7 The intensity of light incident on a light dependent resistor (LDR) can vary both its electrical resistance R and the number of charge carriers per unit volume n. The light intensity on an LDR is increased.

Which row of the table describes the effect on R and n?

	R	n
☒ **A**	decreases	decreases
☒ **B**	decreases	increases
☒ **C**	increases	decreases
☒ **D**	increases	increases

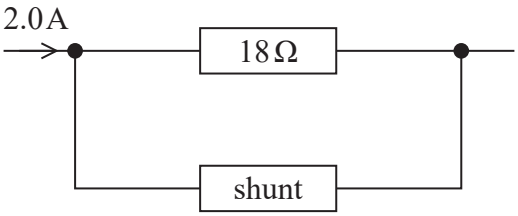
(Total for Question 7 = 1 mark)

(Total for Question 9 = 1 mark)

12 Analogue ammeters were used before digital meters became widely available.
The analogue ammeter shown will measure a maximum current of 1.0 mA and has a resistance of 18 Ω.

(Source: © David J. Green/Alamy Stock Photo)

The analogue ammeter can be adapted to measure a larger current by adding a resistor, known as a shunt, in parallel with the ammeter. The arrangement is shown below.
The analogue ammeter is represented by the 18 Ω resistor.



The maximum current through the 18 Ω resistor remains as 1.0 mA.

(a) Show that the shunt would need to have a resistance of about 0.01 Ω to adapt this ammeter to read up to a maximum current of 2.0 A.

(3)

(b) A shunt of this resistance was usually made from Manganin wire.

Calculate the length of Manganin wire of radius 0.95 mm required to make this shunt.

resistivity of Manganin = $4.55 \times 10^{-7}\,\Omega\,\text{m}$

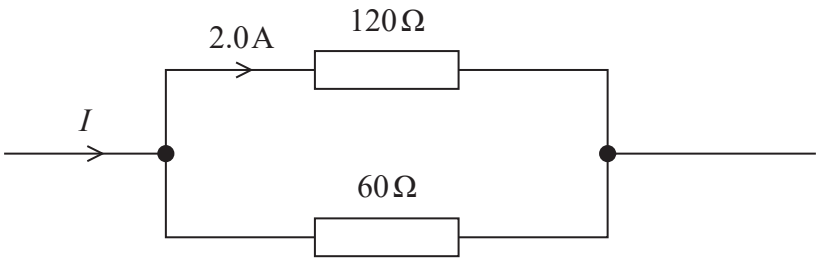
(3)

Length = ...

(Total for Question 12 = 6 marks)

Questions 4 and 5 refer to the information below.

Two resistors are connected in parallel and the current in one of them is 2.0 A, as shown.



4 Which of the following is the current I in ampere?

- ☒ **A** 3.0
- ☒ **B** 4.0
- ☒ **C** 5.0
- ☒ **D** 6.0

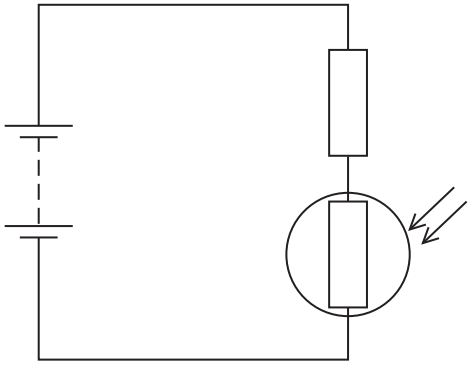
(Total for Question 4 = 1 mark)

5 Which of the following is the total resistance of the resistors in parallel?

- ☒ **A** 20 Ω
- ☒ **B** 40 Ω
- ☒ **C** 90 Ω
- ☒ **D** 180 Ω

(Total for Question 5 = 1 mark)

7 A light dependent resistor (LDR) and a resistor are connected to a battery, as shown.



The intensity of light incident on the LDR increases.

Which row of the table describes the change in the resistance of the LDR and the change in the potential difference across the resistor?

