TOPIC 17 Current Electricity

1 Which of the following is a correct unit for electrical energy?

A ampere
B coulomb
C joule
D volt
E watt

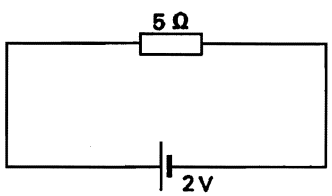
J90/I/27

2 Which quantity can be measured in units of joule/coulomb?

A charge
B current
C potential difference
D power
E resistance

N90/I/26

3 The diagram shows a resistor connected to a cell of e.m.f. 2V.



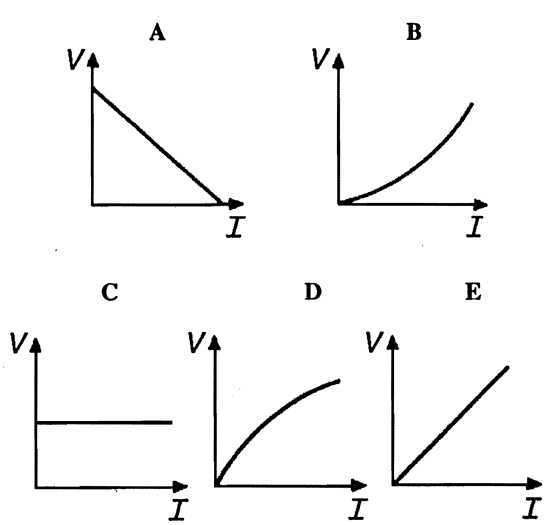
How much heat energy is produced in the resistor in six seconds?

A 0.4 J
B 2.5 J
C 4.8 J
D 10 J
E 60 J

N90/I/30

4 The diagrams show the voltage-current graphs for five electrical devices.

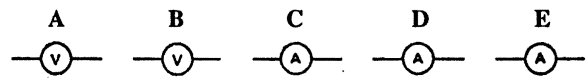
Which diagram shows the resistance increasing as the current rises?



J91/I/27

5 The diagrams show the symbols and ranges of five meters.

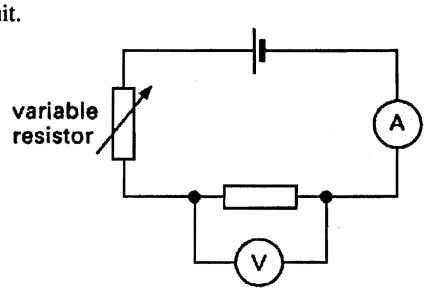
Which meter should be used to measure a current of 0.5 A in a resistor?



A	B	C	D	E
full-scale deflection = 5V	full-scale deflection = 1.5V	full-scale deflection = 1.5A	full-scale deflection = 50mA	full-scale deflection = 1mA

J91/I/28

6 Some students set up the circuit shown in the diagram to investigate how a variable resistor affects an electrical circuit.

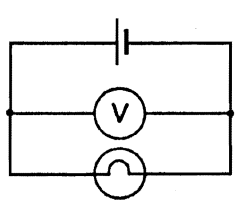


How will the readings on the meters be affected as the resistance of the variable resistor is increased?

	ammeter reading	*voltmeter reading*
A	decrease	decrease
B	decrease	increase
C	no change	no change
D	increase	decrease
E	increase	increase

J91/I/29

7 The diagram shows a simple electrical circuit.



What does the instrument (V) measure?

A the current through the bulb
B the amount of energy stored in the cell
C the potential difference across the cell
D the power dissipated as heat by the bulb
E the resistance of the bulb

N91/I/27

8 How could the unit of potential difference, the volt, also be written?

A A s
B A/s
C C/A
D C/J
E J/C

J92/I/25

9 A battery moves a charge of 60 C around a circuit at a constant rate in a time of 20 s. What is the current in the circuit?

