INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

PHYSICS

Standard Level

Friday 5 November 1999 (afternoon)

Paper 2 — 1 hour

A

Candidate name:	Candidate category & number:

This examination paper consists of 2 sections, Section A and Section B.
The maximum mark for Section A is 25.
The maximum mark for Section B is 25.
The maximum mark for this paper is 50.

INSTRUCTIONS TO CANDIDATES

Write your candidate name and number in the boxes above.

Do NOT open this examination paper until instructed to do so.

Section A: Answer ALL of Section A in the spaces provided.

Section B: Answer ONE question from Section B in the spaces provided.

At the end of the examination, complete box B below by stating the question answered from Section B.

B

QUESTIONS ANSWERED
A/ ALL
B/

C

EXAMINER	TEAM LEADER
/25	/25
/25	/25
TOTAL /50	TOTAL /50

D

IBCA
/25
/25
TOTAL /50

EXAMINATION MATERIALS

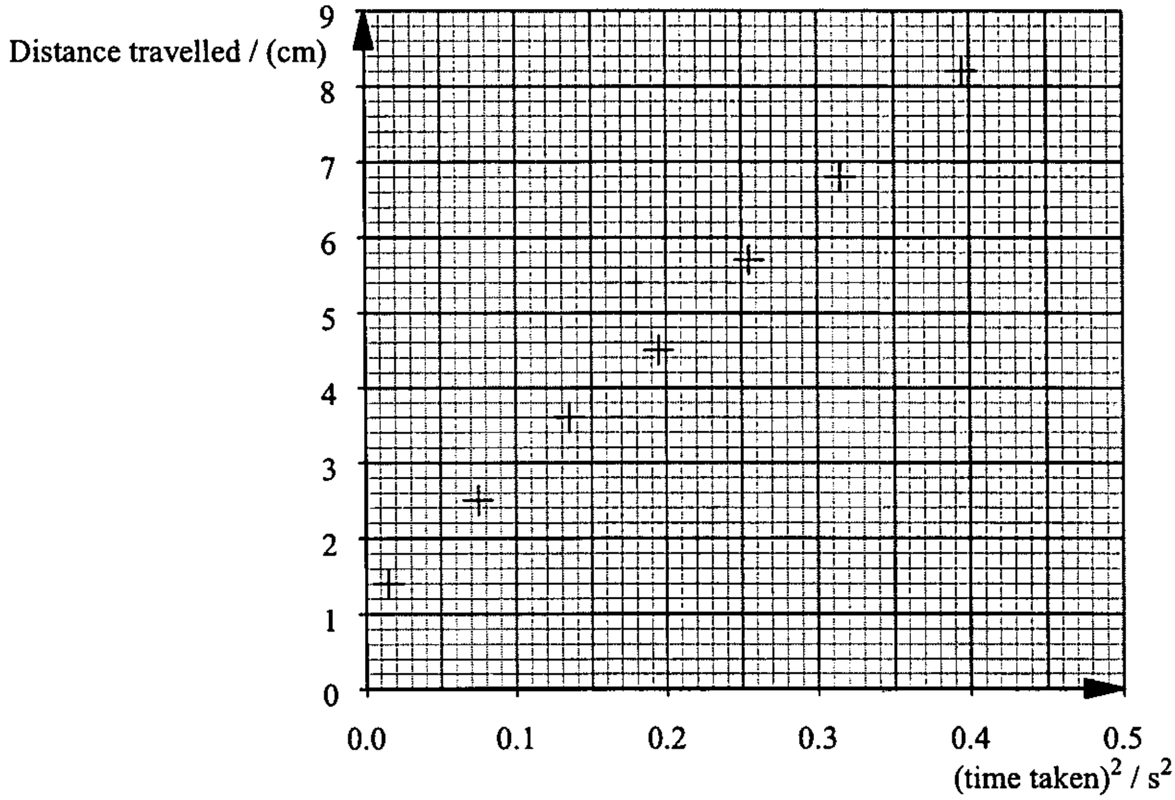
Required:
Calculator
Physics SL Data Booklet

Allowed:
A simple translating dictionary for candidates not working in their own language

SECTION A

Answer ALL questions in this section.

