INTERNATIONAL BACCALAUREATE
BACCALAURÉAT INTERNATIONAL
BACHILLERATO INTERNACIONAL

PHYSICS
STANDARD LEVEL
PAPER 2

Monday 8 May 2000 (afternoon)

1 hour

Name

Number

INSTRUCTIONS TO CANDIDATES

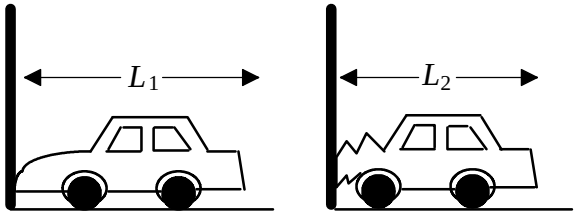
- Write your candidate name and number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Section A: Answer all of Section A in the spaces provided.
- Section B: Answer one question from Section B in the spaces provided.
- At the end of the examination, indicate the number of the Section B question answered in the box below.

QUESTIONS ANSWERED		EXAMINER	TEAM LEADER	IBCA
SECTION A	ALL	/25	/25	/25
SECTION B	. . . . .	/25	/25	/25
		TOTAL /50	TOTAL /50	TOTAL /50

SECTION A

*Candidates must answer **all** questions in the spaces provided.*

A1. This question is about finding the force that acts upon a car when it is in a head on collision.



In order to measure collision forces a car is crashed head-on into a flat, rigid barrier and the resulting crush distance d is measured. The crush distance is the amount that the car collapses in coming to rest. In the above diagram the crush distance $d = L_1 - L_2$.

(a) Show that the average crush force exerted on a car of mass m with impact speed v is equal to $\frac{mv^2}{2d}$. *[2]*

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(b) The table below gives values of the crush distance, d, for different impact speeds v, of cars of the same make. (Uncertainties in measurement are not given.)

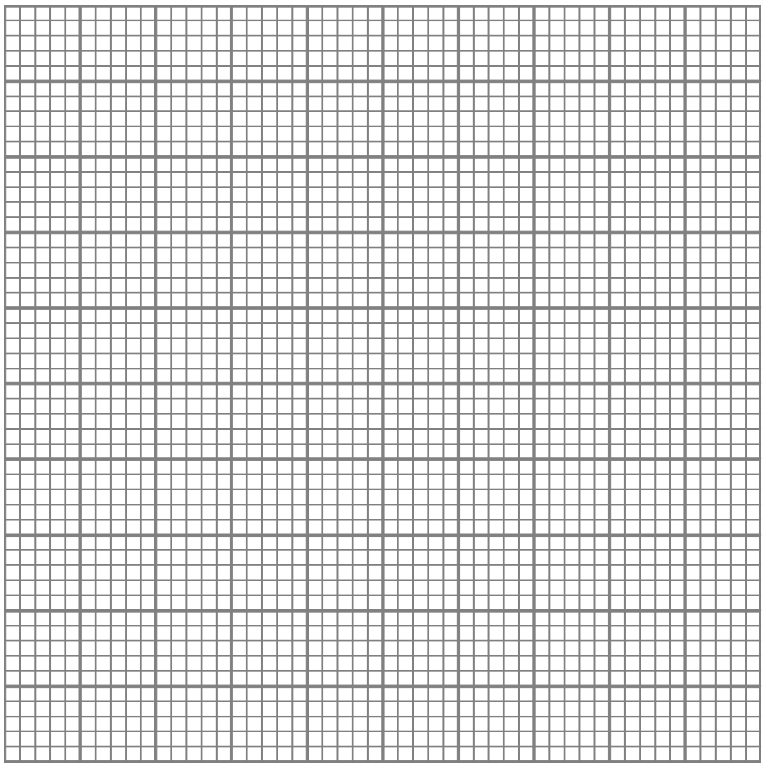
v / m s^{-1}	d / m	$\frac{v^2}{d}$ / m s^{-2}
0	0	0
3.0	0.08	. . . . .
10.0	0.35	. . . . .
15.0	0.65	. . . . .
20.0	1.02	. . . . .