A 0.3 A
B 3.0 A
C 40 A
D 80 A
E 1200 A J92/I/26

10 A piece of wire 0.5 m long has an area of cross-section of 1 mm^2. What wire of the same material has twice the resistance?

	length/m	*area*/mm^2
A	0.25	1.0
B	0.25	2.0
C	0.50	0.5
D	0.50	2.0
E	1.00	0.5

J92/I/27

11 Which of the following changes to a wire will double its resistance?

	cross-sectional area	*length*
A	double	double
B	double	no change
C	no change	halve
D	halve	halve
E	halve	no change

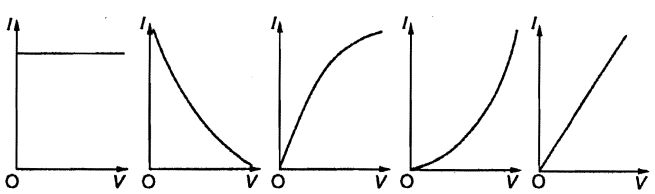
N92/I/27

12 Which of the following has volt (V) as its unit?

A current ÷ resistance
B power × current
C rate of flow of charge
D the charge in a capacitor
E the electro-motive force of a cell J93/I/27

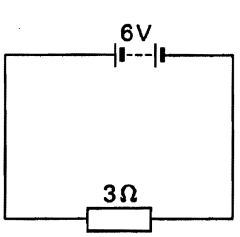
13 Which graph shows the relationship between current *I* and voltage *V* for a conductor that obeys Ohm's law?

A **B** **C** **D** **E**



N93/I/27

14 A 6 V battery is connected to a 3Ω resistor.



How much charge flows through the resistor in 20 s?

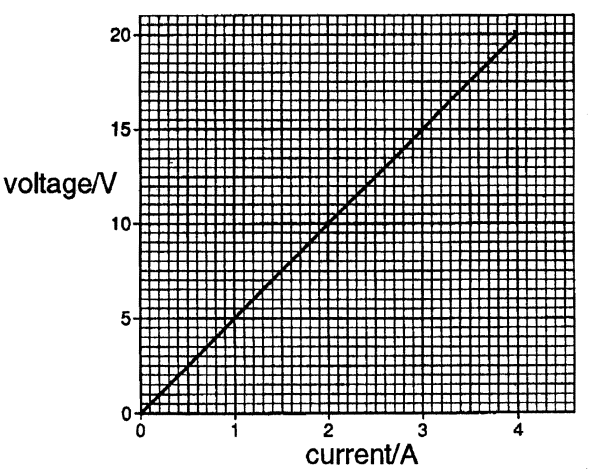
A 0.5 C
B 2.0 C
C 10 C
D 20 C
E 40 C N93/I/28

15 X and Y are lamps with filaments made of the same material. The filament of lamp Y is thinner and longer than that of lamp X.

When connected to the mains and switched on

A X will be the brighter lamp because its filament has the larger resistance.
B X will be the brighter lamp because its filament has the smaller resistance.
C Y will be the brighter lamp because its filament has the larger resistance.
D Y will be the brighter lamp because its filament has the smaller resistance. J94/I/27

16 The graph shows the results of an experiment to measure the resistance of a wire.



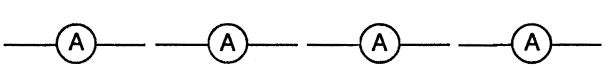
What is the resistance of the wire?

A 0.2 Ω
B 4.0 Ω
C 5.0 Ω
D 80 Ω J94/I/28

17 The diagrams show the symbols and ranges of four meters.

Which meter should be used to measure a current of 0.5 A?

A **B** **C** **D**



A	**B**	**C**	**D**
full-scale deflection = 1 mA	full-scale deflection = 50 mA	full-scale deflection = 1.5 A	full-scale deflection = 5 A

N94/I/26

18 A wire has a current of 2 A in it.

How much charge passes a point in the wire in one minute?

A 2 C **C** 60 C
B 30 C **D** 120 C N94/I/27

19 An electric current in a wire involves the movement of

A atoms.
B electrons.
C molecules.
D protons. J95/I/25

20 A battery drives 50 C of charge round a circuit.

The total work done is 750 J. What is the electromotive force of the battery?

