Jan 06 PH1 Sample Past Paper 3.

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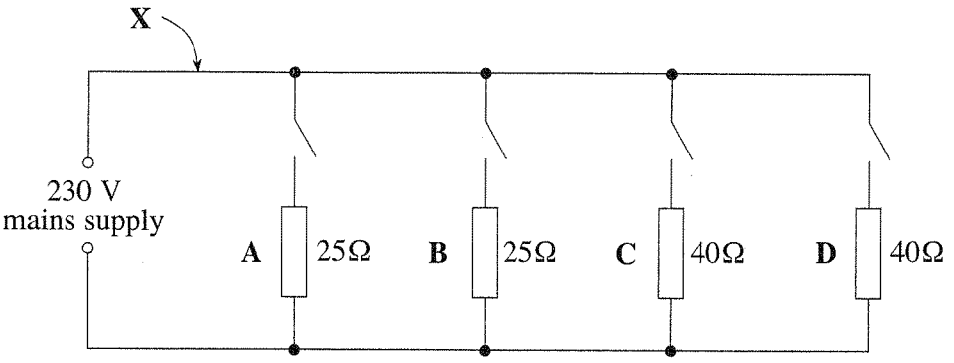
1. An electric 'hob' has four metal 'rings' on which saucepans may be heated. There are two identical large rings, **A** and **B**, and two identical small ones, **C** and **D**. Each ring is heated by passing a current throught a *heating element* (a length of wire) underneath it. [The switches are automatically turned on and off at intervals to keep the average heat output of each ring at a value selected.]



(a) Calculate the currect through

(i) element **A**, when it is switched on, [1]

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(ii) element **C**, when it is switched on. [1]

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(b) Calculate the overall *resistance* of the hob when **all** elements are switched on. [2]

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(c) Calculate the *power* of

(i) element **A**, [2]

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(ii) element **C**. [1]

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(d) Which **two** combinations of rings, when switched on, would give a current of between 20 A and 21 A through wire **X**? Explain your reasoning. [3]

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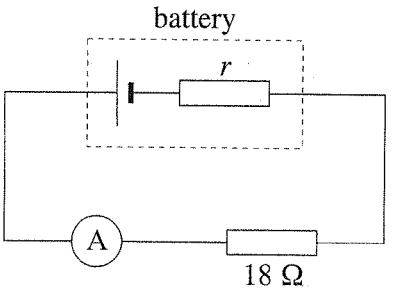
2. A battery is labelled "9V, 450 mAh". This may be assumed to mean that the battery has an e.m.f. of 9·0 V, and will supply a current of 450 mA for one hour before running out of energy.

It is found that a steady current of 450 mA flows when an 18 Ω resistor is connected across the battery terminals. [The resistance of the ammeter is negligible.]



(a) Calculate

(i) the battery's *internal resistance*, [2]

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(ii) the total *charge* (in S.I. units) that will flow if the resistor is left connected until the battery has run out of energy, [2]

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(iii) the total energy given to this charge as it passes through the battery, [1]

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(iv) the **fraction** of this energy which is converted in the 18 Ω resistor. [2]

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(b) Suppose that a resistor of higher resistance had been used instead of the 18 Ω resistor, so that the current was 225 mA.

(i) Calculate the resistance of this new resistor. [2]

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(ii) How long, in this case, might the battery be expected to last before running out of energy? [1]

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4. *(a)* State the conditions necessary for a body to remain in equilibrium.

Condition 1: .....

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[1]

Condition 2: .....

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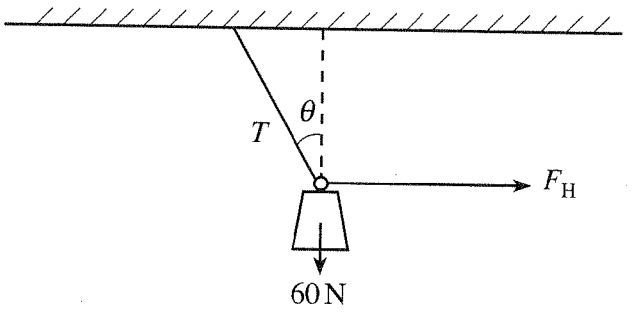
[1]

(b) The diagram shows a weight of 60 N suspended in equilibrium from a rigid beam. F_H is a horizontal force.



