LONDON SCIENCE COLLEGE

Name:

Date:

ELECTRICITY
TEST 3

AS-Level

Mark

Grade

PHYSICS

For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets

1 A student investigates how the power dissipated in a variable resistor, Y, varies as the resistance is altered.

Figure 1 shows the circuit the student uses. Y is connected to a battery of emf ε and internal resistance *r*.

Figure 1

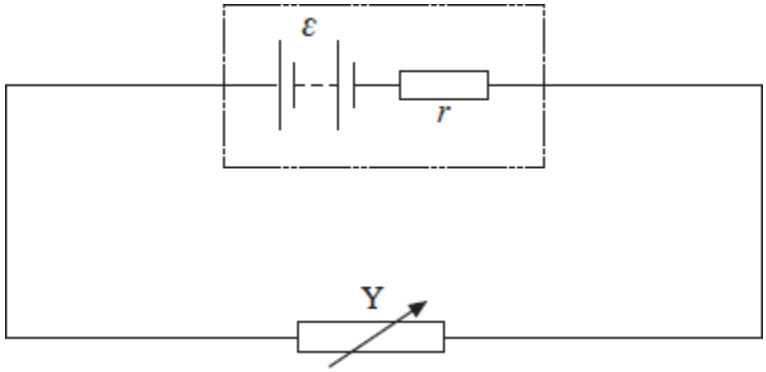
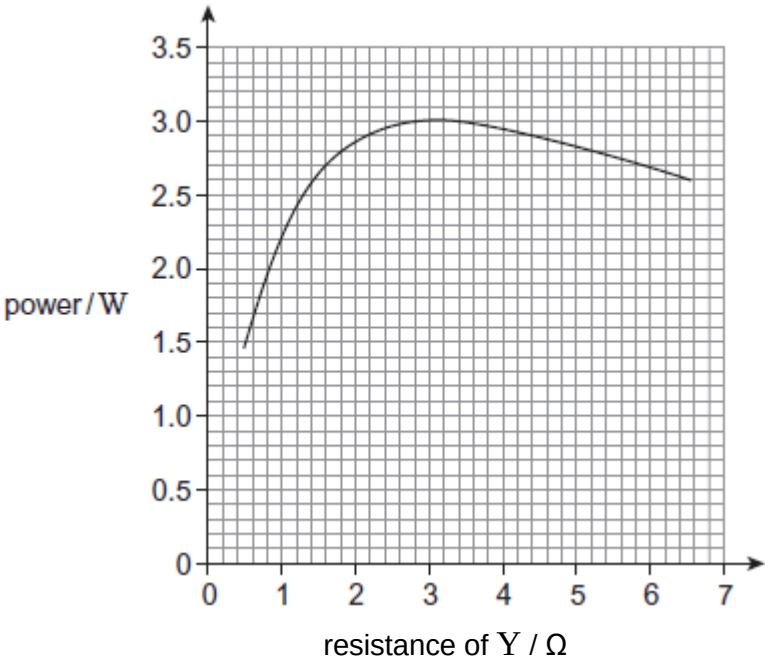


Figure 2 shows the results obtained by the student as the resistance of Y is varied from 0.5 Ω to 6.5 Ω.

Figure 2



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(a) Describe how the power dissipated in Y varies as its resistance is increased from 0.5 Ω to 6.5 Ω.

_____

_____

_____

_____

_____

(2)

(b) The emf of the battery is 6.0 V and the resistance of Y is set at 0.80 Ω.

(i) Use data from **Figure 2** to calculate the current through the battery.

current _____ A

(3)

(ii) Calculate the voltage across Y.

voltage _____ V

(2)

(iii) Calculate the internal resistance of the battery.

internal resistance _____ Ω

(2)

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(c) The student repeats the experiment with a battery of the same emf but negligible internal resistance. State and explain how you would now expect the power dissipated in Y to vary as the resistance of Y is increased from 0.5 Ω to 6.5 Ω.

(3)

(Total 12 marks)

2 The critical temperature of tin is −269 °C. The resistivity of tin increases as its temperature rises from −269 °C.

(a) (i) Define resistivity.

(2)

(ii) State the significance of the critical temperature of a material.

(2)

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(b) A sample of tin in the form of a cylinder of diameter 1.0 mm and length 4.8 m has a resistance of 0.70 Ω.