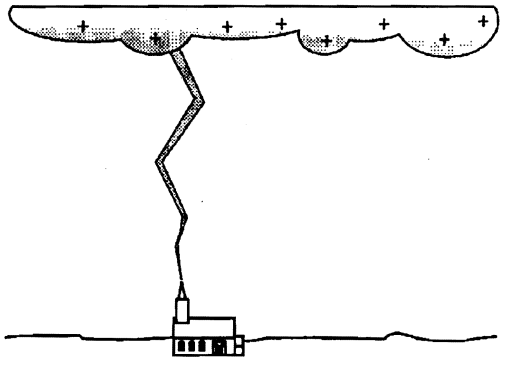
A 0.07V **C** 700V
B 15V **D** 800V J95/I/26

21 When 5.0 C of charge flows through a particular resistor, 10 J of energy are converted.

What is the potential difference across the resistor?

A 0.50 V
B 2.0 V
C 15 V
D 50 V J96/I/27

22 The lower part of a cloud has a positive charge. The cloud discharges in a flash of lightning.



In which direction do electrons and conventional current flow?

	electron flow	*conventional current*
A	downwards	downwards
B	downwards	upwards
C	upwards	downwards
D	upwards	upwards J96/I/35

23 A milliammeter shows a reading of 30 mA.

How much electrical charge flows through the milliammeter in 10 seconds?

A 0.3 C **C** 30 C
B 3.0 C **D** 300 C J97/I/25

24 Which electrical quantity has the same units as electromotive force?

A charge
B current
C potential difference
D power J97/I/26

25 Which of the following describes the e.m.f. of a cell?

A the difference in energy between that needed to drive unit charge through the load resistors and through the cell
B the energy used to drive unit charge through all the load resistors in the circuit
C the energy used to drive unit charge through the resistance of the cell
D the total energy used to drive unit charge round the complete circuit

N97/I/26

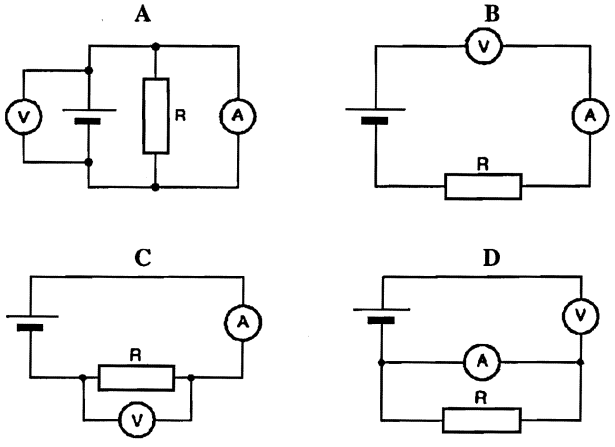
26 A piece of wire 0.5 m long has an area of cross-section of 1 mm^2.

What wire of the same material has twice the resistance?

	length / m	*area* / mm^2
A	0.50	2.0
B	0.50	0.5
C	0.25	2.0
D	0.25	1.0

N97/I/27

27 Which circuit could be used to find the resistance of the resistor R?



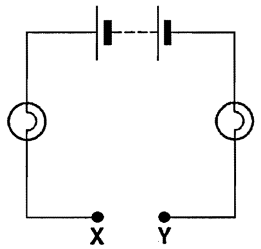
J98/I/26

28 When a current of 2 A flows for 5 seconds through a lamp, 120 W of power are used.

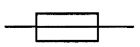
How much charge flows through the lamp?

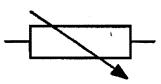
A 10 C
B 12 C
C 24 C
D 60 C J98/I/27

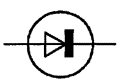
29 The diagram shows part of a circuit.

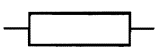


Which component can be connected between **X** and **Y** so that the brightness of the lamps may be varied?

A 

C 

B 

D 

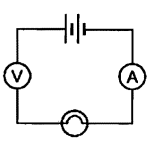
J98/I/28

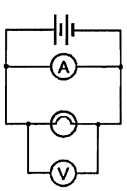
30 What is measured by the energy dissipated when a source drives a unit charge round a complete circuit?

