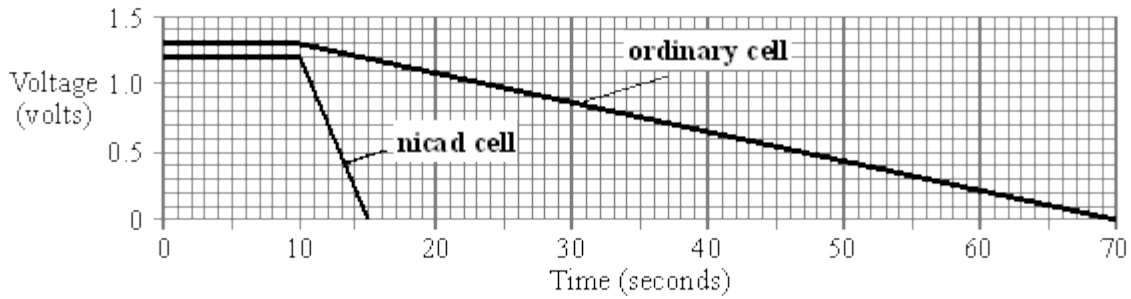**1** A small torch uses a single cell to make the bulb light up.
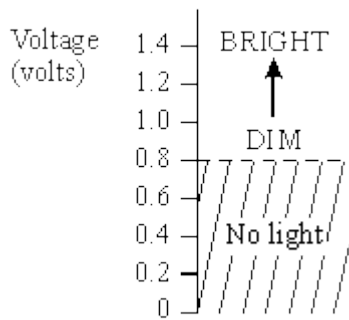
(a) The graphs show the voltage across two different types of cell as they transfer the last bit of their stored energy through the torch bulb.

Describe the differences that the graphs show between the two types of cell.

_____

_____

(3)

(b) The diagram shows how bright the torch bulb is for different voltages.

From the point when the voltage of each cell starts to fall, how long will the bulb stay lit:

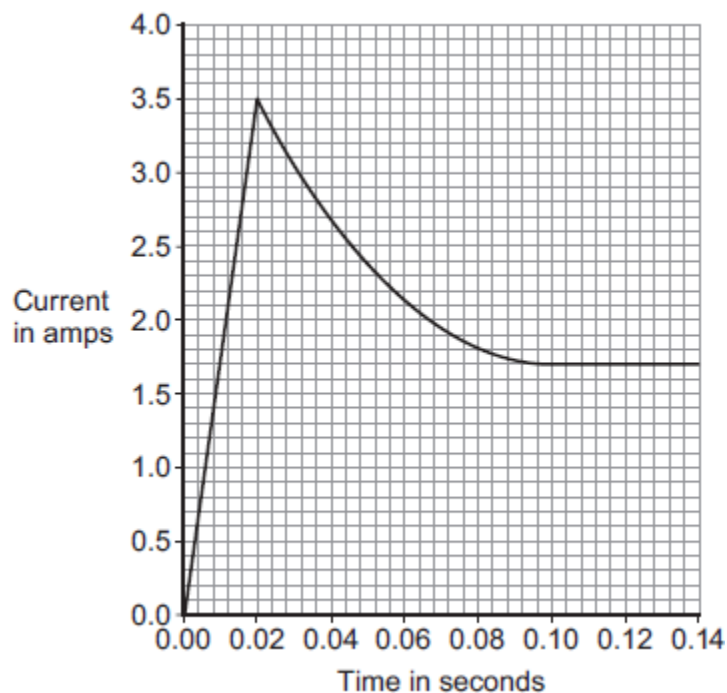(i) with the ordinary cell?

_____

(ii) with the nicad cell?

_____

(4)

(c)   When the voltage across the bulb falls to half, the current through the bulb falls by **less than** half. Why is this?

_____

_____

_____

_____

(3)
(Total 10 marks)

2   A 12 V filament bulb is connected to a 12 V power supply.
The graph shows how the current changes after the bulb is switched on.

(a)   (i)   After 0.10 seconds, the bulb works at its normal brightness.

What is the current through the bulb when it is working at normal brightness?

Current = _____ A

(1)

(ii) The bulb works at normal brightness for 30 seconds before it is switched off.

Calculate the charge that flows through the bulb in the 30 seconds before it is switched off. Give the unit.

