June 04 Additional Examination Questions - use as required.

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4. *(a)* A useful equation applying to a cell of e.*m.f.* *E* and internal resistance *r* is

$$V = E - Ir.$$

(i) State what is meant by the *e.m.f.* of the cell. [2]

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(ii) What does *V* represent? [1]

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(iii) What does *Ir* represent? [1]

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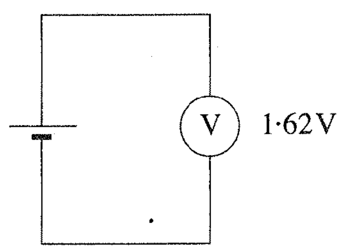
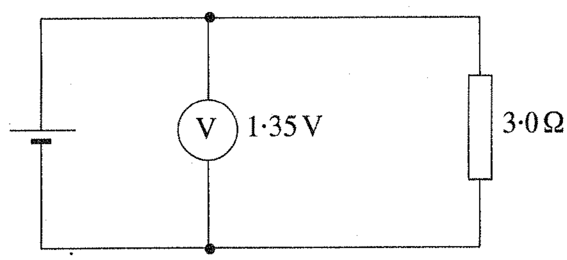
(b) A voltmeter connected across the terminals of a cell reads 1·62 V. The reading drops to 1·35 V when a 3·0 Ω resistor is connected in parallel with the voltmeter.





(i) (I) State the value of the e.m.f. of the cell. [1]

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(II) Calculate the cell's internal resistance. [2]

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(ii) Calculate the rate, in watts, at which the cell's stored energy is converted when the resistor is connected. [2]

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(iii) Calculate the power which is dissipated in the $3{\cdot}0\,\Omega$ resistor. [1]

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Jan 03

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3. *(a)* A fixed potential difference of 6·0 V is applied across a coil of copper wire. At a temperature of 0°C the current through the coil is found to be 0·30 A. At 50°C the current is 0·24 A.

(i) Explain **in terms of electrons** why the current is smaller at 50°C than at 0°C. [3]

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(ii) Calculate the temperature coefficient of resistance of copper. [4]

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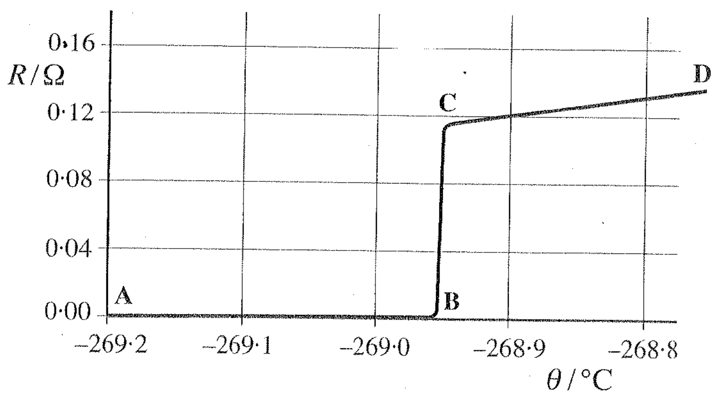
(b) In 1911 a Dutch physicist was investigating the effects of very low temperatures. He plotted a graph (see below) of the measured resistance, R, of a solid mercury specimen against temperature, θ.



(i) What name do we now give to the effect responsible for the region AB? [1]

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(ii) What potential difference would be needed to **maintain** a current of (say) 10 mA in a ring of solid mercury at a temperature of –269·0 °C or lower? [1]

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(iii) No 'points' were obtained for the region BC. Suggest a reason for this. [1]

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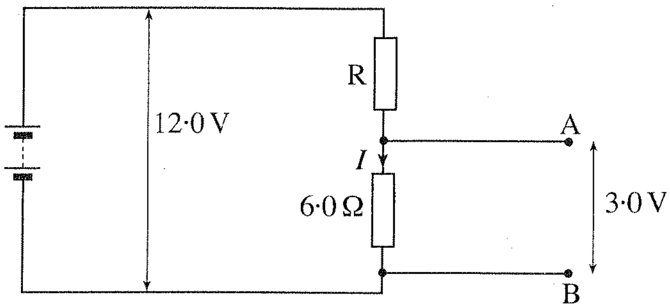
4. *(a)* The diagram shows two resistors connected in a series across a 12·0 V supply to give an 'output' of 3·0 V. [The supply has negligible internal resistance.]



