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LEAVING CERTIFICATE EXAMINATION, SAMPLE PAPER

MAY 2001

PHYSICS – HIGHER LEVEL

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3 HOURS DURATION

Answer **three** questions from section A and **five** questions from section B.

Data

Gravitational constant = 6.7×10^{-11} N m^2 kg^{-2}

Radius of the earth = 6.4×10^6

Mass of the earth = 6.0×10^{24} kg

Speed of light in a vacuum = 3.0×10^8 m s^{-1}

Speed of sound in air = 340 m s^{-1}

SECTION A (120 marks)

Answer **three** questions from this section.
Each question carries 40 marks.

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1. In investigating simple harmonic motion, a simple pendulum was set up so that it could swing freely about a fixed point. The length of the pendulum was measured. The pendulum was allowed to swing through a small angle and the time for 25 oscillations, t, was found. This procedure was repeated for a series of values of the length l. The data obtained are shown in the table.

l/cm	40.0	50.0	60.0	70.0	80.0	90.0	100.0
t/s	31.1	34.5	38.8	42.5	44.4	47.8	49.6

Is the period of the pendulum proportional to its length? Justify your answer. (7)
Draw a suitable graph on graph paper to illustrate the relationship between the period and the length. Hence determine a value for the acceleration due to gravity, g. (21)
How is the pendulum set up so that it swings freely? (6)
Explain why the pendulum is allowed to swing through only a small angle. (6)

2. The following is part of a report given by a student of an experiment to measure the wavelength of monochromatic light. "The apparatus was arranged so that a number of bright images could be observed. The angular position θ for each of these images was determined. The data obtained are shown in the table. The diffraction grating had 600 lines per mm."

n	2	1	0	1	2
θ/°	45.0	20.4	0.0	20.7	45.2

Describe, with the aid of a diagram, how the student might have obtained the data. (12)
Use the data to calculate a value for the wavelength of the light. (12)
Explain why it is not possible to get more than five bright images with this diffraction grating. (10)
Name two factors that would affect the accuracy of the experiment. (6)

3. A student investigated the variation of the fundamental frequency f of a stretched string with its length l and the following data was obtained.

l/m	0.2	0.3	0.4	0.5	0.6	0.7	0.8
f/Hz	675	455	335	273	230	193	173

Describe, with the aid of a diagram, how the student might have obtained the data. (12)
How would the student have known that the string was vibrating at its fundamental frequency? (6)
Explain why the tension in the string should be kept constant during the investigation. (3)
Draw a suitable graph to illustrate the relationship between the fundamental frequency and the length of the stretched string. (13)
From your graph, estimate the length of the string when its fundamental frequency is 256 Hz. (6)

4. The current I through a component was measured for a range of different values of potential difference V applied across it. The recorded data are shown in the table.

V/V	0.0	1.0	2.0	3.0	4.0	5.0	6.0
I/A	0.0	0.20	0.28	0.35	0.38	0.39	0.40

Draw a suitable circuit diagram to obtain the data. (9)
Describe how the data could be obtained from your circuit. (6)
Plot a graph of the current against the potential difference for this component. (12)
Referring to your graph, discuss how the current varies with the potential difference. Your answer should make reference to Ohm's law and the resistance of the component. (13)

SECTION B (280 marks)

Answer **five** questions from this section.
Each question carries 56 marks.

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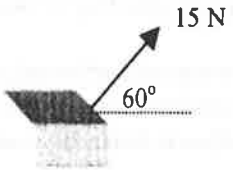
5. Answer all of the following parts.



(i) A force of 15 N acts on a box as shown.
What is the horizontal component of the force? (6)

(ii) State Hooke's law. (6)

(iii) 100 litres of carbon dioxide gas at an atmospheric pressure of 1×10^5 Pa was pumped into a gas cylinder of volume 0.5 litres. What is the pressure in the gas cylinder? (6)

(iv) What is meant by the U-value of a structure? (6)

(v) What is the shortest wavelength of sound that can be heard in air by a person given that the frequency response of the ear ranges from 20 Hz to 20 kHz? (6)

(vi) A tin whistle has a fundamental frequency of 256 Hz. What is the frequency of the third harmonic? (6)

(vii) A capacitor is marked 100 μF. What is the energy stored in the capacitor when it is connected to a 6 V supply? (6)

(viii) If the peak voltage of an a.c. source is 15 V, calculate its rms value. (7)

(ix) Distinguish between leptons and baryons. (7)
OR
(ix) What is the physical principle on which a loudspeaker is based. (7)

6. Isaac Newton developed the theory of gravitation at the end of the seventeenth century. According to this theory, what is gravity? State Newton's law of universal gravitation. (12)

What is meant by centripetal force? Describe how you would demonstrate the effect of centripetal force. (12)

A satellite of mass m orbits the earth in a circular orbit at a constant height h above the earth's surface.
Show that the period T of the satellite is given by

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

where R is the radius of the earth, G is the gravitational constant and M is the mass of the earth. (15)

A communications satellite is usually in an orbit such that it appears stationary above a point on the earth's equator.
What is the period of such a satellite? (6)
Calculate the height of such a communications satellite above the surface of the earth. (11)

7. Explain what is meant by the term *power*. (6)

Microwave ovens are common in many kitchens. In such an oven microwave energy is absorbed by the water present in food and is converted to heat.
An electrician tested the efficiency of a microwave oven, which had a power rating of 650 W, as follows.
A plastic jug, of negligible heat capacity, containing 500 cm^3 of water at 20 °C was placed in the microwave oven.
The oven was switched on at full power. After two minutes the temperature of the water had risen to 54 °C.
Calculate the energy absorbed by the water. Hence determine the efficiency of the microwave oven. (24)

