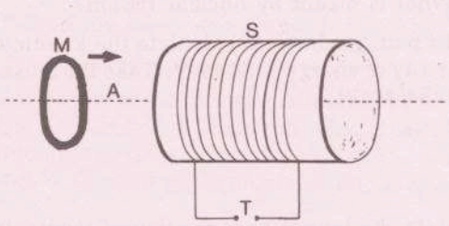

FIG. III

7. *(a)* Outline an experiment to show the current/voltage relation for a thermionic diode with a fixed temperature of the filament. Comment briefly on the main features of the characteristic curve associated with this experiment.

(b) Describe an experiment by which the horizontal component of the earth's magnetic flux density may be measured and give the theory associated with the experiment.

8. "For a fuller understanding of the nature of light and of the electron, the wave concept and the particle concept must be considered." Discuss this statement with particular reference to the work of Young, Einstein, Compton and de Broglie.

9. Describe how you would show experimentally that α, β and γ radiations are emitted in the decay of some radioactive sources. Comment on the relative ionising abilities and penetrating powers of these radiations.
Calculate the number of α-particles and the number of β-particles you would expect to be emitted during the radioactive decay of an atom of $^{226}_{88}Ra$ to form the stable atom $^{206}_{82}Pb$.
Construct a radioactive decay series beginning with $^{226}_{88}Ra$ and ending with $^{214}_{83}Bi$ considering only the isotopes of elements with atomic numbers 86, 84 and 82. (Refer to the Periodic Table of the elements in the Mathematics Tables p. 44.)

10. Answer any *two* of the following.

(a) With regard to sound, explain the terms (i) fundamental, (ii) harmonics, and describe a laboratory experiment in each case to demonstrate (i) and (ii).

(b) State Ohm's law. Outline an experiment to verify this law. Mention two types of conducting media which do not obey Ohm's law.

(c) Define simple harmonic motion (S.H.M.).
Show that when a mass is attached to a spiral spring, then displaced downwards slightly from its rest position and released, it will execute simple harmonic motion. Derive an expression for the periodic time of the motion.

(d) Write down an expression for the force on a current-carrying conductor in a magnetic field. Hence, derive the expression for the force on a charge q moving with velocity v in a field of magnetic flux density B.
Describe briefly an experiment to show how the force on an electron in a magnetic field depends on v and B.