(i) What is the name for a resistor combination used in this way? [1]

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(ii) Calculate the current, I. [1]

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(iii) State the potential difference across the resistor R. .... [1]

(iv) Calculate the resistance of R. [2]

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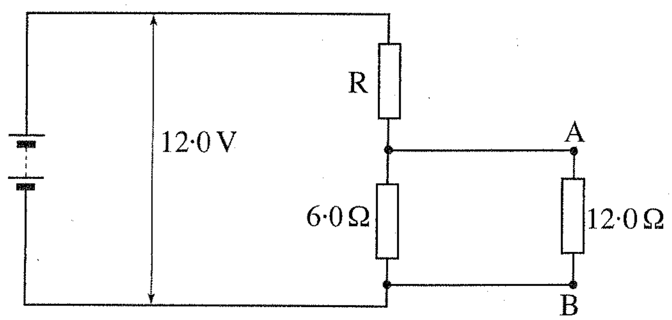
(b) A 12·0 Ω 'load' resistor is now connected across the output terminals, A and B, as shown.



(i) Calculate the resistance of the parallel combination of 6·0 Ω and 12·0 Ω resistors. [2]

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(ii) Calculate the current through resistor R. [2]

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(iii) Calculate the new potential difference between A and B. [1]

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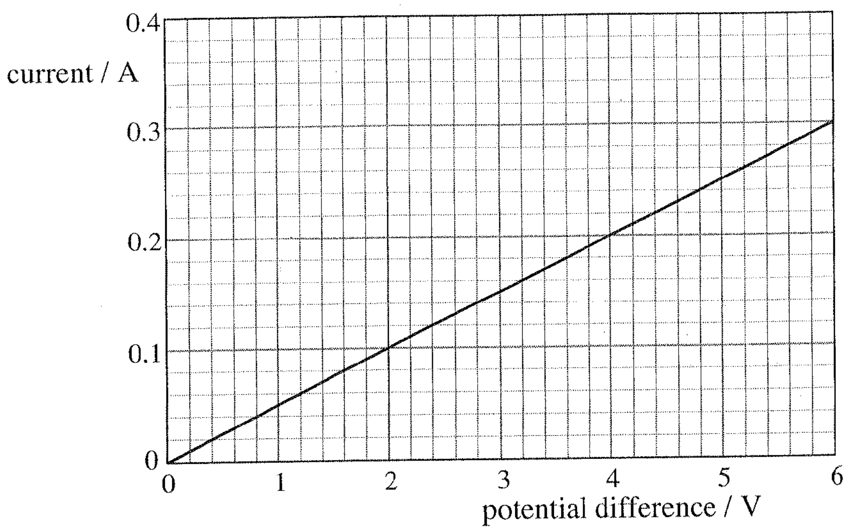
6. *(a)* A graph of current against applied potential difference is given for a piece of alloy wire.



(i) Draw a circuit diagram of an arrangement that could have been used to obtain the readings. Show the alloy wire as a resistor labelled 'W'. [3]

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

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(iii) Calculate the current in the wire if a potential difference of 14 V were applied, stating any assumption you are making. [2]

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(iv) The wire has a length of 8·0 m and a **diameter** of $2{\cdot}5 \times 10^{-4}$ m. Calculate

(I) its cross-sectional area, [2]

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(II) the resistivity of the alloy. [3]

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(v) Draw on the same graph-grid (facing page) the current against voltage graphs for

(I) a wire, made of the same alloy, of diameter $2{\cdot}5 \times 10^{-4}$ m and length 24 m. [Label this graph 'I'] [1]