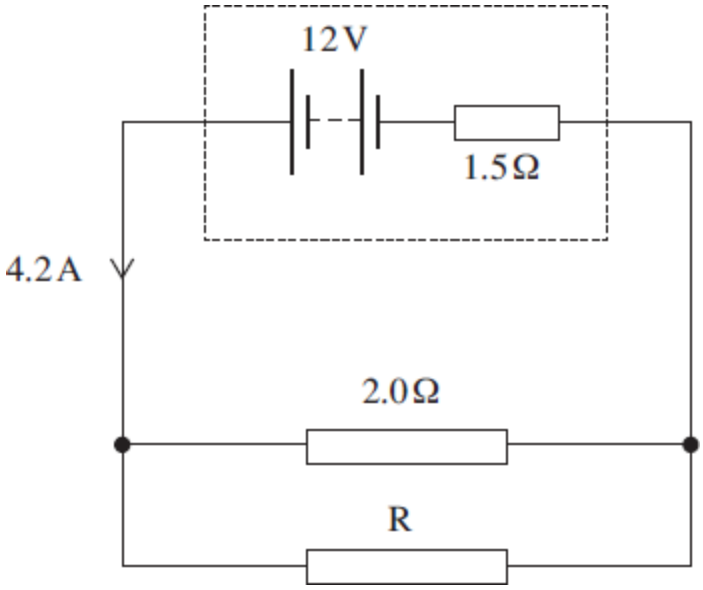
Use these data to calculate a value of the resistivity of tin.
State an appropriate unit for your answer.

resistivity _____ unit _____

(4)

(Total 8 marks)

3 The circuit diagram below shows a battery of electromotive force (emf) 12 V and internal resistance 1.5 Ω connected to a 2.0 Ω resistor in parallel with an unknown resistor, R. The battery supplies a current of 4.2 A.



(a) (i) Show that the potential difference (pd) across the internal resistance is 6.3 V.

(1)

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(ii) Calculate the pd across the 2.0 Ω resistor.

pd _____V

(1)

(iii) Calculate the current in the 2.0 Ω resistor.

current _____A

(1)

(iv) Determine the current in R.

current _____ A

(1)

(v) Calculate the resistance of R.

R _____ Ω

(1)

(vi) Calculate the total resistance of the circuit.

circuit resistance _____ Ω

(2)

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(b) The battery converts chemical energy into electrical energy that is then dissipated in the internal resistance and the two external resistors.

(i) Using appropriate data values that you have calculated, complete the following table by calculating the rate of energy dissipation in each resistor.

resistor	**rate of energy dissipation / W**
internal resistance	
2.0 Ω	
R	

(3)

(ii) Hence show that energy is conserved in the circuit.

_____

_____

(2)

(Total 12 marks)

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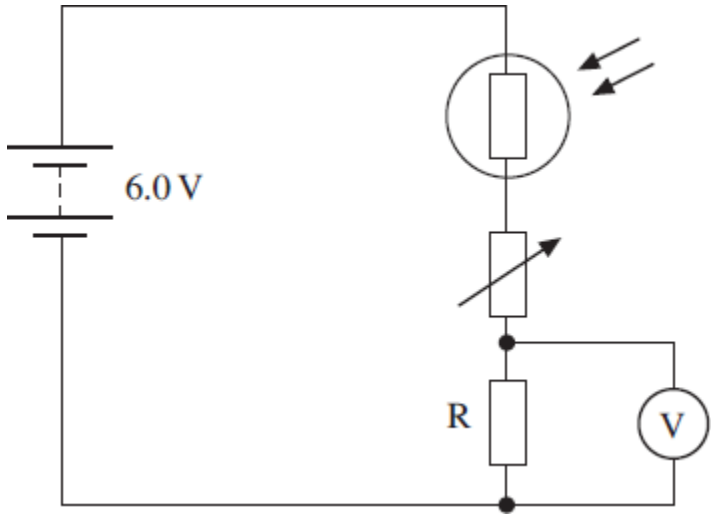
4 The circuit diagram below shows a 6.0 V battery of negligible internal resistance connected in series to a light dependent resistor (LDR), a variable resistor and a fixed resistor, R.



(a) For a particular light intensity the resistance of the LDR is 50 kΩ. The resistance of R is 5.0 kΩ and the variable resistor is set to a value of 35 kΩ.