Complete the last column of the table. *[1]*

(This question continues on the following page)

(Question A1 continued)

(c) On the grid below plot a graph of $\frac{v^2}{d}$ against v. *[4]*



(d) Consider the situation in which a car of mass 1200 kg has an impact speed of 12 $\mathrm{m\,s^{-1}}$. Use information from the graph you have drawn to find the average force exerted on the car during the collision as it is brought to rest. *[2]*

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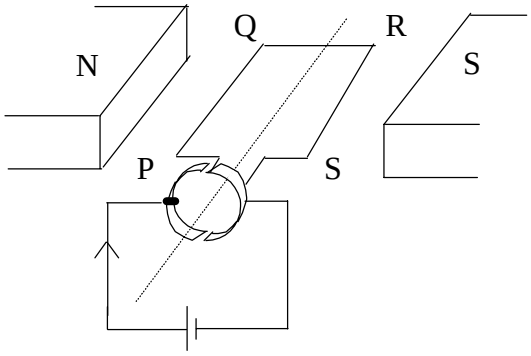
A2. This question is about the simple d.c. electric motor.

The diagram below shows a sketch of a simple d.c. electric motor.



(a) Draw the direction of the force acting on the side PQ and the side RS. *[1]*

(b) It is noted that when the loop is first connected to the battery the initial current measured in the loop is greater than the current measured when the loop is rotating at a steady speed. Explain this. *[4]*

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A3. This question is about the phase (state) changes of the element lead.

A sample of lead has a mass of 0.50 kg and a temperature of 27 °C. Energy is supplied to the lead at the rate of 1.5 kW. After 0.2 minutes of heating it reaches its melting point temperature of 327 °C. After heating for a further 3 minutes all the lead has become liquid.

(a) Assuming that all the energy goes into heating the lead, calculate a value for the

(i) specific heat capacity of lead. *[3]*

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(ii) latent heat of fusion of lead. *[2]*

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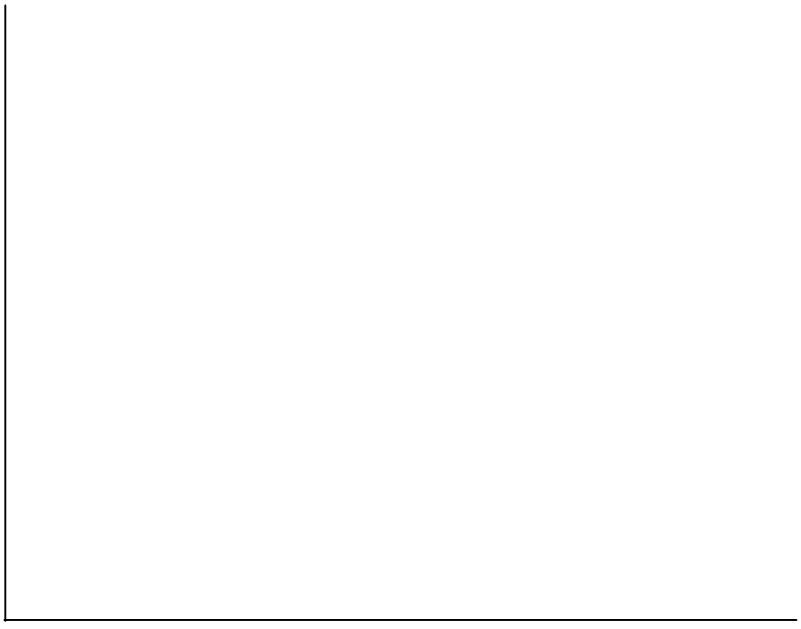
(b) Energy continues to be supplied to the lead. On the axes below sketch a graph to show how the temperature of the lead varies with time from the start of heating to some 5 minutes after the time when all the lead has become liquid. Indicate on the graph the time at which it starts to melt and the time when it has become liquid. *[2]*

(You are not expected to have accurate scales, this is just a **sketch** *graph.)*



A4. This question is about the isotope tritium.