A1. An object is rolled from rest down an inclined plane. The distance travelled by the object was measured at seven different times. A graph was then constructed of the distance travelled against the (time taken)^2 as shown below.



(a) (i) What quantity is given by the gradient of such a graph? *[2]*

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(ii) Explain why the graph suggests that the collected data is valid but includes a **systematic error**. *[2]*

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(Question A1 continued)

(iii) Do these results suggest that distance is proportional to (time taken)^2? Explain your answer. *[2]*

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(iv) Making allowance for the systematic error, calculate the acceleration of the object. *[2]*

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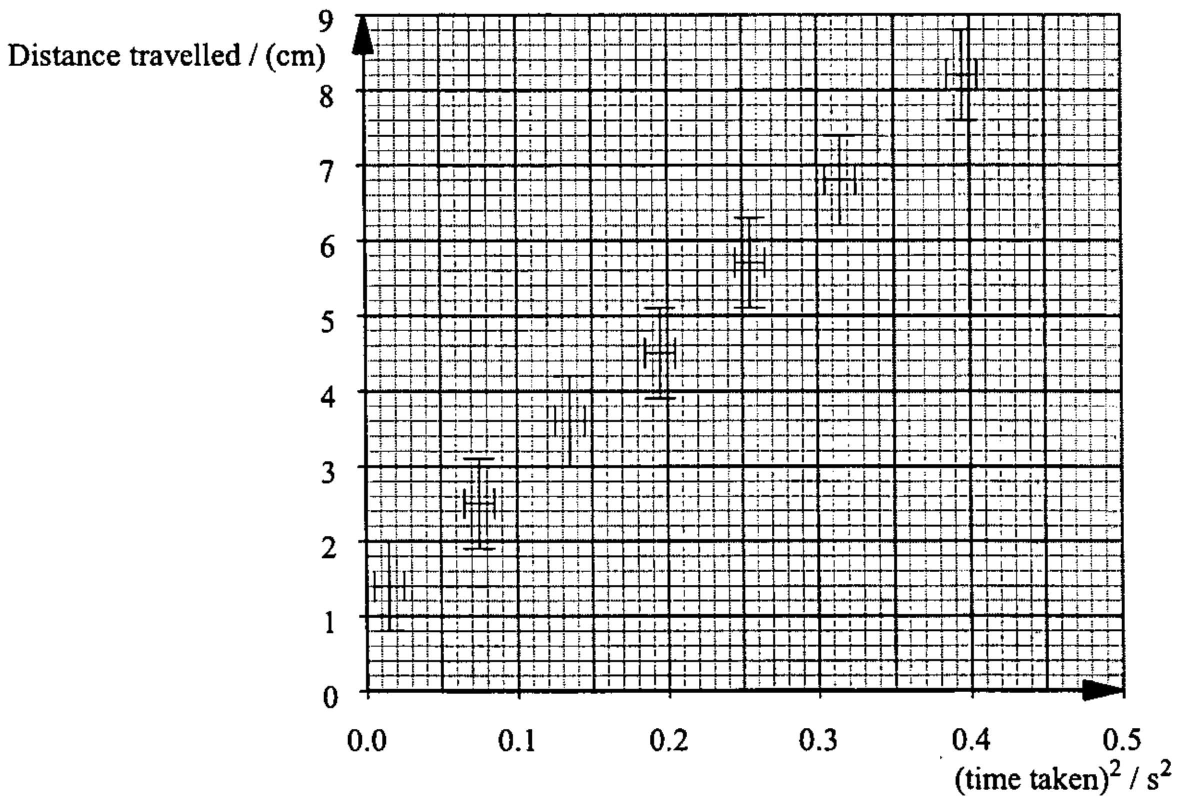
(b) The following graph shows that same data after the uncertainty ranges have been calculated and drawn as error bars.



Add two lines to show the range of the possible acceptable values for the gradient of the graph. *[2]*

A2. Water flows over a waterfall of height 75 m at a volume flow rate of 6.0 $m^3\ s^{-1}$ and then lands in a pool below.