Microwaves are continuously reflected off the walls of the oven. Interference occurs where they meet.
What effect might this have on the cooking of food placed in the oven?
Explain how this effect is lessened by using a turntable. (12)

The microwaves produced in the oven have a frequency of 2.45 GHz. Calculate their wavelength. (9)

Give another use for microwave radiation. (5)

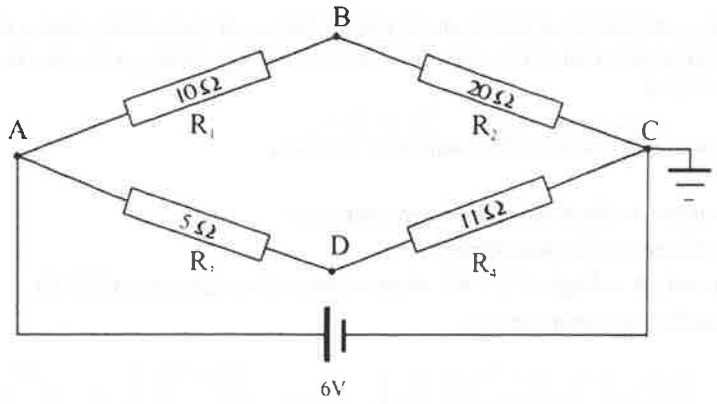
8. (a) Draw a ray diagram to show the formation of a virtual image in a concave mirror. (6)
A dentist holds a concave mirror of focal length 25 mm at a distance of 20 mm from a cavity in a tooth. Where is the image of the cavity and what is its magnification? (12)
Explain why a concave mirror should not be used as a rear-view mirror in a car. (6)

(b) The focal length, and hence the power, of a diverging lens can be determined by placing it in contact with a converging lens such that the two lenses together act as a converging lens.
In an experiment to measure the focal length of a diverging lens, a converging lens of power + 0.05 m^{-1} is placed in contact with it. The combination has a power of + 0.02 m^{-1}.
Describe how the focal length of the combination could have been determined experimentally.
What is the focal length of the diverging lens? (21)

Use a ray diagram to show how short sight can be corrected using a diverging lens. (11)

9. Describe, with the aid of a circuit diagram, how a potential divider can provide a variable voltage from a fixed voltage supply. (9)

Derive an equation for the effective resistance of two resistors joined in series. (12)



The diagram shows a Wheatstone bridge circuit that is almost balanced, with the point C earthed.

Calculate the current flowing through the resistor R_1 and hence calculate the potential at the point B. (12)

What is the potential at the point D? (6)

If a galvanometer is connected between the points B and D, what is the direction of the current flowing through it? (6)

What value of the resistance of R_4 would make the galvanometer read zero? (5)

Give two practical uses for a Wheatstone bridge. (6)

10. Outline the contribution of Michael Faraday to the development of the understanding of electricity in the 19th century. (12)

State the laws of electromagnetic induction. Describe an experiment to demonstrate one of these laws. (21)

The vertical component of the magnetic flux density of the earth's magnetic field is 7.9×10^{-6} T.

A train is travelling at 100 km h^{-1} along two continuous horizontal metal tracks, which are 2 m apart.

What would be the reading on a voltmeter connected across the tracks? (17)

Why would the voltmeter read zero if it were attached across two ends of one of the train's axles? (6)

11. Give the composition of the proton and the neutron in terms of quarks. (6)

A quark and an antiquark combine to form a meson. The π - meson family is made up of u and d quarks only.

A π - meson can be positively charged, negatively charged or neutral.

Give the quark composition of each of the three types of π - meson. (12)

A beam of charged π - mesons is travelling with a speed $v = 0.3c$ (where c is the speed of light in a vacuum).

What is the mean distance travelled before decay? The mean life of a π - meson is 2.6×10^{-8} s. (6)

List three of the fundamental forces of nature and give one property of each. (18)

Describe how particle accelerators have increased our knowledge of particle physics. (14)

OR

11. How would you demonstrate that a current-carrying conductor experiences a force when placed in a magnetic field? (9)

A moving-coil galvanometer has a resistance of 100 Ω and it gives a full-scale deflection when a current of 1 mA flows through it. It is converted to a voltmeter with a full-scale deflection of 1 V by placing a resistor in series with it. Calculate the resistance of the resistor. (12)

Draw a labelled diagram of a simple d.c. motor and explain how it works. (18)

Transformers have many applications in the home. Give two examples. (6)
List two factors that affect the efficiency of a transformer. (6)
A transformer is used to give an output voltage of 2.2 kV when connected to the mains (230 V).
Calculate the turns-ratio of the coils in the transformer. (5)

12. *Irish Times: 19 February 2000*

Pupils from 13 schools at risk from radon

An Irish secondary school has radon gas more than thirteen times the safety level set by the Radiological Protection Institute of Ireland (RPII). It is among 13 schools whose radon levels are so high that immediate remedial action needs to be taken.
The safety limit for radon gas, which can cause lung cancer, is 200 becquerels per cubic metre.
The school's levels were measured at 2688 becquerels in a survey carried out by the RPII last year.
Radon is a naturally occurring radioactive gas, which is formed by the radioactive decay of uranium, which is present in all rocks and soils. If the gas enters an enclosed space it can rise to unacceptably high levels.

(i) Name the physical quantity that is measured in becquerels and give the definition of this unit. (12)

(ii) Explain the term *radioactive decay*. (9)

(iii) Outline how the level of radon gas could have been measured. (9)

(iv) According to the above article, radon gas can cause lung cancer. How can radon gas cause lung cancer? (12)

(v) Suggest what remedial action could be taken to reduce the level of radon gas in the school. (9)

(vi) Name another source of natural radiation. (5)