LEAVING CERTIFICATE EXAMINATION, 1982

PHYSICS—HIGHER LEVEL

THURSDAY, 24 JUNE—MORNING, 9.30 to 12.30

Any six questions to be answered.
All questions carry the same marks.

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

(*a*) Define work.

(*b*) A car starts from rest with a constant acceleration of 2 m s^{-2}. What is its speed after it has travelled 16 m?

(*c*) Fig. 1 shows a uniform lever supported at its centre, C. Two bodies, of weight 5 N and 10 N, are attached to it at A and B respectively. The lever is in equilibrium and the distance AB is 90 cm. What is the distance AC?

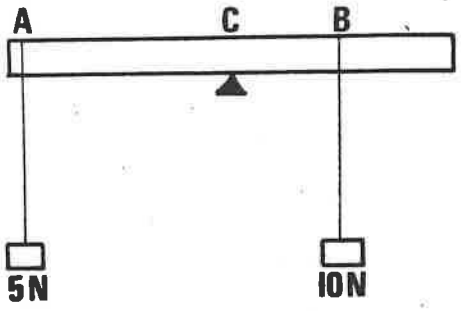

Fig. 1

(*d*) Define temperature on the Celsius scale for a constant volume gas thermometer.

(*e*) In the equation $\mu = \dfrac{\sin \frac{1}{2}(A + D)}{\sin \frac{1}{2} A}$ for the refractive index of the glass of a prism, what do the letters A and D represent?

(*f*) A thin convex lens of focal length 0·25 m is placed in contact with a thin concave lens of focal length 0·5 m. What is the focal length of the combination?

(*g*) Write down an expression for Coulomb's law of force between electric charges.

(*h*) A and B are two points a distance of 1·5 m apart in a uniform electric field. If the potential at A is 100 V and at B is 400 V, what is the field intensity (strength)?

(*i*) Fig. 2 shows a straight wire carrying a current of 4 A which lies in a uniform magnetic field of flux density 0·1 T (0·1 Wb m^{-2}). If the direction of the field makes an angle of 30° with the wire, what is the force on the wire per metre of its length?

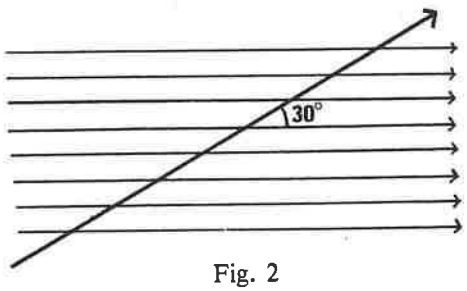

Fig. 2

(*j*) What is (i) magnetic dip, (ii) magnetic declination.

(*k*) When an electric motor slows down due to an increased load, the current flowing through the motor increases. Explain.

(*l*) What determines (i) the intensity, (ii) the penetrating power, of the X-rays produced in an X-ray tube?

(*m*) Complete the following statement: The ..... of a cadmium sulphide (CdS) cell decreases as the ..... of the light falling on it increases.

(*n*) State two ways of reducing energy losses in a transformer.

(*o*) What is meant by pair production?

(*p*) Why do the leaves of a charged electroscope collapse when a radioactive substance is brought near to the cap of the electroscope?

2. State (i) Newton's laws of motion, (ii) the law of conservation of momentum.
Describe an experiment to verify the parallelogram law for the addition of forces.

A spacecraft of mass M is travelling with velocity V. The craft ejects an object of small mass m with a speed v in a direction perpendicular to V. (Fig. 3). As a result the direction in which the craft is travelling is changed. Assuming that the resulting change in the mass of the spacecraft may be neglected show that the new velocity of the craft is of magnitude

$$\frac{1}{M}\left[\ (mv)^2 + (MV)^2\ \right]^{\frac{1}{2}}$$

and is at an angle θ to the original velocity, where

$$\tan\theta = \frac{mv}{MV}.$$

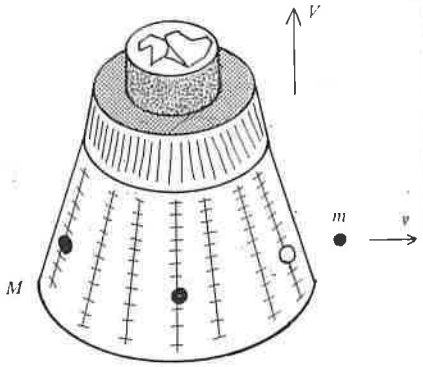

Fig. 3

3. (*a*) State *four* of the basic assumptions of the kinetic theory of gases.
State (i) Boyle's law, (ii) Avogadro's law, and show how the kinetic theory equation

$$p = \frac{1}{3}\frac{nmc^2}{v}$$

is consistent with *one* of these laws.
Outline an experiment to estimate the size of a molecule.

(*b*) Define specific heat capacity.
Water is being pumped through a central heating system at a rate of $0{\cdot}5\ m^3\ h^{-1}$. If the temperature of the water leaving the boiler is 60°C while the temperature of the returning water is 36°C calculate the power output of the boiler. Assume heat losses from the boiler to be negligible and take the density of water to be $1{\cdot}0 \times 10^3\ kg\ m^{-3}$ and the specific heat capacity of water to be $4{\cdot}2 \times 10^3\ J\ kg^{-1}\ K^{-1}$.