(a) Outline the energy changes that take place. *[1]*

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(b) It is suggested that installing a turbine at the bottom of the waterfall could provide a source of electrical energy. Estimate the power that might be available, stating **one** assumption that you make.

(The density of water = 1000 kg m^{-3}) *[4]*

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(c) In fact, not much useful electrical energy would be available from such a system because most of the energy simply raises the temperature of the water. Given the following information, calculate the temperature rise for the water.

- 70% of the potential energy is converted into internal energy.
- Specific heat capacity of water = 4200 J $kg^{-1}\ K^{-1}$ *[4]*

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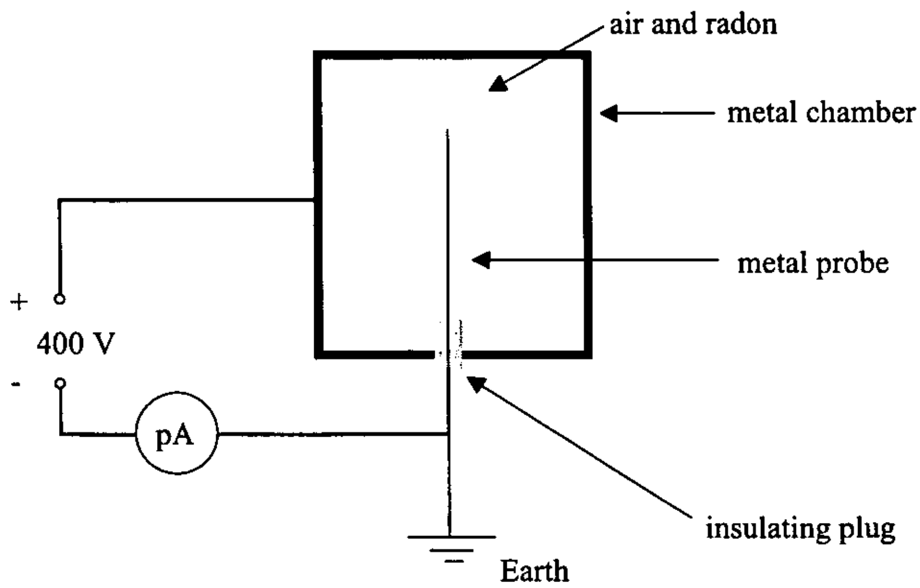
A3. *This question is about an instrument used to detect radiation.*

The diagram below shows the basic components of an 'ionisation chamber' for detecting radiation. It consists of a metal chamber containing air. The walls of the chamber are maintained at a potential of 400 V above earth. A metal probe inside the chamber is insulated from the walls of the chamber and is kept at earth potential. The meter labelled 'pA' is a sensitive ammeter (picoammeter).

When a small amount of radioactive radon gas (an alpha-emitter) is introduced into the chamber, the pA meter registers a small current.



(a) (i) Describe the processes that give rise to the small current. *[3]*

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(ii) In practice, the current diminishes with time. Explain why. *[1]*

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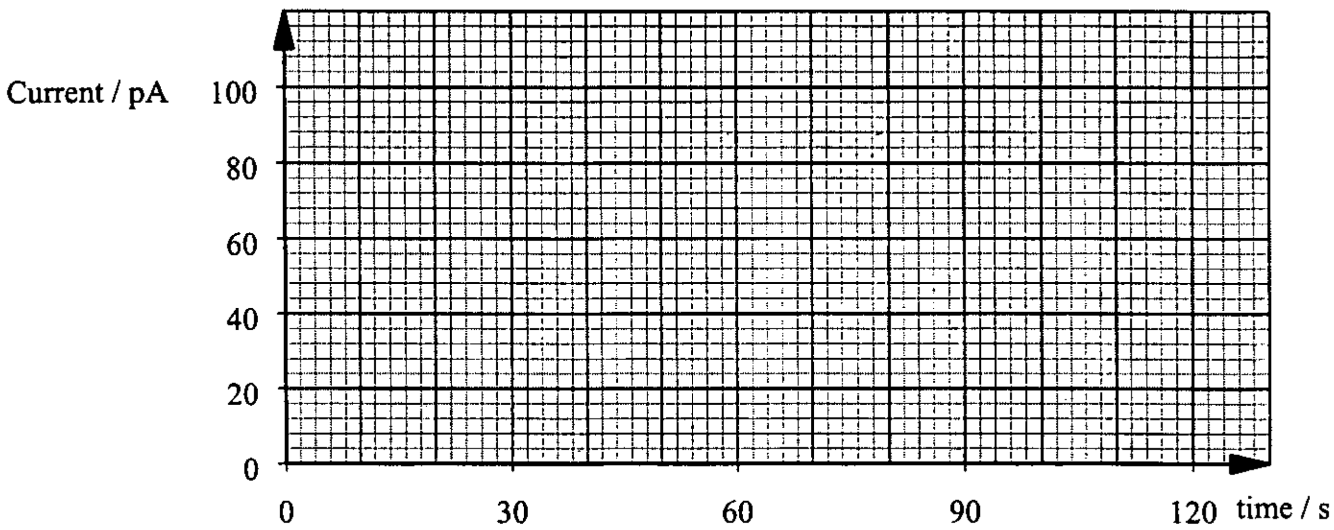
(Question A3 continued)

