LEAVING CERTIFICATE EXAMINATION, 1990

PHYSICS—HIGHER LEVEL

FRIDAY, 15 JUNE—MORNING, 9.30 to 12.30

Answer **all** questions in Section A.

Answer **two** questions from Section B and **three** questions from Section C.

SECTION A (120 marks)

Answer each question in this section.
Each question carries the same number of marks.
Write your answers in the spaces provided.
Write your examination number at the top.
Be sure to return this section of the examination paper, enclosing it in the answer book you use in answering Sections B and C.

1. Answer *five* of the following items, (i), (ii), (iii), etc. In the case of each item write the letter corresponding to the correct answer in the box provided.

(i) The unit of pressure, the pascal, is equivalent to the

A. kg m^{-2}
B. kg m^2
C. N m
D. N m^2
E. N m^{-2}

Answer [E] (6)

(ii) The triple point of water, on the Kelvin scale, is assigned the value

A. 0 K
B. 270 K
C. 273 K
D. 273·16 K
E. 373 K.

Answer [D] (6)

(iii) When the intensity of a sound increases from 10 mW m^{-2} to 20 mW m^{-2} the relative increase in intensity, in bels, is

A. 0·3
B. 1·0
C. 1·3
D. 2·0
E. 10.

Answer [A] (6)

(iv) The energy stored in a parallel plate capacitor is

A. proportional to the capacitance and proportional to the potential difference between the plates
B. proportional to the capacitance and proportional to the potential difference between the plates squared
C. proportional to the capacitance squared and proportional to the potential difference between the plates
D. proportional to the capacitance squared and inversely proportional to the potential difference between the plates
E. proportional to the capacitance and inversely proportional to the potential difference between the plates squared.

Answer [D] (6)

(v) The circuit shown in Fig. 1 consists of two diodes and a resistor of large resistance connected to a 6 V d.c. power supply. The voltage at X is

A. approximately 6 V because diode A is reverse biased
B. approximately 6 V because diode B is forward biased
C. approximately 0 V because diode B is reverse biased
D. approximately 0 V because diode B is forward biased
E. approximately 0 V because diode A is reverse biased.

Answer [ ] (6)

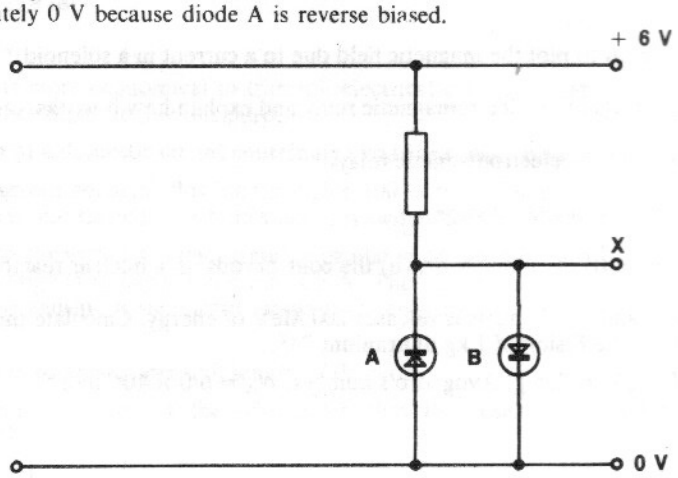

Fig. 1

(vi) When $^{238}_{92}U$ decays to $^{226}_{88}Ra$ the numbers of α-particles and β-particles given out are

A. 3 α-particles and 2 β-particles
B. 4 α-particles and 3 β-particles
C. 3 α-particles and 4 β-particles
D. 2 α-particles and 3 β-particles
E. 4 α-particles and 2 β-particles.