(i) Calculate the tension T in the string when $\theta = 30°$. [2]

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(ii) Hence, or otherwise, determine the value of the horizontal force F_H. [2]

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(iii) On the diagram, draw an arrow to represent the **direction** of the resultant force due to F_H and the 60 N weight. [1]

(iv) F_H can be varied in magnitude thus varying T and θ. When T is at its **smallest** possible value write down the values of

(I) F_H, [1]

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(II) θ, [1]

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(III) T. [1]

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5. *(a)* State in words the formula used to calculate the moment of a force about a pivot. [2]

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(b) Diagram 1 shows a beam of wood **(AB)** of weight 40 N pivoted in equilibrium at point **C**.

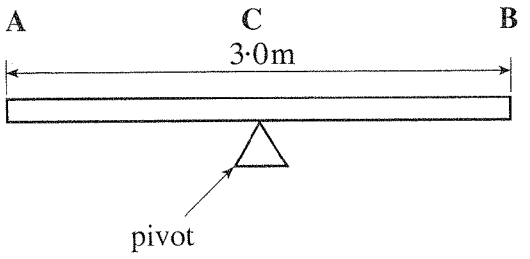

Diagram 1.

(i) Determine the distance **AC**, stating any assumptions you make. [2]

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(ii) A cube of weight 60N is now placed on the beam 1·0m from **C**, between **C** and **A** as shown in diagram 2. The pivot will now have to be moved in order to restore equilibrium.

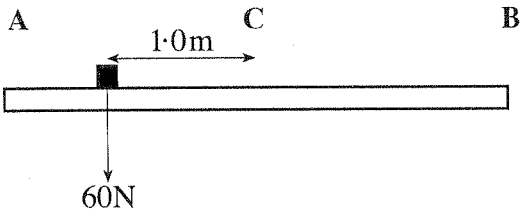

Diagram 2.

(I) **Draw on diagram 2** an approximate (new) position for the pivot so that equilibrium can be restored [1]

(II) Calculate the distance that the pivot has to be moved in order to restore equilibrium. [3]

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(iii) (I) What is meant by the term *centre of gravity*? [1]

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(II) **Draw a vertical arrow** on diagram 2 through the *centre of gravity* of the system, i.e. the beam and the cube. [1]

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7. *(a)* (i) Define acceleration. [1]

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(ii) $s = \frac{(u+v)t}{2}$ is one equation of uniformly accelerated motion. Use this equation and your answer to *(a)*(i) to show clearly that [3]

$$s = ut + \frac{1}{2}at^2$$

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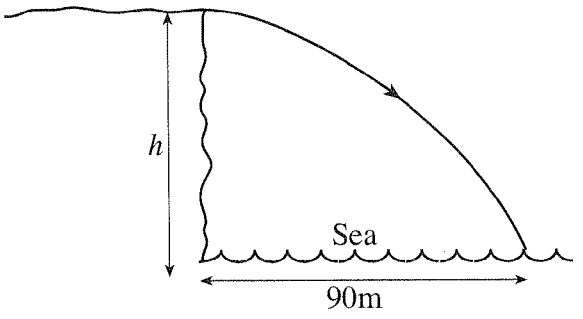
(b) Two students carry out an experiment to determine the height of a cliff. One student throws a stone **horizontally** from the cliff top as shown in the diagram. The other student has a stop watch to record the time of flight of the stone. **Ignore air resistance**.[Refer to the data on page 2.]



(i) The stone took 5·0 s to reach the sea. Determine the height (h) of the cliff. [3]

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(ii) (I) Determine the vertical velocity of the stone at impact. [3]

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(II) The stone landed at a point 90 m from the base of the cliff. Calculate the horizontal velocity of the stone. [1]