(b) The initial value of the current is 80 pA and the half-life of radon is 60 s. On the axes below plot a graph to show how the current changes with time. *[2]*



SECTION B

Answer only ONE question from this section. Write your name and candidate number on each extra sheet of paper and attach it this booklet.

B1. *This question is about different types of waves.*

A violin string is fixed at both ends. It can oscillate in different ways.

(a) On the diagrams of the string below, sketch the pattern of vibration for the fundamental, and one of the harmonic modes. *[2]*

Fundamental

Harmonic

(b) (i) If the string is 0.400 m long, calculate the wavelength of the fundamental on the string. *[2]*

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(ii) If the fundamental frequency for the string is 440 Hz, calculate the frequency of the harmonic that you have drawn. *[1]*

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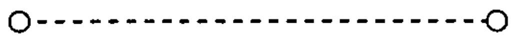
(This question continues on the following page)

(Question B1 continued)

(c) The violinist wishes to play a note of fundamental frequency 524 Hz. This is done by using a finger to shorten the effective vibrating length of the string.

(i) Use the diagram below to sketch the pattern of vibration for the new fundamental. *[1]*

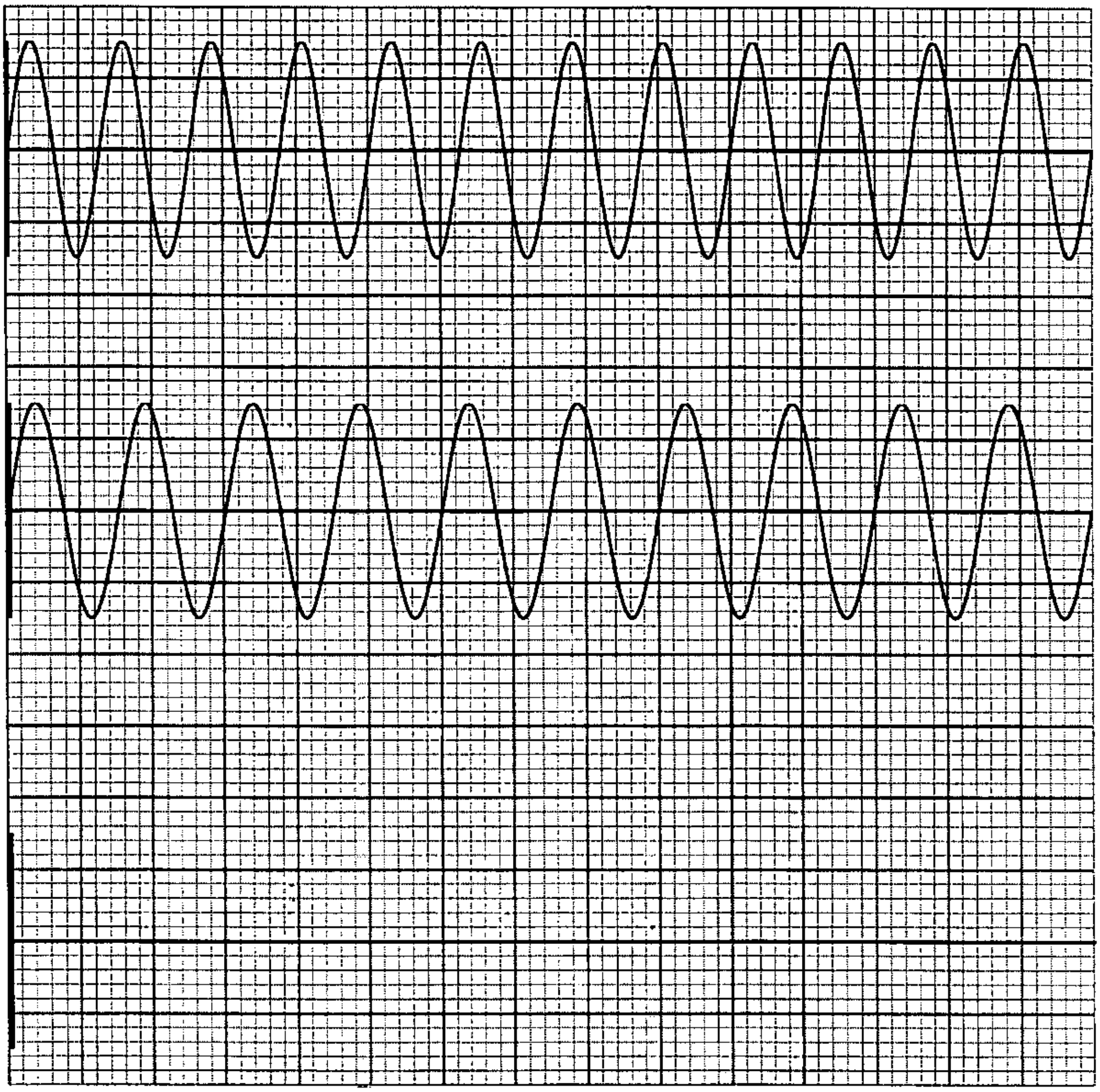


(ii) Determine where on the string the violinist should place his finger in order to produce the new note. *[3]*

(This question continues on the following page)

(Question B1 continued)

(d) When playing in an orchestra, players must ensure that their instruments are in tune with each other. If they do not, then **beats** may be heard when they try to play the same note. Describe what **beats** sound like, **and** explain how they are formed. (You can refer to the sketches below, and you may add to them if you wish.) *[6]*



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(Question B1 continued)

(e) Young's double slit experiment demonstrated that light has wave properties.

(i) Sketch the apparatus and describe Young's experiment. *[4]*

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(ii) Sketch and label the pattern produced by red (monochromatic) light. *[3]*

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(Question B1 continued)

(iii) Explain why this pattern appears. *[3]*

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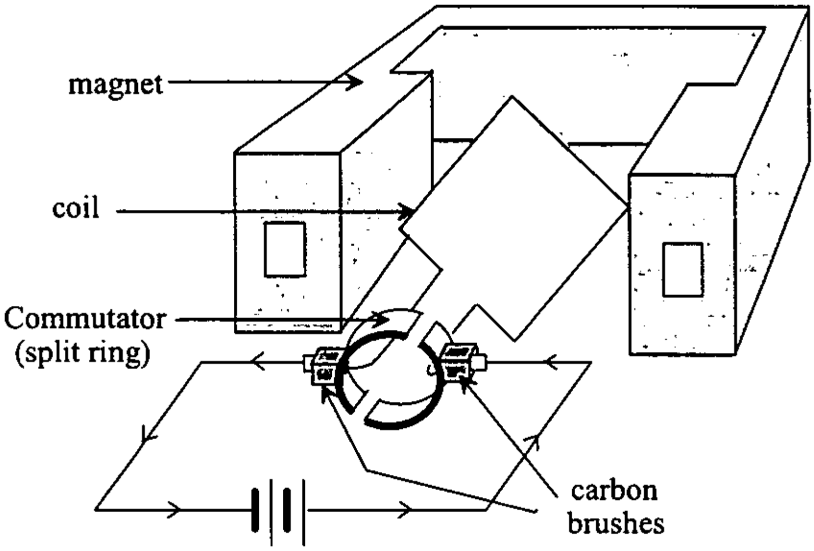
B2. *This question is about the structure and operation of a motor.*

Below is a schematic diagram of a d.c. motor.