(II) a wire, made of the same alloy, of diameter $5{\cdot}0 \times 10^{-4}$ m and length 8·0 m. [Label this graph 'II'] [2]

(b) The current in a metal wire of cross-sectional area *A* is given by the formula

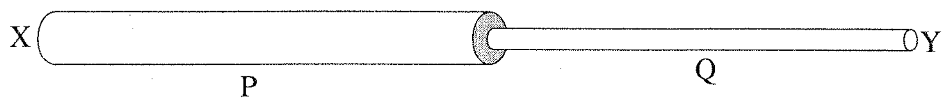
$$I = nAve$$

(i) State the meanings of *n* and of *v*. [2]

n: ....

v: ....

(ii)



Two copper wires, P and Q, are connected in series. P has 10 times the cross-sectional area of Q. A battery is connected between the ends, X and Y, of the combination.

(I) List the quantities in the equation above which have the same value in both P and Q. [2]

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(II) Deduce how the value of *v* in P compares with the value of *v* in Q, explaining your reasoning. [2]

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Turn over.

Jan 03

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2. *(a)* Explain what is meant by the *e.m.f.* of a battery. [2]

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(b) Three cells, **each** of e.m.f. 1·5 V and internal resistance 0·50 Ω, are connected in series to make a battery of e.m.f. 4·5 V. The battery is connected to a resistor, R, of resistance 6·0 Ω.

(i) Sketch a circuit diagram. Include the internal resistance, and label it. [1]

(ii) Calculate the current through the circuit. [2]

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(iii) Calculate the potential difference across the resistor, R. [2]

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(iv) Suppose that one of the cells had been connected the wrong way round. Calculate the current in the circuit in this case. [3]

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7. (a) Define the *e.m.f.* of a cell. [2]

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(b) A car battery consists of six cells, **each** of e.m.f. 2·0 V and internal resistance 0·0020 Ω, connected in series.

(i) Write down the internal resistance of the car battery. [1]

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(ii) To start the car, a 'starter-motor' is connected to the battery. A current of 180 A flows through the battery and the motor. Calculate the p.d. across the battery terminals for this current. [3]

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(iii) When doing repairs under the bonnet of a car, it may be safest to remove the battery to prevent accidental short-circuits. Suppose a spanner were to be dropped and came to rest bridging the battery terminals. The spanner can be taken to have no resistance.

(I) How large would the current be? [2]

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(II) Calculate the *power* produced by the battery. [2]

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(III) Give a reason why such an accident could be very dangerous. [1]

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(c) Suppose the battery in your car is 'flat' (has run out of energy).

(i) A friend (who has not studied AS level Physics) suggests that the battery could be replaced by **a number of** cells of the type used in torches, connected in series. Each cell has an e.m.f. of 1·5 V and an internal resistance of 0·30 Ω. Explain why the **maximum** current such an arrangement could possibly supply is 5·0 A, no matter how many cells are used. [2]

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(ii) A better idea for starting the car is to use a pair of insulated copper wires (called 'jump-leads') to connect to a battery in a friend's car. Suppose that **each** wire is 3·0 m long and that the voltage drop along **each** wire is 0·72 V for a current of 180 A. The resistivity of copper is $1{\cdot}7 \times 10^{-8}$ Ωm.

(I) Calculate the cross-sectional area of the wire. [3]

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(II) Hence calculate the **diameter** of the wire. [2]

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(III) Discuss whether, ideally, jump leads should be made of wire of larger or smaller diameter. [2]

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Jan 04

2. *(a)* In a Physics practical class a teacher gives a student a sealed box with **two** terminals, containing a combination of two resistors. One has a known value of 10 Ω and the other has an unknown resistance, *X*. The student finds that when a p.d. of 15 V is placed across the terminals, a current of 2·5 A flows through the combination.