4. (*a*) Describe an experiment to determine the focal length of a convex mirror.
A pin is placed in front of a convex mirror perpendicular to the principal axis of the mirror. If the distance between the mirror and the pin is four times the focal length of the mirror determine the magnification of the image.

(*b*) Use a ray diagram to show how the final image is formed in an astronomical telescope.
The magnifying power of an astronomical telescope in normal (infinite) adjustment is 24. If the distance between the lenses is 1·0 m calculate the focal length of the objective lens.

5. (*a*) What is monochromatic light?
Describe an experiment to measure the wavelength of monochromatic light.

(*b*) Explain the terms: frequency: amplitude.
Fig. 4 shows two sources of sound, S_1 and S_2 (e.g. a pair of speakers connected in parallel to a signal generator), which emit notes of the same frequency and amplitude. While walking slowly along the line LM a person notices that the loudness of the sound varies in a regular manner.

(i) What can be deduced about the nature of sound from this variation in loudness?

(ii) What causes this variation?

(iii) What would be the effect of increasing the distance *a*?

(iv) What would be the effect of increasing the distance *b*?

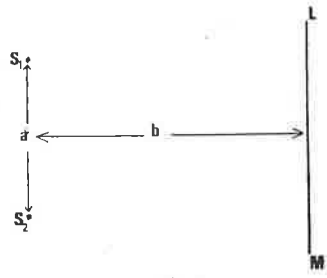

Fig. 4

6. (*a*) Define resistance.
The current, I, flowing through a length of wire kept at a constant temperature was measured for different values of the applied potential difference, V. The table of results below shows the values of V, with the corresponding values of I.

V(volt)	0·5	1·0	1·5	2·0	2·5	3·0	3·5	4·0	4·5
I(ampere)	0·12	0·23	0·30	0·42	0·54	0·66	0·74	0·84	0·92

Plot a graph of V against I and, from the graph, determine the resistance of the wire.

(*b*) Describe an experiment to plot the variation of resistance with temperature for a given length of wire. Sketch the form of graph you would expect to obtain from this experiment.

7. (*a*) Describe an experiment to compare the electromotive force (e.m.f.) of two cells and give the theory associated with the experiment.

(*b*) Describe an experiment to plot the variation of current with potential difference for a thermionic diode. Explain the main features of the resulting graph.

8. What are electrons? How may it be demonstrated that electrons have a wave nature?
What are photons? Write down an expression for Einstein's photoelectric law.
Describe an experiment to investigate the effect of varying the intensity of the light incident on a photoelectric cell.
In an experiment to determine the value of Planck's constant a negative potential was applied to the anode of a photoelectric cell and the minimum potential required to reduce the photocurrent to zero was measured for incident light of various frequencies. For frequencies of $8{\cdot}5 \times 10^{14}$ Hz and $2{\cdot}35 \times 10^{15}$ Hz the minimum potentials required were found to be 0·4 V and 6·4 V, respectively. Given that e, the charge on the electron is $1{\cdot}6 \times 10^{-19}$C, calculate the value of Planck's constant, h.

9. State the properties of α–particles, β–particles and γ–rays.
Given a sample of a radioactive substance describe an experiment you would carry out to establish which types of radiation were being emitted from the sample.
In the following nuclear reaction the mass of each deuterium nucleus ($^2_1$H) is $3{\cdot}344 \times 10^{-27}$ kg and the mass of the helium nucleus is $6{\cdot}646 \times 10^{-27}$ kg. E is the energy released in the reaction

$$^2_1\text{H} + {}^2_1\text{H} \rightarrow {}^4_2\text{He} + E$$

(i) What name is given to this type of nuclear reaction?
(ii) Calculate the value of E.
(iii) Why is it difficult to produce this type of reaction?

(Speed of light in vacuum, $c = 3{\cdot}0 \times 10^8$ m s^{-1})

10. Answer any *two* of the following.

(*a*) State the laws of electromagnetic induction.
Describe an experiment which illustrates *one* of these laws.
Explain the principle of operation of an induction motor.

(*b*) Define: potential difference; capacitance.
What is the relationship between the capacitance of a parallel plate capacitor and (i) the distance between the plates, (ii) the area of the plates? Describe an experiment which illustrates the relationship between the capacitance and *either* (i) *or* (ii).

(*c*) State Newton's law of gravitation.
Use this law to show that the periodic time (T) of a satellite in a circular orbit at a height h above the earth's surface is given by

$$T^2 = \frac{4\pi^2(r+h)^3}{GM}$$

where r and M are the radius and mass, respectively, of the earth and G the gravitational constant.

(*d*) State Faraday's laws of electrolysis.
Describe how the first law may be verified experimentally.
Given that the faraday is 96,500 coulombs and that the charge on the electron, e, is $1{\cdot}6 \times 10^{-19}$ C calculate Avogadro's number (constant).