(a) With a battery connected as shown, the motor coil is observed to rotate **clockwise**.

(i) Indicate on the diagram the direction of the electromagnetic forces on the coil. *[1]*

(ii) Determine which are the N and S poles of the magnet and label them on the diagram. *[2]*

(iii) What is the purpose of the commutator? Explain how it achieves its purpose. *[3]*

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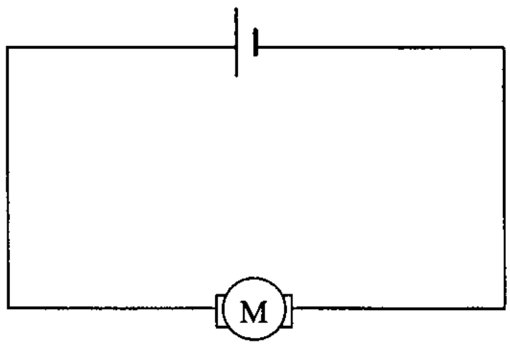
(This question continues on the following page)

(Question B2 continued)

(b) A student wishes to study the electrical properties of a small d.c. motor while it is doing work. To do so, she arranges that the motor will raise a mass while she measures the circuit current and potential difference (p.d.) across the motor.

(i) On the diagram below, show how to connect the voltmeter and the ammeter in the circuit in order to measure the p.d. across the motor and the circuit current. *[2]*



A 6.00 kg mass is fastened by a string to the shaft of the motor. The mass is raised slowly at a constant speed to a height of 0.80 m in 24 s. During this time, the readings of the voltmeter and ammeter are 6.0 V and 0.50 A respectively.

(ii) Calculate the electrical power delivered to the motor. *[3]*

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(iii) Calculate the power delivered to the mass. *[3]*

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(iv) Calculate the efficiency of the motor. *[2]*

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(Question B2 continued)

(c) The student now wishes to run this motor using the 230 V a.c. mains supply rather than a battery. She needs to transform the 230 V a.c. mains supply into a 6 V a.c. supply and then she needs to convert from a.c. to d.c.

(i) Explain the principles of how a transformer is able to produce a low voltage a.c. from a higher voltage a.c. supply. *[4]*

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(ii) If there are 690 turns on the primary of the transformer, calculate the number of turns on the secondary. *[2]*

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(Question B2 continued)

(iii) If the transformer was 80 % efficient and its output supplied one kilowatt-hour of electrical energy, calculate the electrical energy input in joules. *[3]*

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B3. *This question is about the oscillations of a bouncing ball.*

A ball is dropped from rest from a height of 20 m on to a hard surface where it makes an elastic collision. If frictional losses are very small, it returns to its original height and continues to bounce up and down.

(a) Show that the time taken for the ball to reach the ground from its starting position is 2 s. *[2]*