(i) Calculate the current in the circuit.

current _____ A

(2)

(ii) Calculate the reading on the voltmeter.

voltmeter reading _____ V

(2)

(b) State and explain what happens to the reading on the voltmeter if the intensity of the light incident on the LDR increases.

_____

_____

_____

(2)

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(c) For a certain application at a particular light intensity the pd across R needs to be 0.75 V. The resistance of the LDR at this intensity is 5.0 kΩ.

Calculate the required resistance of the variable resistor in this situation.

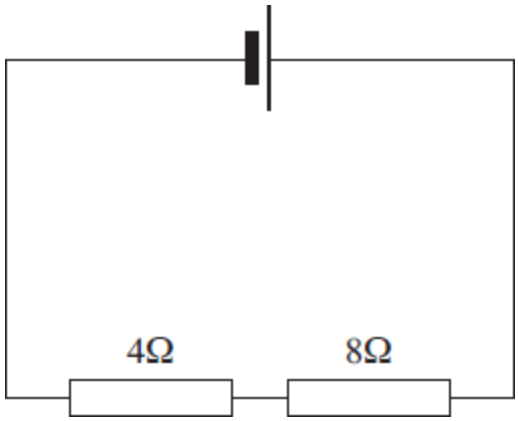
resistance _____ Ω

(3)

(Total 9 marks)

5 (a) The cell in **Figure 1** has an emf of 3.0 V and negligible internal resistance.

Figure 1



Calculate the potential difference across the 8 Ω resistor.

potential difference _____ V

(2)

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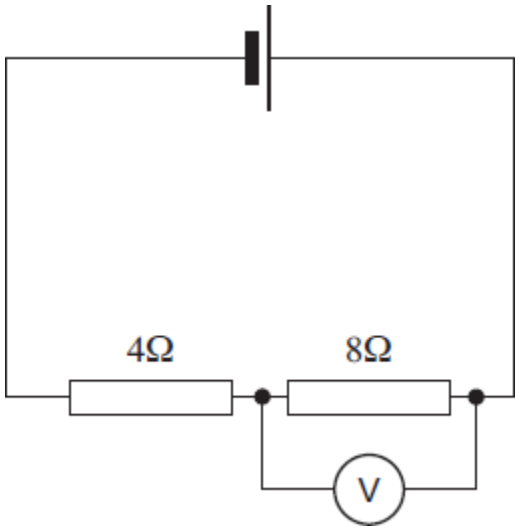
(b) **Figure 2** shows the same circuit with a voltmeter connected across the 8 Ω resistor.

Figure 2



The voltmeter reads 1.8 V. Calculate the resistance of the voltmeter.

resistance _____Ω

(3)

(Total 5 marks)

6 At room temperature a metal has a resistivity of 4.5×10^{-7} Ωm. A wire made from this metal has a radius of 0.70 mm.

(a) (i) Calculate the resistance of a 2.5 m length of the wire at room temperature.

resistance _____Ω

(3)

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(ii) Calculate the power dissipated in this length of wire when it carries a current of 20 mA. Assume the resistance of the wire is constant.

power _____W

(2)

(b) The wire becomes superconducting as it is cooled. Draw a sketch graph on the axes below to show how the wire's resistivity would vary with temperature as it is cooled from room temperature θ_r.

(3)

(c) Explain why the efficiency of electrical power transmission is improved when conventional wires are replaced with superconducting wires.

_____

_____

_____

(1)

(Total 9 marks)

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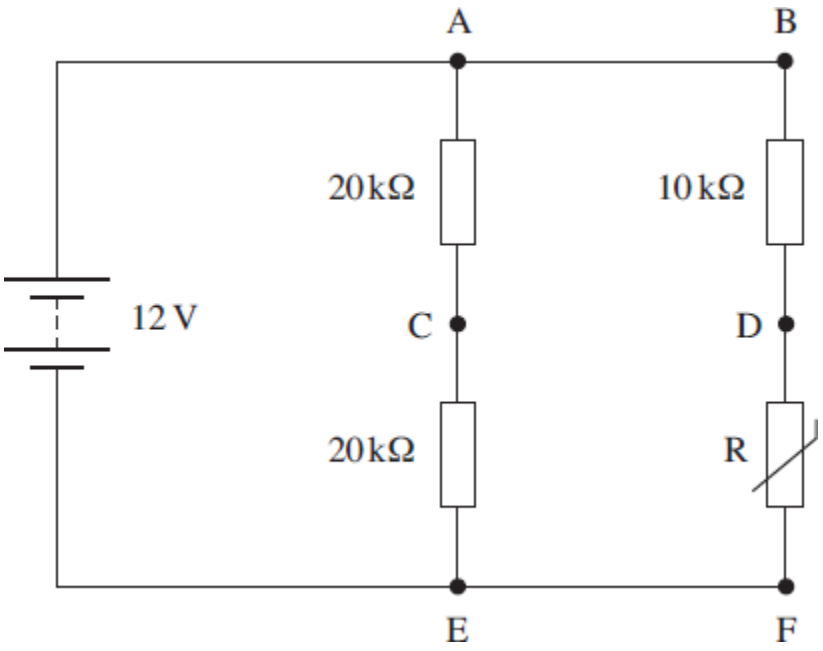
7 The circuit diagram below shows a 12 V battery of negligible internal resistance connected to a combination of three resistors and a thermistor.