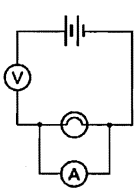
A electromotive force
B potential difference
C power
D resistance

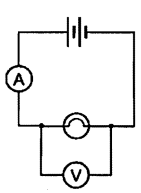
N98/I/24

31 Which circuit can be used to find the resistance of the lamp?

A 

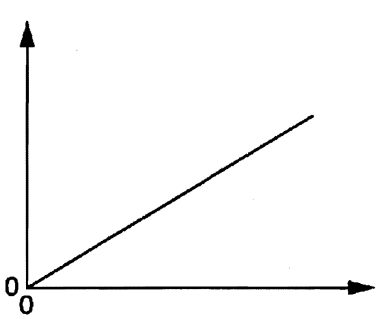
B 

C 

D 

N98/I/25

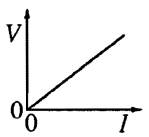
32 Which variation would produce a graph of the shape shown?

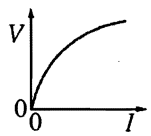


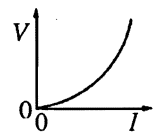
A count rate against time for a radioactive decay
B current against potential difference for a metal obeying Ohm's law
C pressure against volume for a gas at constant temperature
D speed against time for a car moving at constant speed

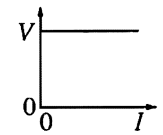
N98/I/40

33 Which diagram shows the *V/I* characteristic graph for a conductor that obeys Ohm's law?

A 

B 

C 

D 

J99/I/25

34 When a p.d. of 2 V is applied across a resistor, 10 J of energy are converted.

What charge flows through the resistor?

A 0.20 C
B 5.0 C
C 12 C
D 20 C

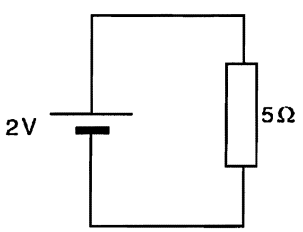
J99/I/27

35 What is the current in a 5.0 Ω resistor when the potential difference between the ends of the resistor is 2.5 V?

A 0.50 A
B 2.0 A
C 2.5 A
D 12.5 A

N99/I/26

36 The diagram shows a resistor connected to a cell of e.m.f. 2 V.



How much heat energy is produced in the resistor in six seconds?

A 2.5 J
B 4.8 J
C 10 J
D 60 J

N99/I/30

37 A 0.4 m length of resistance wire with an area of cross-section of 0.2 mm^2 has a resistance of 2 Ω.

Which wire of the same material will also have a resistance of 2 Ω?

wire	length	area
A	0.2 m	0.2 mm^2
B	0.2 m	0.4 mm^2
C	0.8 m	0.1 mm^2
D	0.8 m	0.4 mm^2

J2000/I/26

38 The amount of energy transferred when 10 C of charge passes through a p.d. of 20 V is the same as the energy needed to raise a 2 kg mass through a distance *x*.

[gravitational field strength = 10 N/kg]

What is the value of *x*?

A 0.1 m
B 1 m
C 10 m
D 100 m

J2000/I/40

39 Why can birds stand on an overhead transmission line without suffering any harm?

A Their bodies have a very high resistance.

B Their feet are very good insulators.

C There is no potential difference between their feet.

D The spaces between their feathers act as insulators.

N2000/I/26

40 The terminals of a battery are joined by a length of resistance wire.

Which change, on its own, will increase the current through the battery?

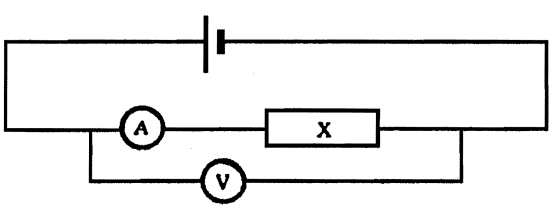
A connecting an identical wire in series with the first one

B covering the wire with plastic insulation

C using a shorter wire of the same material and the same thickness

D using a thinner wire of the same material and the same length N2000/I/27

41 *(a)* The circuit shown in the diagram is used in an attempt to determine an accurate value for the resistance of the component X, known to be approximately 1 Ω. In one particular test the resistances of the ammeter A and voltmeter V used were 0.5 Ω and 1000 Ω respectively.