(i) Calculate the resistance of the combination. [1]

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(ii) Explain why the resistors cannot possibly be in series. [1]

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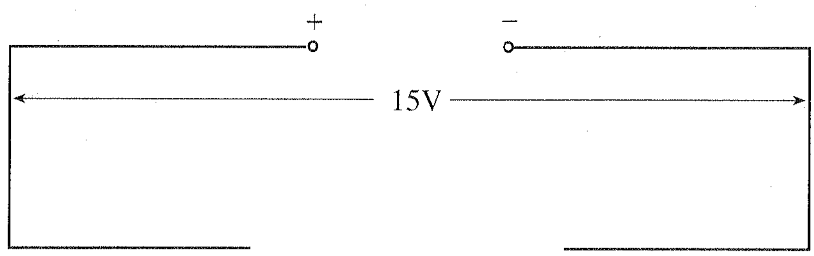
(iii) Add the resistor combination to complete the circuit diagram below. [1]



(iv) For the same p.d. of 15 V, calculate the current in

(I) the 10 Ω resistor, [1]

....

(II) the other resistor. [1]

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(v) **Hence** calculate the resistance *X*, of this other resistor. [1]

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(vi) Use the appropriate resistance combination formula to check whether your answers to (i) and (v) are consistent with each other. Show your method clearly. [2]

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(b) Which step in part *(a)* relies directly on the conservation of charge? Briefly explain your answer. [2]

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June '04

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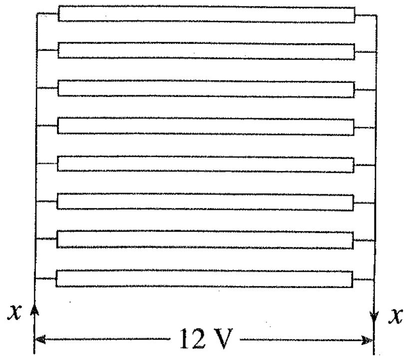
1. A rear-window heater for a car consists of 8 strips of copper, bonded to the glass and connected in parallel, as shown. **Each** strip has a resistance of 5·0 Ω.



(a) A potential difference of 12 V is applied across the combination. Calculate

(i) the current through each strip, [1]

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(ii) the current, x, through the combination, [1]

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(iii) the resistance of the combination. [1]

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(b) If the strips were to be connected *in series* the current, y, would be too small to give a useful heating effect. Calculate the ratio x/y. [2]

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(c) Each strip of copper is 1·1 m long and the resistivity of copper is $1{\cdot}7 \times 10^{-8}\,\Omega$m.

(i) Calculate the cross-sectional area of a strip. [3]

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(ii) Each strip is 1·5 mm wide and its thickness is uniform. Calculate this thickness. [2]

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Turn over.

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3. *(a)* State Ohm's Law. [2]

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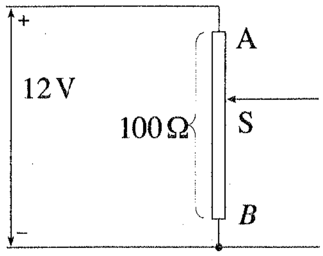
(b) The diagram shows a variable potential divider consisting of a carbon track, AB, of resistance 100 Ω. An 'input' of 12·0 V is applied across AB. The sliding contact, S, is positioned so that the p.d. between S and B is 8·4 V.



Calculate

(i) the resistance of the carbon track between S and B, [2]

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(ii) the p.d. between A and S. [1]

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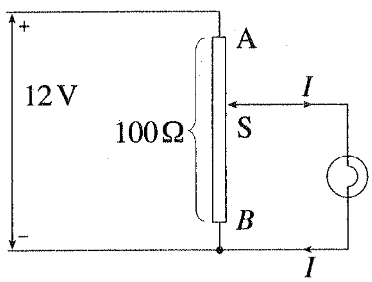
(c) A filament lamp is now connected between S and B in the circuit of part *(b)*. S remains in the same position. A current, *I*, flows through the lamp, as shown. State, **with reasons**, whether the following quantities increase, decrease, or stay the same when the lamp is connected:



(i) the current through the track between A and S; [2]

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(ii) the p.d. between A and S; [1]

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(iii) the p.d. between S and B. [2]

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