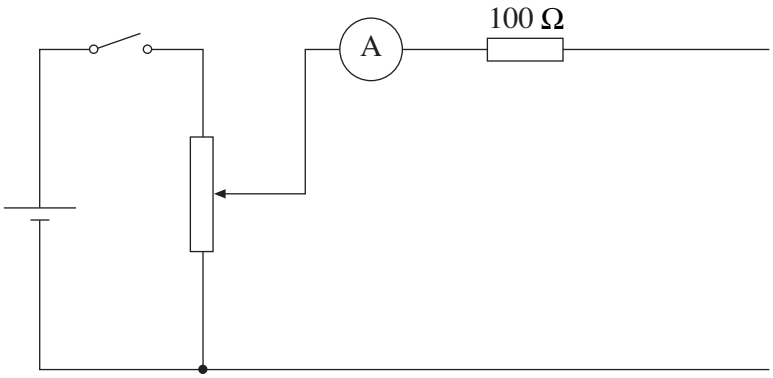
Examiner only

Task A3: Current - Potential difference characteristic for a diode.

In this task you will investigate the relationship between current, *I*, and potential difference, *V*, for a semiconductor diode.

Repeat readings are not required for this task.

(a) Complete the diagram of the electrical circuit that has been set up for you. [2]

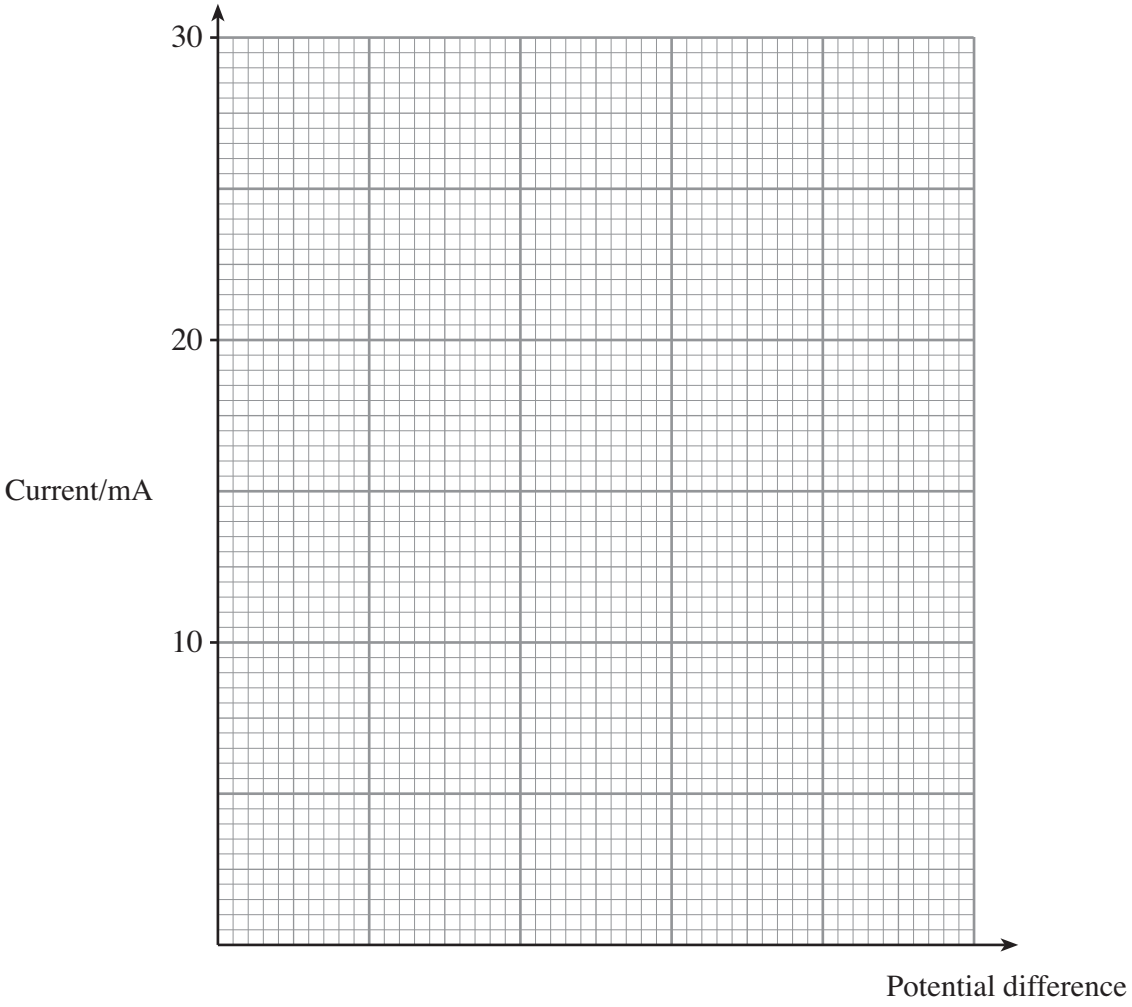


(b) Complete the following table by varying the d.c. supply to the values of current given in the table. Record the appropriate value of potential difference across the diode in the table. [1]

Current (mA)	Potential Difference (V)
30·0	
20·0	
15·0	
10·0	
5·0	
2·0	
0·5	

Examiner only

(c) Complete the following graph. Start by labelling and choosing an appropriate scale for the potential difference axis. [4]



(d) From the graph, determine the value of the potential difference when the current **begins** to flow through the diode. [1]

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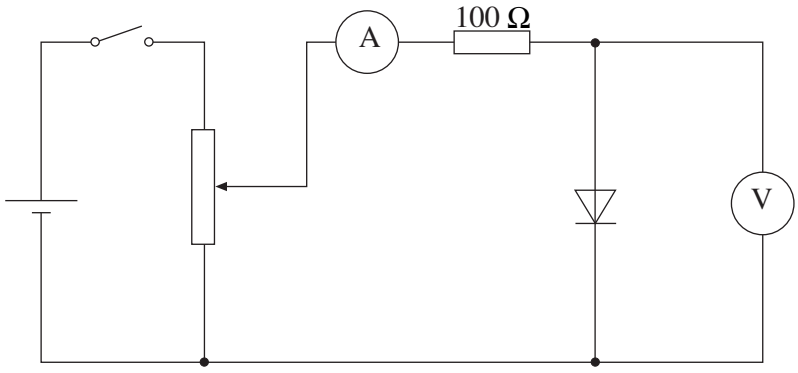
TASK A3

Candidates will be expected to determine the forward current-voltage characteristic of a silicon diode.

Test 1
Apparatus required:

- IN4002 diodes available from Rapid Electronics - Order code: 47–3132 (5p each)
- 100 Ω Resistor - 0·6 W metal film are recommended, e.g. Available from Rapid Electronics: Order code: 62–7446 - £2.20 for a pack of 100
- Ammeter - Resolution ±0·1 mA (or a multimeter set on 0 – 200 mA DC current range)
- Voltmeter - Resolution ±0·01 V (or a multimeter set on 0 – 2 V DC voltage range)
- Connecting leads
- 4 × 'D' type 1·5 V cells arranged in series and 4 × 'D' type battery holders **or** a variable/fixed d.c. power supply set at 6 V
- 1 × switch (push to make or morse key-type)
- Rheostat, e.g. 0–25 Ω [The value is not critical. It should enable the candidates to obtain a series of current measurements in the range 0 – 30 mA]

The following circuit should be set up for the candidates in such a way that they can easily relate it to this diagram. The rheostat slider should be roughly central.



If the circuit is set up using locktronics then the component symbols must be blanked out.

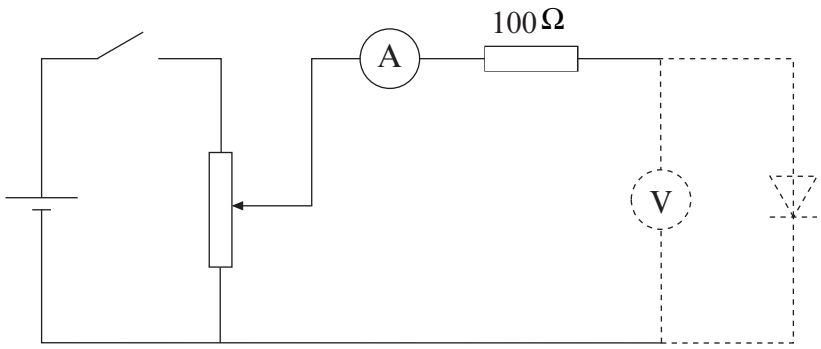
Test 2
The apparatus and circuit are as for **Test 1** except that a different diode should be used – IN4001, order code 47 – 3131 from Rapid Electronics (3.8 p)

Task A3: Current - Potential difference characteristic for a diode (15 minutes).