State why the value of the resistance X, calculated by dividing the voltmeter reading by the ammeter reading, would be inaccurate.

(b) The same meters can be connected in a way which would ensure a more accurate result. In the space below draw a circuit to show how this could be done.

J79/I/13

42 The work done in moving an electric charge of one coulomb from one point P on a wire to another point Q on the same wire is 2.5 J.

What is the potential difference between points P and Q?

Calculate the work done in transferring a charge of 300 C from P to Q.

300 C flow from P to Q as a steady current of 0.5 A: calculate *(a)* the time taken for 300 C to move from P to Q, *(b)* the rate at which work is done.

N81/I/12

43 A conducting body carries a positive charge 0.0036 C and is insulated from earth. When it is connected to earth by a wire, it becomes completely discharged. The average current flowing during the discharge is 0.012 A.

How long does it take for the body to discharge completely?

In which direction does charge flow during the discharge?

J82/I/13

44 To transfer 4.0 C of charge from point A to point B in an electrical circuit 22 J of energy are needed. What is the electrical potential difference between points A and B?

Points A and B are connected by a resistor and the 4.0 C of charge are transferred through it in 0.50 s. Calculate the resistance of the resistor. J83/I/11

45 A coil of copper wire is connected across the terminals of a battery of e.m.f 6.0 V.

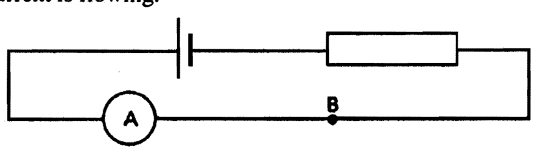
(a) What is the total chemical energy transformed when 30 C of charge passed round the complete circuit?

(b) If this charge circulates in 120 s, what current is flowing? N83/I/11

46 The difference in potential between a cloud and earth is 1.0×10^9 V. In a lightning discharge from the cloud to earth, a charge of 20 C passes. Calculate the energy involved in this discharge.

Given that the discharge takes place in 4.0×10^{-3} s, calculate the average current flowing. N84/I/13

47 The diagram shows an electric circuit in which a direct current is flowing.

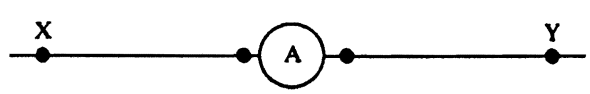


Calculate the number of electrons per second passing a point B, in the wire, when a current of 0.7 A is flowing.

[The charge on an electron is 1.6×10^{-19} C.]

Show on the diagram the direction in which these electrons move past the point B. J86/I/10

48 The diagram shows XY, part of a circuit into which is connected an ammeter of resistance 5.0 Ω. A current flows through the ammeter. A resistor of resistance 0.010 Ω is now connected across the ammeter terminals. Calculate the combined resistance of the ammeter and the resistor.



What is the effect of connecting the resistor across the meter on

(i) the current through the ammeter,

(ii) the total current in the circuit?

Explain your answers.

State a practical advantage of using an ammeter and a resistor connected in this way.

Define the coulomb.

The current indicated by the ammeter was 4.2 A and it flowed for 20 s. Calculate the total charge passing through the ammeter. N86/II/4

49 Describe an experiment, using a voltmeter and ammeter, that you could perform in order to measure experimentally the resistance of a resistor, the value of which is known to be about 8 Ω.

Make clear how the result is obtained from the observations made.

Identify one possible source of error in your experiment and indicate how you would attempt to minimise its effect.

An ammeter has a resistance of 0.12 Ω and gives a full-scale deflection for a current of 1.0 A. A resistor of resistance 0.04 Ω is connected across the terminals of the ammeter. When the combination is connected as part of another circuit, the deflection on the ammeter indicates a current of 0.3 A through it.

Calculate

(a) the potential difference between the terminals of the ammeter,

(b) the current flowing in the 0.04 Ω resistor,

(c) the current in the circuit.