(a) When the element $^{6}_{3}\mathrm{Li}$ is bombarded with neutrons the isotope $^{3}_{1}\mathrm{H}$ (tritium) and another element are produced. Write down the equation for this reaction and identify the other element.

[2]

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(b) Tritium is radioactive with a half-life of 12.2 years. If the activity of a particular sample of tritium is measured as 800 disintegrations s^{-1}, how long will it take the activity of the sample to fall to 100 disintegrations s^{-1}? *[2]*

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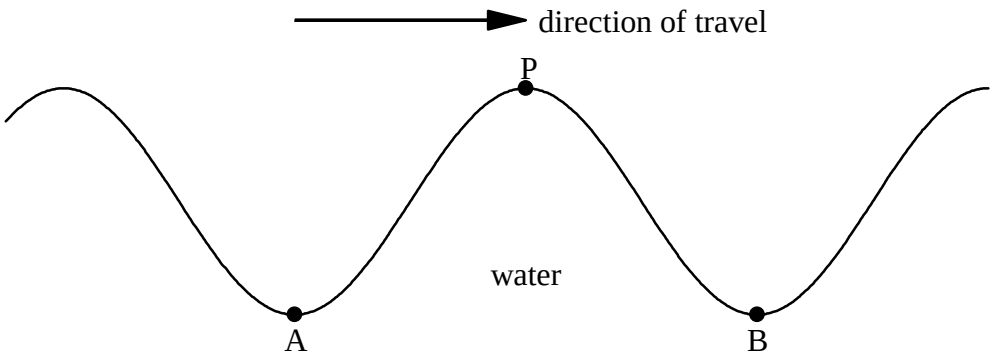
SECTION B

*This section consists of three questions: B1, B2 and B3. Answer **one** question in this section.*

B1. This question is about the properties of water waves, the energy that they carry and the conversion of this energy into electrical energy.

The diagram below, which is not to scale, represents an instantaneous photograph of a section of deep water through which a wave is moving. The arrow gives the direction of travel of the wave and P is a molecule of water.

As the wave moves forward the water molecule P travels in a circle of radius equal to the amplitude of the wave.



(a) Show on the diagram

(i) the wavelength of the water wave; *[1]*

(ii) the amplitude of the water wave; *[1]*

(iii) the direction of the acceleration of the molecule P. *[1]*

(b) In the space below sketch a diagram of the section A to B of water wave after the molecule P has completed one half of its circular path. Show on your diagram the new position of P and the direction of the acceleration of P. *[3]*

(This question continues on the following page)

(Question B1 continued)

(c) The speed c of a wave in deep water depends on its wavelength and is given by $c = \sqrt{\frac{\lambda g}{2\pi}}$ where λ is the wavelength and g is the acceleration due to gravity.

For deep water waves of wavelength 100 m and taking $g = 10 \text{ m s}^{-2}$, calculate the

(i) speed of waves; *[1]*

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(ii) frequency of the waves; *[2]*

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(iii) time it takes a water molecule to go round one complete circular path. *[3]*

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(d) Particular deep water waves of wavelength 100 m have an amplitude of 1.0 m. Assuming the molecules move with constant speed, calculate the speed of a molecule of water in such a wave. *[3]*

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(e) Use your answer to (d) above to explain why deep water waves of amplitude 2.0 m will propagate **four** times as much energy as waves of amplitude 1.0 m. *[3]*

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(This question continues on the following page)

(Question B1 continued)

(f) The power generated by the waves can be converted into electrical power by generating an alternating voltage. For a particular system the power generated is 45 MW.

(i) If the voltage generated is 250 V what is the value of the current generated? *[2]*

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(ii) The voltage is stepped up by an ideal transformer to a value of 2.5×10^5 V. What is the corresponding value of the current in the secondary of the transformer? *[3]*

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(iii) Show that as a result of stepping up the voltage, transmission power losses in the cables will be reduced by a factor of 10^6. *[2]*

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B2. This question is about the motion of a firework rocket.