_____

_____

_____

Charge = _____ unit _____

(3)

(iii) Calculate the energy transferred by the 12 V bulb when it is working at normal brightness for 30 seconds.

_____

_____

Energy transferred = _____ J

(2)

(b) Between 0.02 seconds and 0.08 seconds, there is an increase in both the resistance and the temperature of the metal filament inside the bulb.

Explain, in terms of the electrons and ions inside the filament, why both the temperature and the resistance increase.
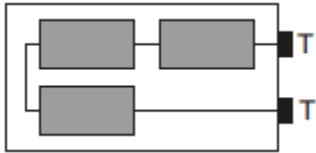
_____

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_____

_____

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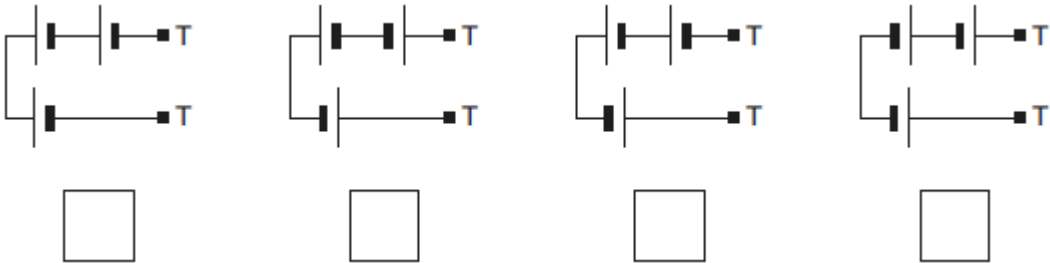
_____

(2)
(Total 8 marks)

3 (a) **Figure 1** shows the inside of a battery pack designed to hold three identical 1.5 V cells.

Figure 1

Which **one** of the arrangements shown in **Figure 2** would give a 4.5 V output across the battery pack terminals **T**?
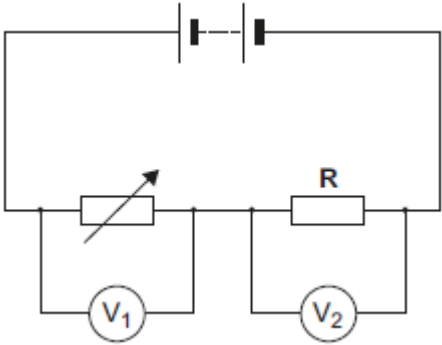
Figure 2

(1)

(b) **Figure 3** shows a variable resistor and a fixed value resistor connected in series in a circuit.

Figure 3

Complete **Figure 3** to show how an ammeter would be connected to measure the current through the circuit.
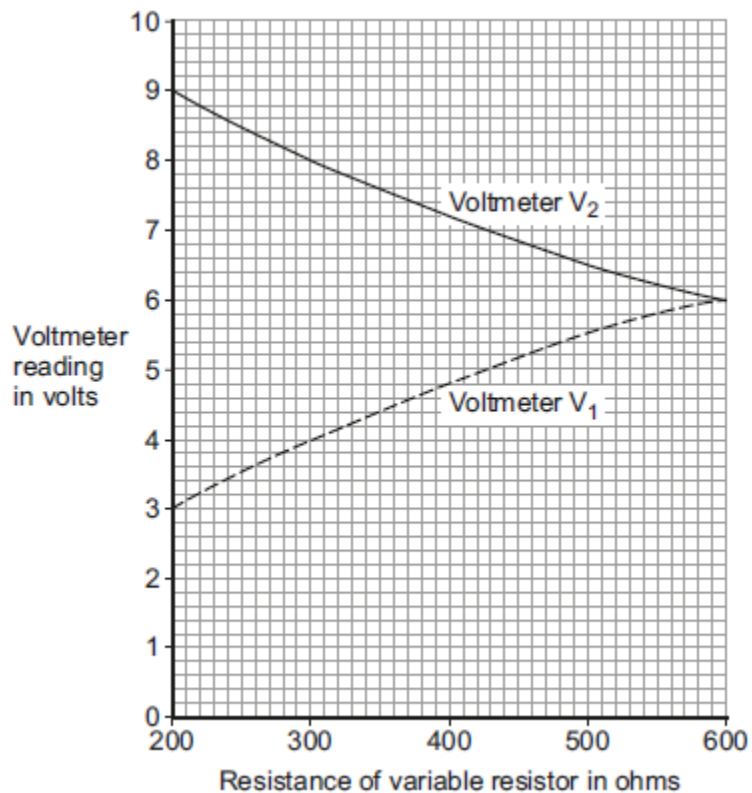
Use the correct circuit symbol for an ammeter.