What circuit current would now result in a full-scale deflection on the ammeter?

Could the ammeter be adapted by the connection of an external resistor to give a full-scale deflection for currents *less* than 1.0 A? Give a reason for your answer.

J87/II/10

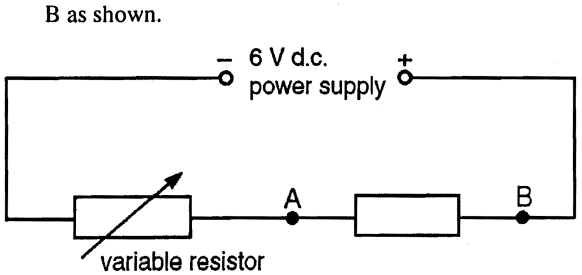
50 A torch uses 3 cells, each of e.m.f. 1.5 V and negligible internal resistance, to light a lamp rated 4.5 V, 0.5 A. In the space below draw a circuit diagram of the cells and lamp when the torch is switched on.

Calculate

(i) the resistance of the filament of the lamp when lit.

(ii) the charge flowing through the filament of the lamp per minute. N87/I/13

51 *(a)* The apparatus shown in the circuit diagram is available, together with a suitable voltmeter and ammeter. Initially a resistor is connected between points A and B as shown.



(i) Copy the circuit diagram, and show how the voltmeter and ammeter should be connected to enable the resistance of the resistor to be determined.

(ii) State the readings you would take and indicate the graph you would draw. Explain how an accurate value of the resistance can be found from the graph.

(iii) The connections to the resistor are now reversed and the experiment is repeated. How, if at all, would you expect the results to differ?

J88/II/10*(a)*

52 A battery is charged for 6 hours using a current of 0.50 A.

Calculate

(a) the total charge which flows through the battery, [2]

(b) the work done in passing this charge through the battery if the average voltage between the battery terminals during charging is 11.0 V. [2] J89/I/11

53 A battery has an e.m.f. of 4.0 V and negligible resistance.

(a) What does this tell you about the work done by the battery in driving 1 coulomb of charge around a closed circuit? [1]

(b) When a resistor is connected across the terminals of the battery, a current of 0.20 A is passed.

(i) What is the time taken for 1.0 C of charge to pass a given point in the circuit?

(ii) Calculate the rate at which heat is produced in the resistor. [3] N89/1/10

54 Fig. 1 shows a circuit containing a battery of e.m.f. 3.00 V, a resistor of resistance 12.0 Ω and a switch S.

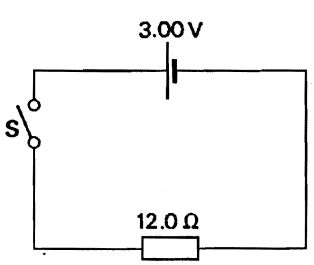


Fig. 1

When switch S is closed, what is

(a) the current through the circuit,

(b) the charge passing through the battery in 1.00 s,

(c) the energy output in the resistor in 1.00 s? [5] N91/II/7

55 You have been asked to carry out an experiment to separate some materials into electrical conductors and insulators. You have been given, in addition to these materials, a battery, a switch, a high resistance resistor, a very sensitive ammeter, lengths of connecting wire and two connecting clips.

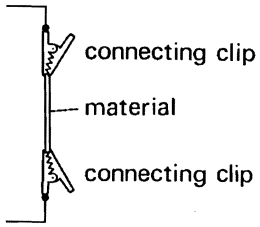


Fig. 2

(a) Complete Fig. 2 to show the circuit you would use. The clips which would connect each material to the rest of the circuit, in turn, have been drawn for you. [3]

(b) State briefly how you would use your circuit to find out which of the materials were insulators. [2] J92/II/5

56 A copper wire of length 1.5 m and diameter 1.2×10^{-4} m has a resistance of 2.0 Ω.

Determine the resistances of copper wires

(a) of length 2.5 m and diameter 1.2×10^{-4} m,

(b) of length 1.5 m and diameter 2.4×10^{-4} m .

resistance of 2.5 m length, 1.2×10^{-4} m diameter, copper wire = ...

resistance of 1.5 m length, 2.4×10^{-4} m diameter, copper wire = ... [5] J95/II/5

57 *(a)* (i) How much energy is transferred by a battery of e.m.f. 4.5 V when 1.0 C of charge passes through it?