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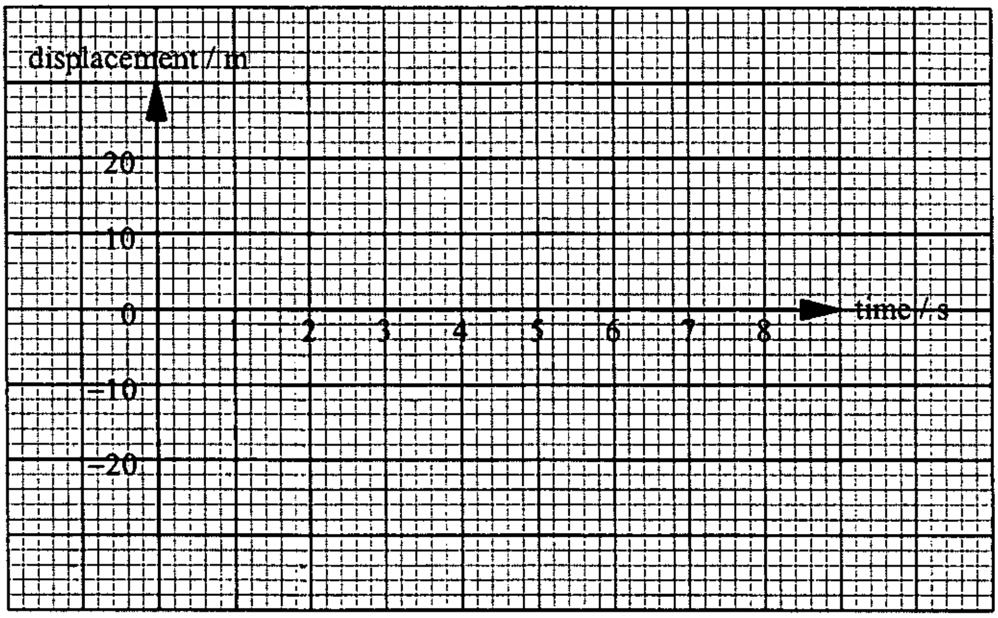
(b) Use the axes below to sketch a graph of how the **displacement** of the ball varies from its original position during several bounces *[4]*



(c) Show that the speed of the ball just before it hits the ground is 20 m s^{-1}. *[2]*

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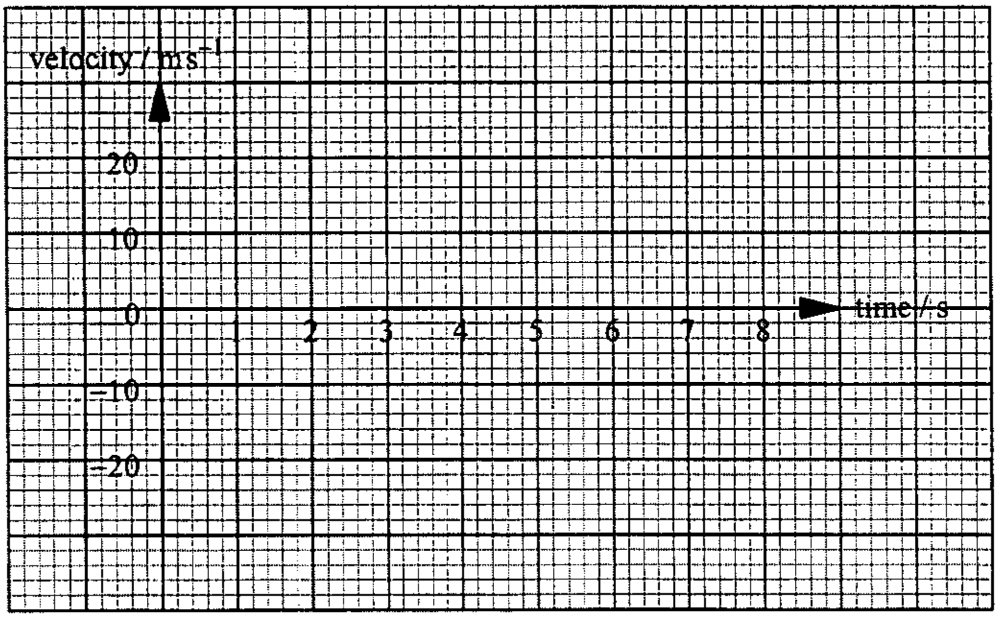
(Question B3 continued)

(d) Use the axes below to sketch a graph of how the **velocity** of the ball varies during the same bounces as part (b). *[4]*



(e) (i) Identify the **two** forces that act on the ball during its collision with the ground. *[2]*

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(ii) Each of the forces that you named in (e) (i) will form a Newton's third law pair with another force. Identify these **two** other forces and state the direction in which they act. *[3]*

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(Question B3 continued)

(iii) Calculate the average value of the acceleration of the ball during the collision, if the time taken for the collision was 0.1 s. *[3]*

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(iv) If the mass of the ball is 500 g, calculate the average value of the resultant force acting on the ball during its collision with the ground. *[3]*

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(f) Is this bouncing motion an example of **simple harmonic motion**? Justify your answer. *[2]*

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