(a) When the resistance of the thermistor is 5.0 kΩ

(i) calculate the total resistance of the circuit,

total resistance = _____ kΩ

(3)

(ii) calculate the current in the battery.

current = _____ mA

(1)

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(b) A high-resistance voltmeter is used to measure the potential difference (pd) between points A-C, D-F and C-D in turn.
Complete the following table indicating the reading of the voltmeter at each of the three positions.

voltmeter position	pd / V
A-C	
D-F	
C-D	

(3)

(c) The thermistor is heated so that its resistance decreases. State and explain the effect this has on the voltmeter reading in the following positions.

(i) A–C _____

_____

_____

_____

(2)

(ii) D–F _____

_____

_____

_____

(2)

(Total 11 marks)

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8 A copper connecting wire is 0.75 m long and has a cross-sectional area of 1.3×10^{-7} m^2.

(a) Calculate the resistance of the wire.

resistivity of copper = 1.7×10^{-7} Ωm

resistance = _____ Ω

(2)

(b) A 12 V 25 W lamp is connected to a power supply of negligible internal resistance using two of the connecting wires. The lamp is operating at its rated power.

(i) Calculate the current flowing in the lamp.

current = _____ A

(1)

(ii) Calculate the pd across each of the wires.

pd = _____ V

(1)

(iii) Calculate the emf (electromotive force) of the power supply.

emf = _____ V

(2)

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(c) The lamp used in part (b) is connected by the same two wires to a power supply of the same emf but whose internal resistance is not negligible.

State and explain what happens to the brightness of the lamp when compared to its brightness in part (b).

(2)

(Total 8 marks)

9 Which statement about superconductors is correct?

A When a material becomes a superconductor, its resistivity is almost zero. ⬭

B The temperature at which a material becomes a superconductor is called the critical temperature. ⬭

C When current passes through a superconductor the pd across it becomes a maximum. ⬭

D Copper is a superconductor at room temperature. ⬭

(Total 1 mark)

10 A wire has a resistance R.

What is the resistance when both the length and radius of the wire are doubled?

A $\frac{R}{4}$ ⬭

B $\frac{R}{2}$ ⬭

C $2R$ ⬭

D $4R$ ⬭

(Total 1 mark)