(ii) How much power is developed in a battery of e.m.f. 4.5 V when a current of 1.0 A is passing through it? [2]

(b) Fig. 3 shows a battery of e.m.f. 4.5 V connected to a resistor of resistance 18 Ω.

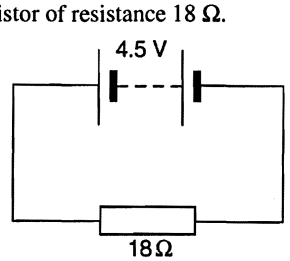


Fig. 3

Determine, for the resistor,

(i) the voltage across it,

(ii) the current in it. [3] N96/II/7

58 Fig. 4 shows a resistor of resistance 2.0 kΩ connected in series with a switch, a 12 V battery and an ammeter of negligible resistance.

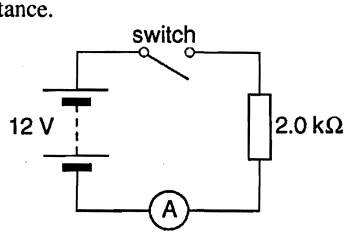


Fig. 4

(a) The switch is closed. Calculate

(i) the current in the circuit,

(ii) the charge which passes through the battery in 5.0 min. [3]

(b) Suggest a suitable full-scale deflection for the ammeter. Give your reasons for your answer. [1] N97/II/7

59 A d.c. supply of 2.0 V is connected across part of a resistance wire. As contact C is moved along the wire, the length l of the wire and the current I through the wire are measured. The voltage across the wire is constant.

The circuit is shown in Fig. 5.1 and the results of the experiment are shown in Fig. 5.2.

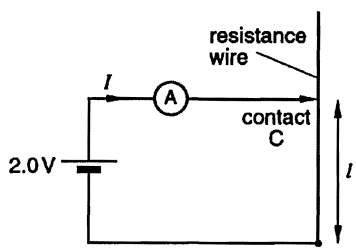
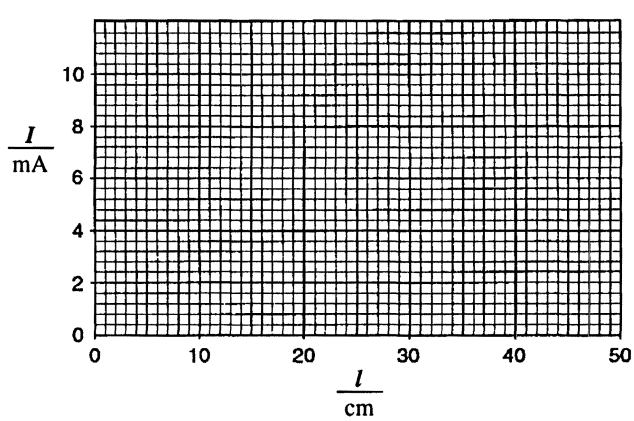


Fig. 5.1

l / cm	I / mA
10.0	8.6
20.0	4.3
30.0	2.9
40.0	2.2

Fig. 5.2

(a) On the axes, plot the data given in Fig. 5.2 and draw a smooth curve through the points. [2]



(b) For a length l of wire of 25.0 cm, determine

(i) the value of the current I,

I = ...

(ii) the resistance of this length of wire. Give your value for the resistance to a sensible number of significant figures.

resistance = ... [3]

(c) Determine the resistance of a 25.0 cm sample of wire of the same material as used in *(b)* but which has ten times the cross-sectional area.

resistance = ... [1] J98/II/7

60 Fig. 6 shows a circuit set up to test whether electrical resistance changes when temperature rises.

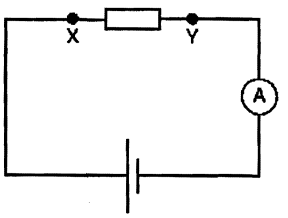


Fig. 6

Two components, a length of metal wire and a thermistor, are tested. They are each tested in turn, by placing them between terminals X and Y. As the temperature changes, the current readings on the ammeter are noted. The results are shown in the table.

component under test	current at 0 °C / A	current at 50 °C / A	current at 100 °C / A
metal wire	0.100	0.090	0.080
thermistor	0.002	0.004	0.080

(a) (i) On Fig. 6, draw a voltmeter to show how it is connected to measure the potential difference across XY.

