AN ROINN OIDEACHAIS

LEAVING CERTIFICATE EXAMINATION, 1976

PHYSICS—HIGHER LEVEL

WEDNESDAY, 23 JUNE—MORNING, 9.30 to 12.15

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

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

(*a*) A mass of 5 kg moving at 20 $m\,s^{-1}$ collides with a mass of 15 kg which is at rest. After collision both masses move on together as a combined mass. What is the velocity of the combined mass?

(*b*) Give an example of a body having zero velocity but not zero acceleration.

(*c*) Fig. I shows an object attached to a string at A, the other end of the string being fixed at B. Show that when the body is released the velocity at the lowest point C is $\sqrt{2gh}$, where g is the acceleration due to gravity.

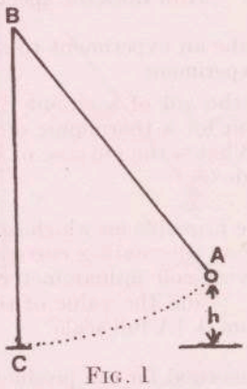

FIG. I

(*d*) The work function of a metal is w_0. Write down an expression for the maximum wavelength that will eject electrons from the metal.

(*e*) What is a thermocouple?

(*f*) State a physical characteristic that is common to pitch in sound and colour in light.

(*g*) A tank full of water appears to be 2 metres deep when viewed vertically. If the refractive index of water is 1·3 what is the real depth of the tank?

(*h*) A dielectric material is inserted between the plates of a parallel plate air capacitor. How is the capacitance affected?

(*i*) If the disc (cap) of an electroscope is connected to the case and the electroscope is then charged, why will the leaves not diverge?

(*j*) A large current is passed through a loosely wound spiral spring. Why does the spring contract?

(*k*) Fig. II shows the relation between current (I) and voltage (V) for a water voltameter using platinum electrodes. What does the length AB represent?

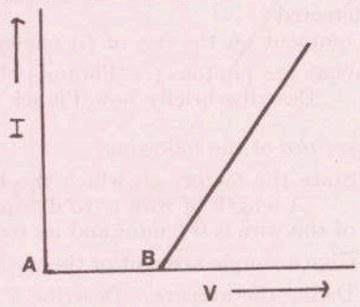

FIG. II

(*l*) Name one way of reducing energy losses in a transformer.

(*m*) A charged particle is projected into a uniform magnetic field at right angles to the lines of force. Why does the particle move in a circle?

(*n*) Write down a relation between the universal constant of gravitation, G, and the acceleration due to gravity, g.

(*o*) In nuclear reactions why does the destruction of a very small quantity of matter result in the liberation of a very large amount of energy?

(*p*) What is meant by the breeding of plutonium from uranium in a nuclear reactor?

2. State Newton's second law and show how it leads to a quantitative definition of force. Describe how you would show experimentally that the acceleration of a body is proportional to the force acting on it.

A body leaves a point A and moves in a straight line with constant velocity 36 $m\,s^{-1}$. Seven seconds later another body of mass 2 kg at rest at A is acted on by a constant force of 4 N and moves in the same direction as the first body. How long will it take the second body to catch up on the first body?

3. (*a*) State the basic assumptions of the kinetic theory of gases.
The root-mean-square velocities of the molecules of two gases at 0°C are $4{\cdot}6 \times 10^2$ $m\,s^{-1}$ and $18{\cdot}4 \times 10^2$ $m\,s^{-1}$ respectively. Find the ratio of the densities of the gases.
Mention any experimental evidence which supports the kinetic theory of gases.

(*b*) What is an ideal (perfect) gas? Give a definition of temperature in terms of the gas scale.
Describe the constant volume gas thermometer.

4. (*a*) What is meant by (i) the harmonics, (ii) the quality, of a musical note?
Explain by means of diagrams how the quality of the note from a pipe open at one end differs from the quality of the same note from a pipe open at both ends.

(*b*) Describe an experiment to find the focal length of a convex mirror.
A convex mirror forms an image that is $\frac{1}{4}$ the size of an object placed 30 cm from the mirror. What is the focal length of the mirror?

5. What is meant by the diffraction of light? Outline the experimental procedure for measuring the wavelength of monochromatic light using Young's slits *or* a diffraction grating.

Use the diffraction grating formula to explain the following, assuming that the wavelength of visible light lies between 400 nm and 800 nm.

(i) Why is dispersion greater in the higher orders?

(ii) Why is the red light diffracted more than the violet?

(iii) What is the maximum wavelength that can be obtained with a given grating (*a*) in the first order, (*b*) in the second order?

(iv) What would be the effect of varying the grating constant?

How does the spectrum obtained by a diffraction grating differ from that obtained by a prism?

6. (*a*) Describe an experiment to measure the internal resistance of a cell and give the theory associated with the experiment.

(*b*) With the aid of a circuit diagram, describe how you would show experimentally the current/voltage relation for a thermionic diode for a fixed temperature of the filament.
What is the purpose of a grid in a triode? Why is the grid usually kept negative with respect to the cathode?

7. Outline the principle on which (*a*) the alternating current dynamo, (*b*) the moving-coil meter depends. Show how an alternating current dynamo may be converted to a direct current dynamo.
A moving-coil milliammeter has a resistance of 5 ohms and gives a full scale deflection with a current of 50 mA. Find the value of the resistance required in order to convert the milliammeter to an ammeter reading from 0–1A full scale.

8. Outline a method for the production of X-rays and summarise their properties.
On what does (i) the intensity (ii) the penetrating power of X-rays depend? How do they differ from gamma rays in their origin?
An X-ray tube is operating at V volts. Electrons, charge e coulombs, strike the target of the X-ray tube. Show that the minimum X-ray wavelength which is emitted is $\frac{ch}{eV}$, where c is the velocity of light and h is Planck's constant.

9. (*a*) Describe a method for detecting the radiations emitted from radioactive isotopes. How are neutrons detected?
Comment on the use of (i) neutrons, (ii) charged particles, for the production of radioactive isotopes.

(*b*) What are photons? "Photons obey the same conservation laws as particles": discuss.
Describe briefly how Planck's constant may be estimated experimentally.

10. Answer *two* of the following.

(*a*) State the factors on which the heating effect of an electric current depends.
A length of wire is to dissipate 40 watts when connected to a 220 volt supply. The cross section of the wire is 0·1 mm^2 and its resistivity is 1×10^{-6} ohm metres. What is the length of the wire?

(*b*) Give a simple account of the measurement of the electronic charge, e, by Millikan's oil-drop experiment.

(*c*) Define the ampere. Describe a method to check the accuracy of an ammeter without using another ammeter.

(*d*) Derive an expression for the energy of a charged parallel plate capacitor in terms of the capacitance and the potential difference between the plates.
A 400 μF capacitor has an energy of 8 J when charged. What is the potential difference between its plates?