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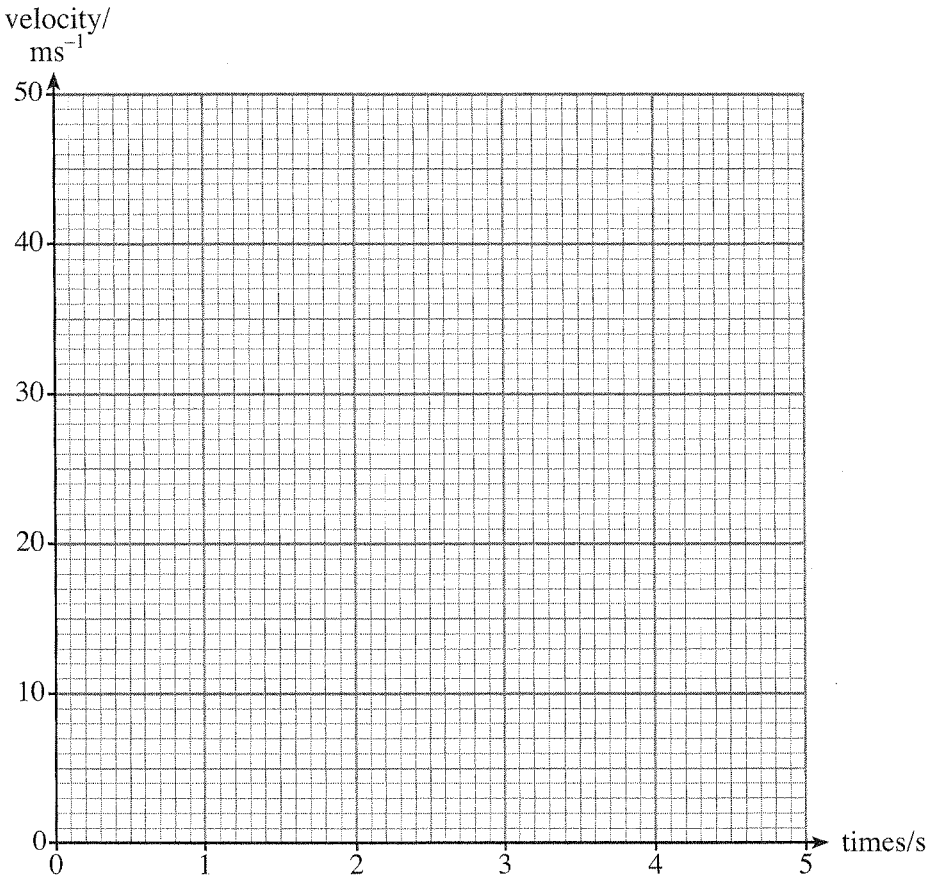
(III) Plot, on the grid below, lines to represent **both** the vertical **and** horizontal velocities of the stone for the time of flight. [2] [1]



(iii) Using the graph (or otherwise) determine the height of the stone above the sea at the instant when the vertical and horizontal velocities are equal in magnitude. [3]

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(iv) Calculate the resultant velocity of the stone just before impact with the sea. [3]

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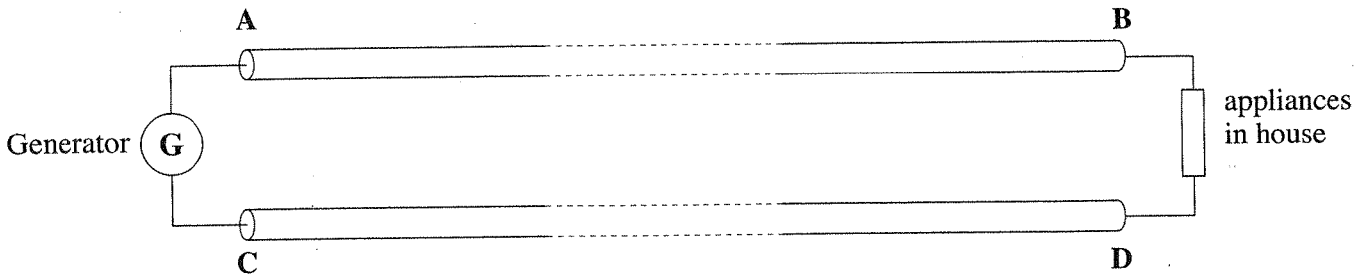
7. A house in a remote location is to be supplied with electrical energy by a generator, **G**, in an out-building. Each of the wires, **AB** and **CD**, from the generator to the house is 120 m long.