(ii) State how you would use the apparatus to obtain a value for the resistance of the component.

(iii) State whether the resistance of each of the components **increases** or **decreases** as it is heated.

1. metal wire .....

2. thermistor ..... [4]

(b) The current through each component changes with temperature. The current values are used to set up a temperature scale. Each circuit then acts as a thermo-meter, reading temperatures between 0 °C and 100 °C. Using information from the table, state, giving a reason in each case, which component would make a thermometer with

(i) the greater sensitivity,

component .....reason .....

(ii) the greater linearity.

component .....reason .....

[2]

J2000/II/6

61 Fig. 7 shows how the current in the filament of a lamp depends on the potential difference across it.

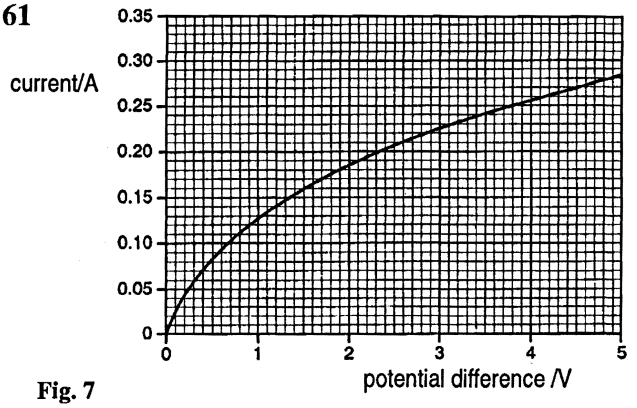


Fig. 7

(a) Calculate the resistance of the filament when the current is 0.25 A. Give your answer to an appropriate number of significant figures.

resistance = ... [3]

(b) Explain how Fig. 8.1 shows that the *resistance* of the filament increases with *temperature rise.* [2]

N2000/II/8

ANSWERS

1. **C**	2. **C**	3. **C**	4. **B**	5. **C**
6. **A**	7. **C**	8. **E**	9. **B**	10. **C**
11. **E**	12. **E**	13. **E**	14. **E**	15. **B**
16. **C**	17. **C**	18. **D**	19. **B**	20. **B**
21. **B**	22. **C**	23. **A**	24. **C**	25. **D**
26. **B**	27. **C**	28. **A**	29. **C**	30. **A**
31. **D**	32 **B**	33. **A**	34. **B**	35. **A**
36. **B**	37. **D**	38. **C**	39. **C**	40. **C**

42. 2.5 V ; 750 J *(a)* 600 s *(b)* 1.25 W
43. 0.3 s
44. 5.5 V ; 0.69 Ω
45. *(a)* 180 J *(b)* 0.25 A
46. 2×10^{10} J ; 5×10^{3} A
47. 4.4×10^{18}
48. 0.01 Ω ; 84 C
49. *(a)* 0.036 V *(b)* 0.9 A *(c)* 1.2 A
50. (i) 9 Ω (ii) 30 C
52. *(a)* 10 800 C *(b)* 118 800 J
53. *(a)* 4 J *(b)* (i) 5 s (ii) 0.8 W
54. *(a)* 0.25 A *(b)* 0.25 C *(c)* 0.75 J
56. *(a)* 0.33 Ω *(b)* 0.5 Ω
57. *(a)* (i) 4.5 J (ii) 4.5 W
(b) (i) 4.5 V (ii) 0.25 A
58. *(a)* (i) 6 mA (ii) 1.8 C
59. *(b)* (i) 3.4 mA (i) 590 Ω
(c) 59 Ω
60. *(a)* (iii) 1. increase 2. decreases
61. *(a)* 15.20 Ω