Answer [ ] (6)

2. Answer *five* of the following.

(i) Give the equation which defines simple harmonic motion ..... (6)

(ii) Give two assumptions of the kinetic theory of gases ..... (6)

(iii) The relationship between the power developed in a resistor and the current flowing through it was established by ..... This relationship may be expressed as P ..... (6)

(iv) In order to convert a galvanometer to an ammeter a resistor of ..... resistance is connected in ..... with it. (6)

(v) An oil drop, falling between two parallel metal plates, may be used in an experiment to determine the ..... (6)

(vi) The nature of alpha particles was established by ..... working at Cambridge in the early years of the ..... century. (6)

3. Answer *five* of the following.

(i) What is meant by the solar constant? ..... (6)

(ii) Give an expression for the refractive index of a medium in terms of the relative speeds of light in the medium and in vacuum (air) ..... (6)

(iii) For an astronomical telescope in normal adjustment, what is the relationship between the focal lengths of the lenses and the magnifying power of the telescope? ..... (6)

(iv) The fact that light may be ..... shows that it is a ..... wave. (6)

(v) What type of source is associated with:

(*a*) a continuous spectrum, ...

(*b*) a line spectrum? ..... (6)

(vi) The current flowing through a ..... diode is proportional to the .....of the light falling on it. (6)

4. Answer *five* of the following.

(i) A current flowing in a coil may be regarded as a magnetic ..... (6)

(ii) Give an expression for the force on a current-carrying conductor in a magnetic field ..... (6)

(iii) Name two devices based on the principle that a current-carrying conductor in a magnetic field experiences a force ..... (6)

(iv) When would a current-carrying conductor in a magnetic field not experience a force? ..... (6)

(v) Define the term magnetic flux ..... (6)

(vi) What is the force on an electron travelling with a velocity of 5×10^7 m s^{-1} at right angles to a magnetic field of flux density 3 T? (Charge on electron, $e = 1{\cdot}6 \times 10^{-19}$ C.) ..... (6)

LEAVING CERTIFICATE EXAMINATION, 1990

PHYSICS—HIGHER LEVEL

Section A is on a separate sheet which provides spaces for your answers. The completed sheet should be enclosed in your answer book.
Write your answers to Sections B and C in your answer book.

SECTION B (80 marks)

Answer **two** of the questions from this section.
Each question carries the same number of marks.

5. In an experiment to determine the coefficient of dynamic friction between two surfaces a force, F, was applied to a body of mass m. The value of F was increased until the body moved at a constant speed when given a gentle push. This procedure was repeated for different values of m and the following results were obtained.

m/g	200	300	400	500	600	700	800	900
F/N	0·6	1·0	1·4	1·8	2·0	2·5	2·7	3·2

Draw a suitable graph on graph paper and hence determine the value of the coefficient of dynamic friction. (Take acceleration due to gravity, $g = 9{\cdot}8$ m s^{-2}.) (18)

Use a diagram to show how the apparatus might have been arranged in this experiment. (6)

Why is it important that the body should move with a constant speed? (9)

Why is it necessary to give the body a gentle push to get it to move at a constant speed? (6)

6. The following is part of a student's account of an experiment to investigate the relationship between the length of a stretched string and its natural frequency.

"A force was applied to the end of a wire. The natural frequency of the wire was determined and its length was measured. The length of the wire was then changed, the force being kept constant. The natural frequency was again found and the new length measured. This procedure was repeated a number of times and a graph was plotted."

(i) Draw a labelled diagram of the apparatus which might have been used in this experiment. Indicate clearly on the diagram the points between which the length of the wire would have been measured. (12)

(ii) Explain how the natural frequency of the wire might have been determined. (12)

(iii) Why was the force applied to the wire kept constant during the experiment? (6)

(iv) Sketch the graph, clearly labelling the axes, which the student should have obtained. (9)

7. The electrochemical equivalent of copper was determined by passing a current, I, through a copper voltameter for a time, t, and measuring the mass of copper liberated from the solution. This was done for three different values of I and the following results were obtained.

I/A	0·5	1·0	1·5
m/g	0·20	0·42	0·59

Given that the value of t in each case was 20 minutes calculate a value for the electrochemical equivalent of copper. (15)
Draw a circuit diagram for this experiment, labelling the anode and the cathode. (9)
Explain how the mass of the copper deposited might have been determined in each case. (9)
Give two precautions which should be taken to ensure a more accurate result. (6)

SECTION C (200 marks)

Answer **three** questions from this section.
Each question carries the same number of marks.