(1)

(c) The variable resistor can be adjusted to have any value from 200 ohms to 600 ohms.

Figure 4 shows how the reading on voltmeter V_1 and the reading on voltmeter V_2 change as the resistance of the variable resistor changes.

Figure 4

Resistance of variable resistor in ohms

(i) How could the potential difference of the battery be calculated from **Figure 4**?

Tick (✓) **one** box.

9 + 3 = 12 V ☐

9 − 3 = 6 V ☐

9 ÷ 3 = 3 V ☐

Give the reason for your answer.

_____

_____

(2)

(ii)   Use **Figure 4** to determine the resistance of the fixed resistor, **R**.

Resistance of R = _____ Ω

Give the reason for your answer.

_____

_____

(2)

(iii)   Calculate the current through the circuit when the resistance of the variable resistor equals 200 Ω.

_____

_____

_____

Current = _____ A

(3)
(Total 9 marks)

Mark schemes

1   (a)   ordinary cell has higher voltage (normally / at start)
or
ordinary cell 1.3V nicad 1.2V (normally / at start)

        for 1 mark

   voltage of ordinary cell falls more slowly

        gains 1 mark

   (*accept* ordinary cell lasts longer)
but
as above with relevant quantification e.g. falls to zero in 60 seconds
compared to 6 seconds
or
nicad falls to zero 10 times as fast

        gains 2 marks

3

   (b)   (i)   answer in range 32-34 (seconds) (inclusive)

        gains 1 mark

        but
   answer in range 22-24 (seconds) (inclusive)

        gains 2 marks

       (ii)   12 (seconds)

        gains 1 mark

        but
   2 (seconds)

        gains 2 marks

4

   (c)   resistance of the lamp / filament changes / increases

        gains 1 mark

   but
resistance of the lamp / filament decreases

        gains 2 marks

   because the temperature of the filament falls / filament cools

        for 1 mark

3

[10]

2 (a) (i) 1.7

1

(ii) 51
or
30 × their (i) correctly calculated

allow **1** mark for correct substitution i.e. $1.7 = \dfrac{Q}{30}$

or their $(i) = \dfrac{Q}{30}$

2

coulomb / C
do **not** accept c

1

(iii) 612
or
their (ii) × 12 correctly calculated
or
their (i) × 360 correctly calculated

allow **1** mark for correct substitution i.e. E = 12 × 51

or 12 × their (ii)

or their (i) × 360

2

(b) ions vibrate faster
or
ions vibrate with a bigger amplitude

accept atoms for ions throughout

accept ions gain energy

accept ions vibrate more

ions start to vibrate is insufficient

1

electrons collide more (frequently) with the ions
or
(drift) velocity of electrons decreases

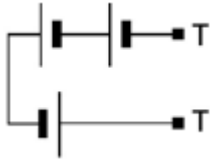electrons start to collide is insufficient

there are more collisions is insufficient, unless both electrons and ions are implied

1

[8]

3 (a) 3rd box from the left ticked

1

(b) correct symbol drawn in series with other components

symbol must have upper case A

1

(c) (i) 9 + 3 = 12V

reason only scores if this mark scored

1

pd of battery is shared between the variable resistor and fixed resistor

accept $V_1 + V_2$ = pd of the battery

accept p.d. is shared in a series circuit

accept voltage for p.d.

1

(ii) 600

reason only scores if this mark scored

1

p.d. of supply shared equally when resistors have the same value
or
ratio of the p.d. is the same as the ratio of the resistance

1

(iii) 0.015
or
their (c)(i) ÷ (their (c)(ii) + 200) correctly calculated

*allow **2** marks for correct substitution ie 12 = I × 800*

or

their (c)(i) = I × (their (c)(ii) + 200)

*allow **1** mark for total resistance = 800 (Ω) or their (c)(ii) + 200*

or

*allow **1** mark for a substitution of 12 = I × 200*

or

their (c)(i) = I × 200

or

alternative method using the graph

V = 3 V (1)

3 = I × 200 (1)

3

[9]