A firework rocket is fired vertically upwards from the ground. It accelerates uniformly from rest with an acceleration of 8.0 $\mathrm{m\,s^{-2}}$ for 5.0 s after which time the fuel of the rocket has all been used.

(a) (i) Sketch below a graph to show how the **velocity** of the rocket changes with time from the moment it leaves the ground until the moment that it returns to the ground. Mark on your sketch the time t_1 at which the fuel has run out, the time t_2 at which the rocket reaches its maximum height and the time t_3 at which it reaches the ground. *[6]*

(Note that you are not expected to give any quantitative values of velocity and time and air resistance can be ignored.)

(ii) Comment on the area(s) under the graph that you have drawn. *[2]*

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(This question continues on the following page)

(Question B2 continued)

In the following calculations you may ignore any effects of air resistance and take the acceleration due to gravity, $g = 10\ m\,s^{-2}$.

(b) Calculate the

(i) speed of the rocket when the fuel runs out. *[2]*

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(ii) height that the rocket reaches when the fuel has just run out. *[2]*

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(iii) maximum height reached by the rocket. *[3]*

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(iv) time it takes the rocket to reach its maximum height. *[2]*

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(v) time that it takes to fall from its maximum height to the ground. *[2]*

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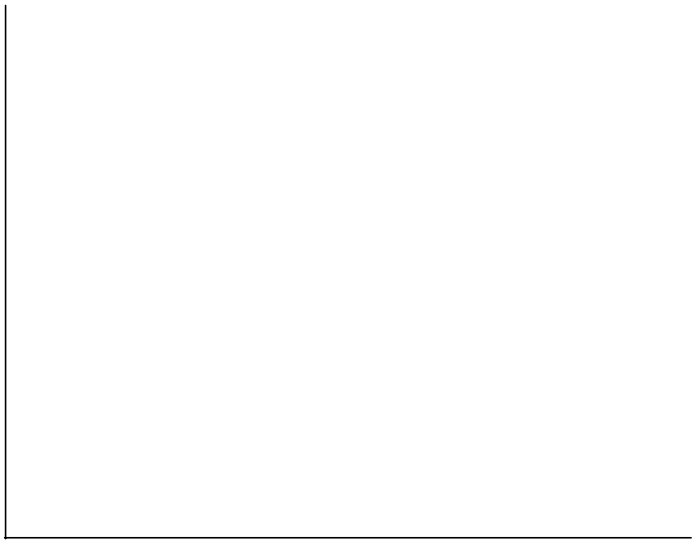
(This question continues on the following page)

(Question B2 continued)

(c) On the axes below sketch graphs to show how the gravitational potential energy and the kinetic energy of the rocket vary as it moves from the ground to its maximum height. *[4]*

(Note that this is only a sketch graph; you do not need to add any numerical values.)



(d) The rocket plus fuel initially have a mass of 0.16 kg. If the initial mass of the fuel is 0.02 kg, calculate the maximum kinetic energy of the rocket when all the fuel has been used. *[2]*

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B3. This question is about electrical conduction and electric circuits.

(a) A conducting material can be thought of as a crystal lattice through which the conductors move at random. Explain how this model of a conductor explains that

(i) when an electric current flows in a conductor the temperature of the conductor rises; *[2]*

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(ii) the electrical resistance of a conducting wire is inversely proportional to the area of cross-section of the wire. *[3]*

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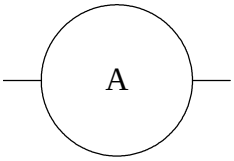
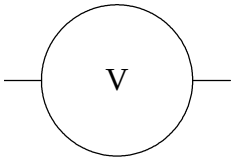
(Question B3 continued)

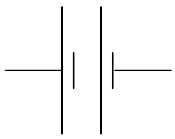
(b) You are given the apparatus shown below which is identified by the appropriate circuit symbol.