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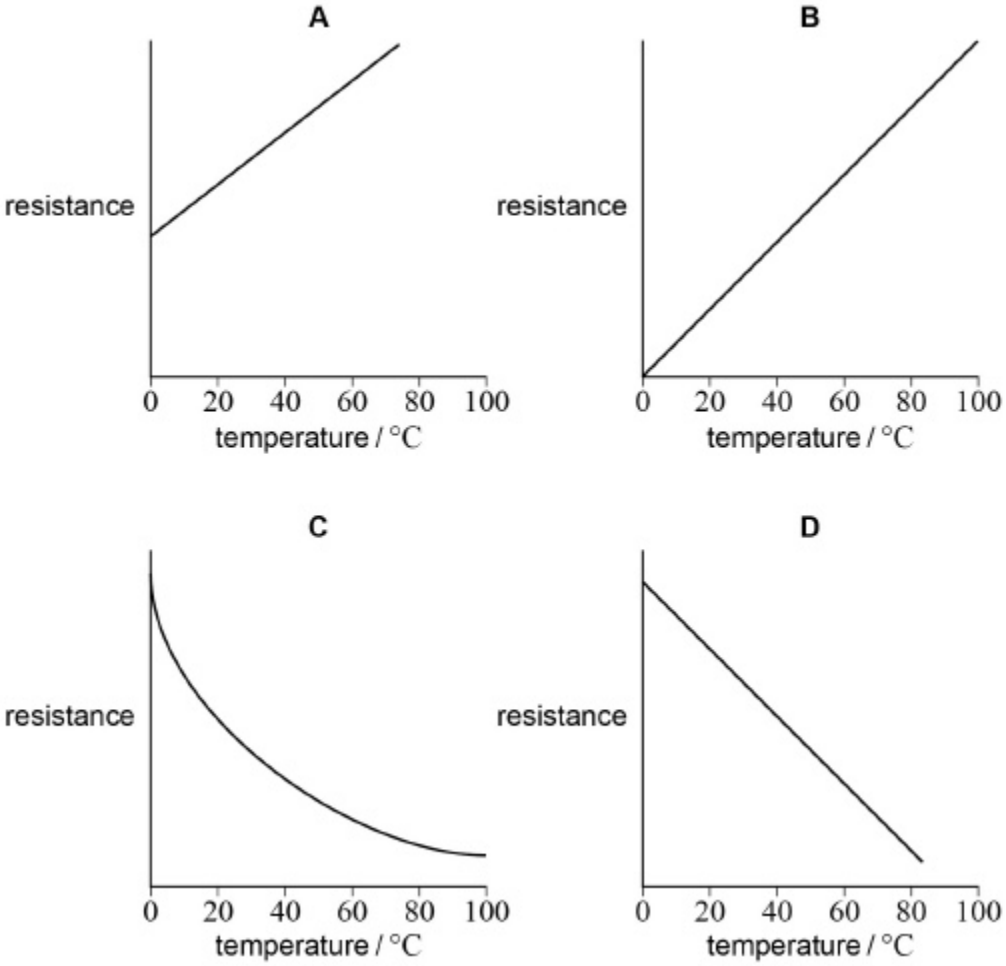
11 Which graph shows the variation of the resistance with temperature for an ntc thermistor?



A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

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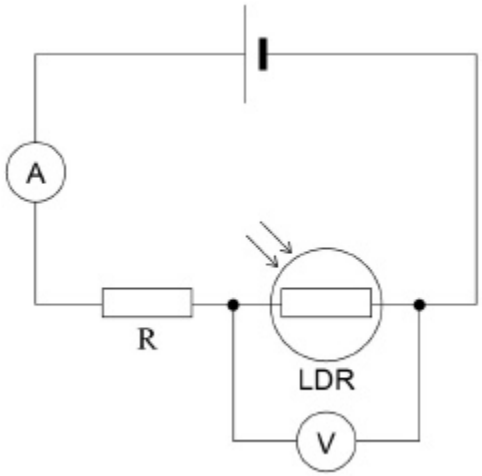
12 The figure shows a light dependent resistor (LDR) and fixed resistor R connected in series across a cell. The internal resistance of the cell is negligible.



Which row shows how the readings on the ammeter and the voltmeter change when the light intensity incident on the LDR is increased?

	Ammeter reading	**Voltmeter reading**	
A	decreases	increases	⬭
B	decreases	decreases	⬭
C	increases	increases	⬭
D	increases	decreases	⬭

(Total 1 mark)

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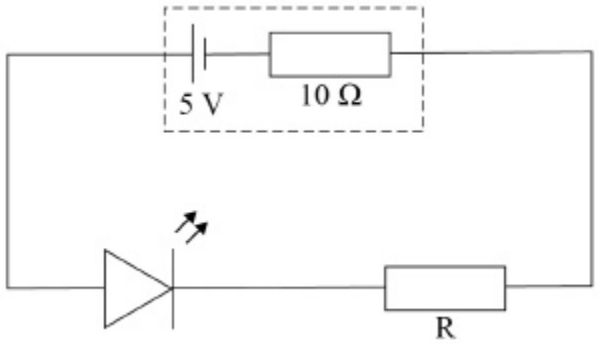
13 In the circuit below, the potential difference across the light emitting diode (LED) is 1.8 V when it is emitting light.



The current in the circuit is 20 mA.

What is the value of the resistor R?

A 80 Ω ⬭

B 90 Ω ⬭

C 150 Ω ⬭

D 160 Ω ⬭

(Total 1 mark)

14 The combined resistance of n identical resistors connected in parallel is R_n.

Which statement correctly describes the variation of R_n as n increases?