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8. (i) State Newton's law of gravitation. (ii) What is meant by centripetal force? (12)
Describe a laboratory experiment to determine the value of g, the acceleration due to gravity. (18)
Using Newton's law of gravitation, derive an expression for g. Calculate the value of g at the equator, given that the radius of the earth at the equator is $6{\cdot}378 \times 10^6$ m. (15)
Calculate the angular velocity of a point on the equator, in rad s^{-1}, given that the period of rotation of the earth about its axis is 24 hours. (6)
A body of mass 5·000 kg is suspended from a spring balance at the equator in order to measure its weight. Calculate (i) the force of gravity on the body, (ii) the reading on the balance. (15)
($G = 6{\cdot}673 \times 10^{-11}$ N m^2 kg^{-2}; mass of earth $= 5{\cdot}977 \times 10^{24}$ kg.)

9. (*a*) Use ray diagrams to show how (i) a concave mirror, (ii) a converging lens, forms an image which is the same size as the object. (12)
Describe an experiment to find the focal length of a concave mirror *or* a converging lens. (12)
Use a ray diagram to show how the final image is formed in a compound microscope. Give two differences between a compound microscope and an astronomical telescope. (15)

(*b*) Explain briefly how it may be shown experimentally that sound is a wave motion. (12)
What is the Doppler effect? Explain, with the aid of labelled diagrams, how this phenomenon occurs. (15)

10. Define (i) resistance, (ii) resistivity. (12)
Describe an experiment to measure the resistivity of the material of a wire. (18)
Two resistors, each of resistance R, are connected in series in a circuit. Show that the effective resistance of the two resistors is $2R$. (12)
Use Kirchhoff's laws to calculate the current flowing through the 6 Ω resistor in the circuit shown in Fig. 2. Assume that the internal resistances of the batteries are negligible. (24)

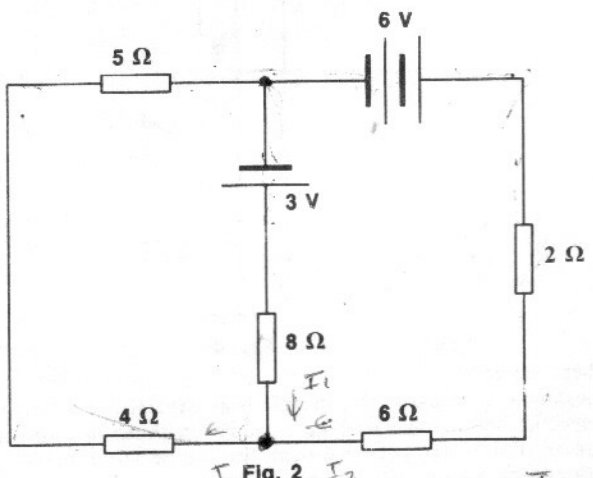

Fig. 2

11. State the laws of electromagnetic induction. (12)

Describe an experiment to illustrate *one* of these laws. (12)

Explain the term self-induction. (9)

Fig. 3 shows a circuit containing a coil with an iron core, C, a switch, S, a neon lamp, L and a low voltage (e.g. 6 V) battery. When the switch is opened the lamp lights briefly. Given that the neon lamp lights only when there is a high voltage (of the order of 90 V) between its terminals, explain

(*a*) why the lamp lights when the switch is opened; (12)

(*b*) why the lamp would be unlikely to light if the coil did not have an iron core. (9)

If the battery in Fig. 3 were replaced with an a.c. supply of the same voltage would the current flowing through the coil be larger or smaller than it was when the battery was in the circuit? Explain. (12)