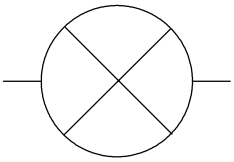
ammeter



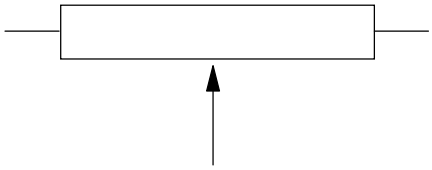
voltmeter



battery (12 V)



bulb



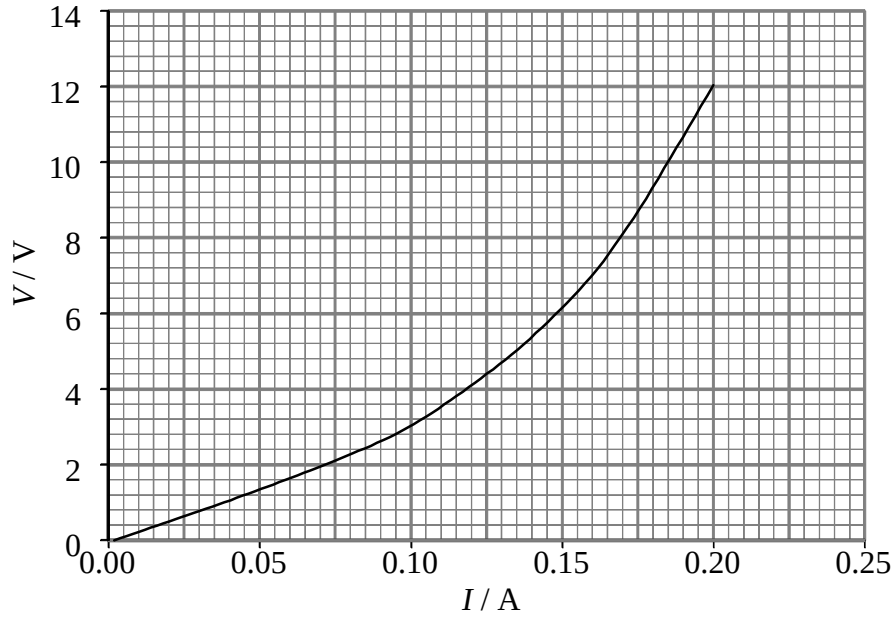
variable resistor

Draw a circuit diagram showing how this apparatus should be connected so that the current through the bulb can be measured as the potential difference across the bulb is varied from **zero** to 12 V. *[4]*

(This question continues on the following page)

(Question B3 continued)

(c) The graph below shows the relationship between the current I through a particular filament lamp and the potential difference V across.



(i) State whether or not the filament of the lamp obeys Ohm's law. *[1]*

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(ii) What is the resistance of the lamp when the potential difference across it is 12 V? *[1]*

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(iii) What is the resistance when the potential difference across it is very small? *[2]*

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(d) How much power is dissipated in the lamp when the potential difference across it is 12 V? *[2]*

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(This question continues on the following page)

(Question B3 continued)

(e) A student connects a filament lamp to a dry battery via a switch. A high-resistance voltmeter connected across the battery reads 12 V when the switch is open. When the switch is closed the voltmeter reads 10.8 V.

(i) Suggest why this might be. *[2]*

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(ii) On measuring the current through the lamp the student finds it to be 0.18 A. Calculate the internal resistance of the battery. *[3]*

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(f) Different countries have different values of mains voltage. In the USA a certain filament lamp is marked "110 V 60 W". In the UK a certain filament lamp is marked "240 V 60 W". When the two lamps are connected to their respective mains supply what will be the ratio (**USA** to **UK**) of the

(i) currents drawn from each supply; *[2]*

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(ii) resistances of each lamp; *[2]*

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(iii) cost of running each lamp for a period of 24 hours? *[1]*

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