A R_n decreases linearly as n increases ⬭

B R_n decreases non-linearly as n increases ⬭

C R_n increases linearly as n increases ⬭

D R_n increases non-linearly as n increases ⬭

(Total 1 mark)

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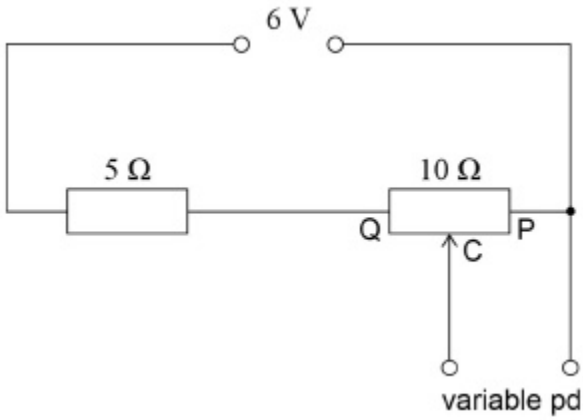
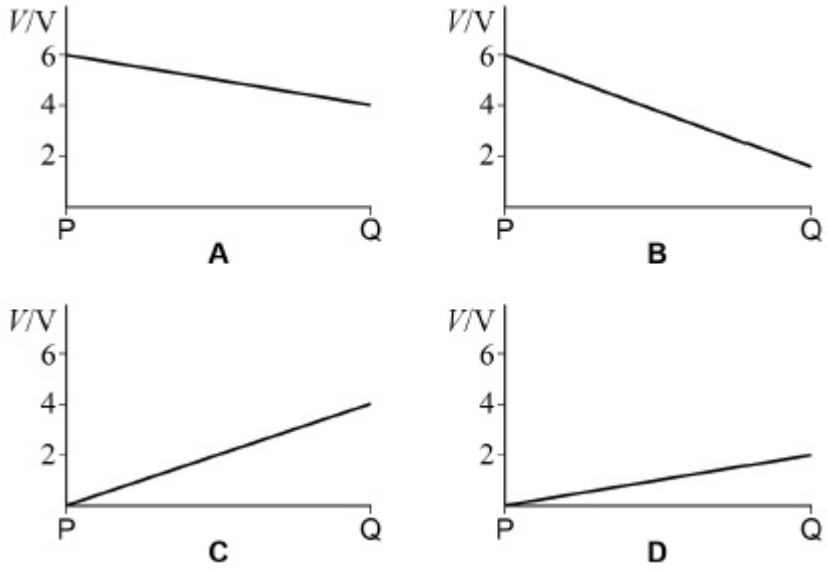
15 The circuit shown is used to supply a variable potential difference (pd) to another circuit.



Which graph shows how the pd supplied V varies as the moving contact C is moved from position P to position Q?



A ⬭

B ⬭

C ⬭

D ⬭

(Total 1 mark)

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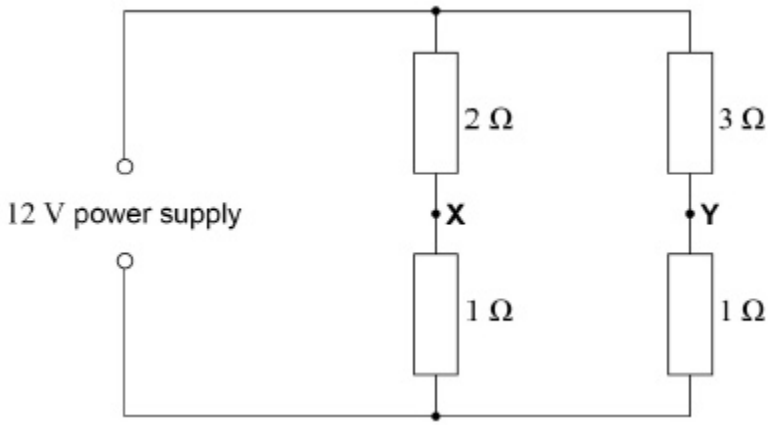
16 In this resistor network, the emf of the supply is 12 V and it has negligible internal resistance.



What is the reading on a voltmeter connected between points **X** and **Y**?

A 0 V ⬭

B 1 V ⬭

C 3 V ⬭

D 4 V ⬭

(Total 1 mark)

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