In this task you will investigate the relationship between current, I, and potential difference, V, for a semiconductor diode.

Repeat readings are not required for this task.

(a) Complete the diagram of the electrical circuit that has been set up for you. [2]



Correct symbol and correct polarity of the diode (1)

Voltmeter connected across diode (1)

(b) Complete the following table by varying the d.c. supply to the values of current given in the table. Record the appropriate value of potential difference across the diode in the table. [1]

Current (mA)	Potential Difference (V)
30.0	
20.0	
15.0	
10.0	
5.0	
2.0	
0.5	

pd values correct (to resolution of the meter)
[no penalty if other similar values of current substituted]

(c) Complete the following graph. Start by labelling and choosing an appropriate scale for the potential difference axis. [4]

- *Potential difference axis labelled with unit (V) (1)*
- *All points plotted correctly to within ½ division (2)*
  Penalise 1 mark for each incorrect plot to a maximum penalty of 2
- *Appropriate smooth curve of best fit (1)*

(d) From the graph, determine the value of the potential difference when the current **begins** to flow through the diode. [1]

Value consistent with graph and unit
(No significant figure penalty)

Question 2

You are going to investigate the current – voltage characteristic of a filament bulb.

Repeat readings are not required for this experiment.

(a) Draw a diagram of the circuit that has been set up for you. [2]

(b) By adjusting the variable resistor note down the minimum and maximum current.

Minimum current = ...

Maximum current = ... [1]

(c) By choosing a suitable sample size take sufficient readings of current and voltage to plot a graph. Record your results in a table below. [4]

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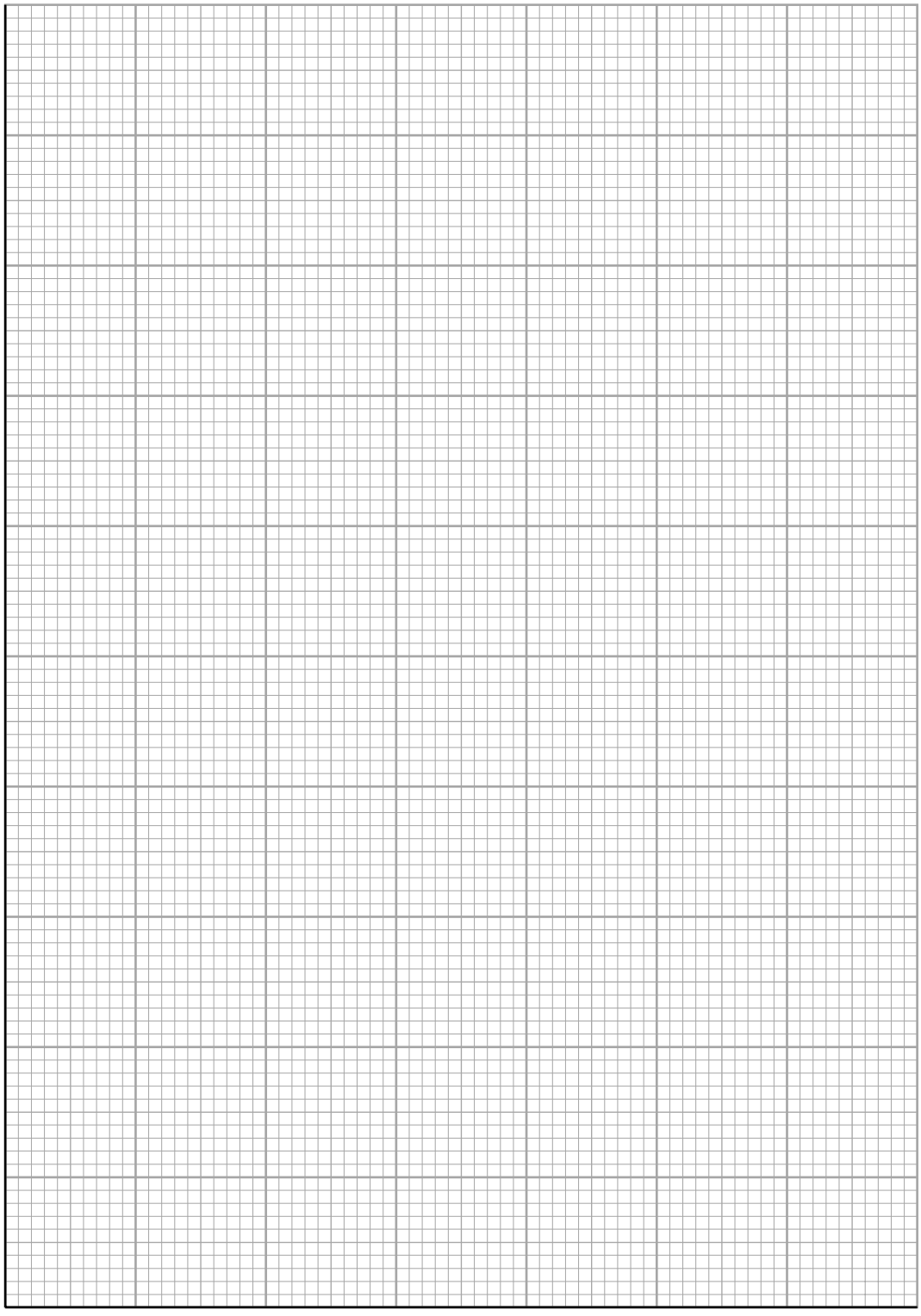
(d) Plot a graph with current on the vertical axis and voltage on the horizontal axis and draw a curve of best fit. [4]