(a) It is decided that 100 W is an acceptable power dissipation in **each** wire when a current of 25 A is flowing, and the wires are selected accordingly. Calculate

(i) the p.d. across each wire (that is the p.d. between **A** and **B**, or between **C** and **D**) when 25 A is flowing, [2]

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(ii) the resistance of each wire. [1]

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(b) (i) Calculate the cross-sectional area of the wires if they are made of

(I) copper (resistivity = $1{\cdot}70 \times 10^{-8}\Omega$m) [3]

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(II) aluminium (resistivity = $2{\cdot}65 \times 10^{-8}\Omega$m) [1]

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(ii) Hence compare the cost of the metal for the wires using these data:
price of copper = £110 000 per m^3, price of aluminium = £40 000 per m^3. [3]

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(c) The p.d. across the generator terminals (that is, between **A** and **C**) is 230 V, and its internal resistance is negligible.

(i) (I) Referring to part *(a)*, calculate the p.d supplied to the house (that is the p.d. between **B** and **D**) when the current is 25 A. [2]

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(II) State, giving a reason, the p.d. between **B** and **D** when there is no current (because all household appliances are turned off). [2]

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(ii) (I) Calculate the electrical power supplied by the generator when the current is 25 A. [1]

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(II) Calculate the cost of supplying this power for a time of one hour, given that the fuel for the generator costs 5.0p for each megajoule of electrical energy produced. [3]

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(III) Determine whether this cost is more or less than the cost of the same quantity of electrical energy from a mains supply, at 8.0p per 'unit' [A *unit* or *kilowatt hour* is the energy used in one hour at a rate of consumption of 1·0kW.] [2]

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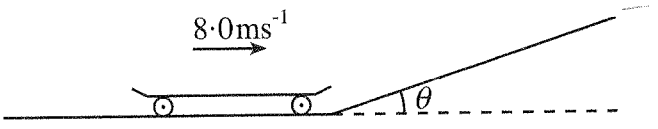
7. *(a)* A free fall parachutist drops vertically. The statements in the left hand boxes **describe** her motion at various stages of her descent. The statements in the right hand boxes **explain** the various stages of the descent in term of physical quantities such as velocity and acceleration.

Join the correct description to the correct explanation. [4]

The instant the parachutist starts her descent.	The parachutist is accelerating but her acceleration is decreasing.
The parachutist is descending but has not reached terminal velocity.	The parachutist has stopped accelerating but she continues to travel with constant velocity.
The parachutist has reached terminal velocity.	The parachutist continues to move in one direction, but her acceleration is directed in the opposite direction.
The parachutist has just opened her parachute.	The parachutist's velocity is zero, but her acceleration is a maximum.

(b) A skateboard travelling at a constant velocity of $8{\cdot}0 ms^{-1}$ approaches an inclined plane as shown.



(i) Show that, when $\theta = 24°$ the skateboard's acceleration is $-4{\cdot}0\,ms^{-2}$. Ignore friction. [Refer to the constants on page 2]. [2]

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(ii) Calculate the distance travelled by the skateboard up the inclined plane until it comes to rest. [3]

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(iii) Calculate the vertical height moved by the skateboard. [2]

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(iv) Calculate the time taken for the skateboard to come to rest from the moment it starts to move up the inclined plane. [3]

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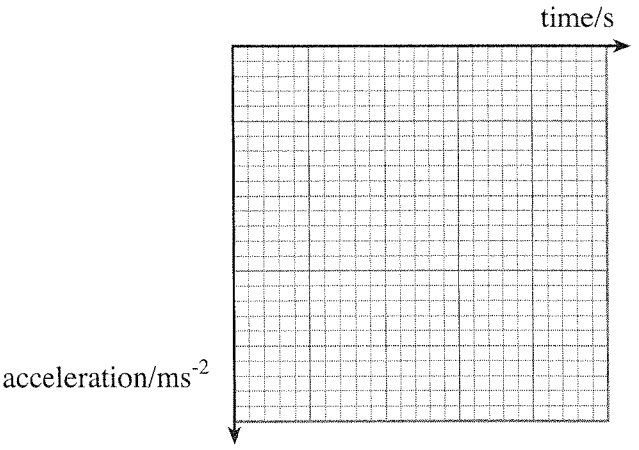
(v) On the axes below, draw an acceleration-time graph for the movement of the skateboard up the inclined plane. You should include numerical values on both axes. The maximum value on the time axis should be the value calculated in *(b)*(iv). [3]



(vi) Calculate the area between the graph line and the time axis. [1]

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(vii) Comment on your answer to *(b)*(vi) stating what this area represents. [2]

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