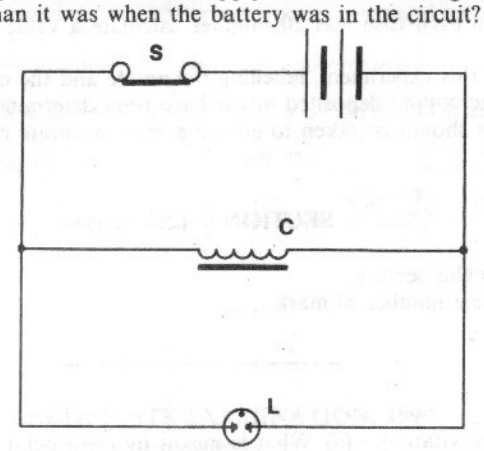

Fig. 3

12. (*a*) What is the photoelectric effect? (6)

Give an expression for Einstein's photoelectric law. (9)

When radiation of wavelength $2{\cdot}4 \times 10^{-7}$ m falls on a metal surface the maximum kinetic energy of the emitted electrons is found to be 4·2 eV. What is the value of (i) the work function of the metal in joules, (ii) the threshold frequency for the metal?

(Speed of light in vacuum, $c = 3{\cdot}0 \times 10^{8}$ m s^{-1}; charge on electron, $e = 1{\cdot}6 \times 10^{-19}$ C; Planck's constant, $h = 6{\cdot}6 \times 10^{-34}$ J s.) (21)

(*b*) "In a unipolar (field effect) transistor the drain current is controlled by the gate voltage". Explain, with the aid of a labelled diagram, the meaning of the underlined terms. (15)

Explain how the drain current is controlled by the gate voltage. (9)

Give two applications of transistors. (6)

13. Answer any *two* of the following.

(*a*) State the principle of conservation of energy. (6)

A body of mass m is released from rest at A, a height h above the ground (Fig. 4). Assuming that the body falls freely, derive an expression, in terms of x, for the kinetic energy of the body at B. (12)

Hence show that the total energy of the body at B is equal to its energy at A and explain how it may be deduced that the sum of the potential and kinetic energies of a freely falling body is constant. (15)

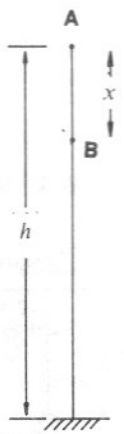

Fig. 4

(*b*) Define specific heat capacity. (6)

Describe an experiment to measure the specific heat capacity of a liquid *or* a solid. (18)

Given that the specific heat capacity of water is eleven times that of copper calculate the mass of copper at a temperature of 100 °C required to raise the temperature of 200 g of water from 20 °C to 24 °C, assuming that no energy is lost to the surroundings. (9)

(*c*) State Coulomb's law of force between electric charges. (6)
What is meant by saying that Coulomb's law is an example of the inverse square law? (6)
Define electric field intensity and give its unit. (9)
Use Coulomb's law to derive an expression for the electric field intensity at a distance r from a point charge Q. (9)
Fig. 5 shows a negative charge at a point A. Copy the diagram and show on it the direction of the electric field intensity at B. (3)

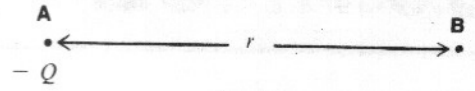

Fig. 5

(*d*) What is meant by the term radioactivity? (6)
Describe, with the aid of a diagram, one type of radiation detector and explain how it works. (18)

"Nuclear radiation has many important applications. However, it may also be dangerous and a number of precautions must be observed when it is being used."

Discuss this statement by giving three examples of applications of nuclear radiation and three precautions which should be observed in its use. (9)

$$\int_r^{\infty} \frac{1}{(s^2 \cdots)^2} \, ds$$

$$F = \frac{G m_1 m_2}{r^2}$$

$$\int_r^{\infty} \frac{G m_1 m_2}{s^2} \, ds$$

$$G m_1 m_2 \int_r^{\infty} \frac{1}{s^2} \, ds$$

$$s^{-2} \qquad -s^{-1}$$

$$G m_1 m_2 \left[-s^{-1} \right]$$

$$G m_1 m_2 \left[-\frac{1}{r} + \frac{1}{\infty} \right]$$