(e) (i) Calculate the gradient of your graph at the origin, 0·00 A and use this value to calculate the resistance of the filament bulb at this point. [3]

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(ii) Determine the resistance of the bulb at 0·80 A. [2]

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(iii) By comparing your results in *(e)*(i) and *(e)*(ii), state and explain what happens to the resistance of the bulb as the current increases. [2]

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(f) (i) If you carried out the same experiment with a fixed resistor instead of the filament bulb, what shape graph would you expect to get? [1]

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(ii) If you then repeated the experiment with a larger **fixed** resistor, what would happen to the graph? [1]

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Experiment 2

Test 1

Candidates will be expected to investigate the current-voltage characteristics of a filament bulb.

Apparatus required:

1. 24 W, 12 V filament bulb.

2. Digital voltmeter reading to 0·01 V.

3. Digital ammeter reading to 0·01 A.
   [N.B. The meters can both be multimeters set onto the appropriate range]

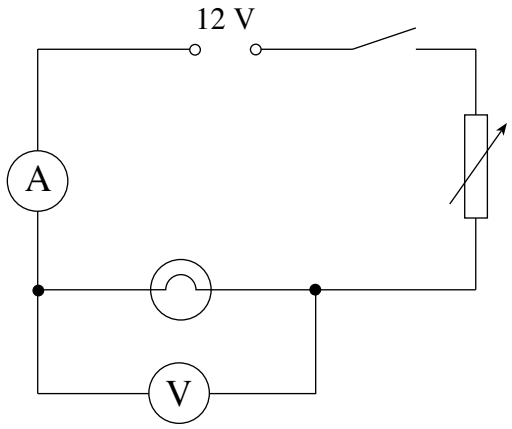
4. Fixed 12 V d.c. power supply.

5. Variable resistor / rheostat with maximum resistance of 15 – 20 Ω.

6. Connecting leads as required.

7. Press switch.

The following circuit should be set up ready for the candidates to use. The variable resistor should be set to approximately mid-range. Unless the meters are auto-ranging, they should be set to the appropriate ranges.



Test 2

The apparatus and circuit are as for Test 1.

Question	Answers / Explanatory notes	Marks available
2. *(a)*	All symbols present / correct [accept cell for power supply] (1) Ammeter in series and voltmeter in parallel. (1)	2
(b)	Reading correct to 2 d.p. with units.	1
(c)	Table: Minimum of 5 readings (1) Headings correct, with units (1) Suitable range consistent with max/min readings (1) All readings to 1-2 d.p. all to 0·01 (1)	4
(d)	Graph: Headings and units on axes – correct alignment (1) Suitable scales chosen (1) Allpoints correctly plotted (1) Smooth curve drawn from (0,0) (1)	4
(e) (i)	Tangent drawn [Δ if a straight line] (1) Gradient calculated correctly (1) Resistance correct (1/gradient) (1)	3
(ii)	R calculated using $R = \frac{V}{I}$ (not tangent) (1) } (ignore s.f.'s)	
	Units correct in either (i) or (ii)(1)	2
	Resistance increases – e.c.f. from (i) and (ii) (1) Filament heats up (1)	2
(f) (i)	Straight line (through the origin)	1
	Lower gradient – e.c.f. if axes incorrect orientation	1
		[20]