	Resistance of LDR	Potential difference across the resistor
☒ **A**	decreases	decreases
☒ **B**	decreases	increases
☒ **C**	increases	decreases
☒ **D**	increases	increases

(Total for Question 7 = 1 mark)

☒

☒

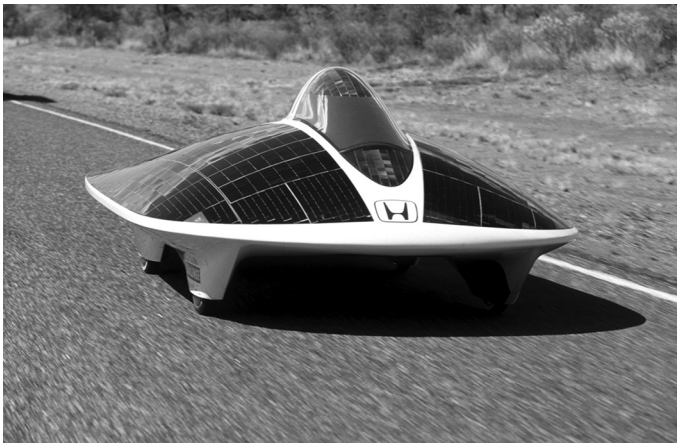
☒

☒

(Total for Question 8 = 1 mark)

14 The world solar challenge is set every two years, in Australia. The challenge is to complete a three thousand kilometre route with a vehicle powered only by the Sun.

Vehicles have their surfaces fitted with solar panels, as shown in the photograph.



(Source: © LAURENT DOUEK/LOOK AT SCIENCES/SCIENCE PHOTO LIBRARY)

(a) One of the solar panels has an e.m.f. of 8.2 V when in sunlight. The terminal potential difference is 5.5 V when a current of 0.45 A is drawn from the solar panel.

Calculate the internal resistance of the solar panel in these conditions.

(3)

Internal resistance = ...

(b) A bank of 380 of these solar panels is used to charge the battery in a vehicle. The panels are connected in parallel and the current provided by each panel is 0.45 A. When fully charged, the energy stored in the battery is 12 kW h.

Calculate the time, in hours, to fully charge this battery if the solar panels are in sunlight. Assume the efficiency of charging this battery is 100%.

(3)

Time = ... hours

(c) The vehicle can reach a maximum speed of 34 m s^{-1} on flat ground. The electric motor used to move the vehicle has a power of 4.5 kW.

(i) Calculate the initial acceleration of the vehicle as it starts from rest.

mass of vehicle and driver = 420 kg

(3)

Initial acceleration = ...

(ii) State one assumption made in this calculation.

(1)

(d) Solar power alone would not be suitable for a family car because it is not sunny all the time.

Give two further reasons why solar power alone would not be suitable.

(2)

(Total for Question 14 = 12 marks)

14 Power supplies provide either alternating or direct currents and potential differences.

(a) A power supply produces an alternating potential difference (p.d.). The p.d. has a period of 0.02 s and a peak value of 4.0 V.

(i) Calculate the frequency of the supply.

(1)

Frequency = ...

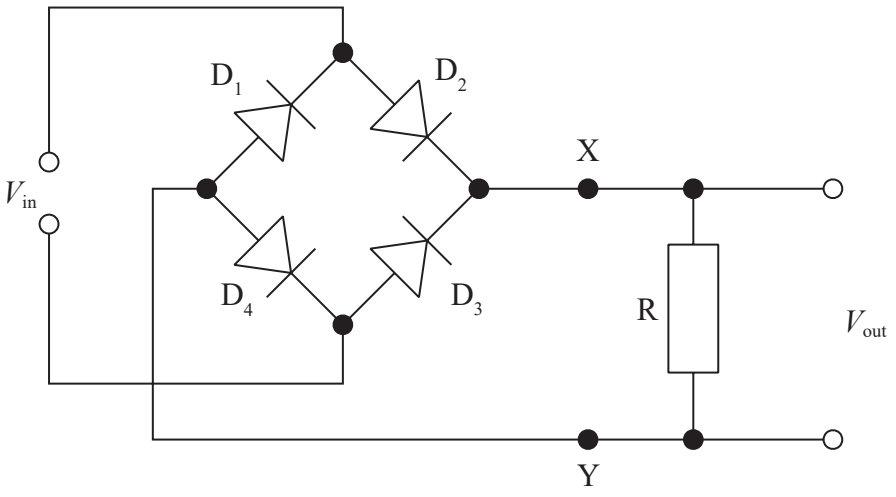
(ii) Calculate the root-mean-square p.d.

(1)

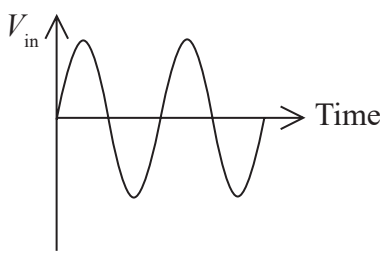
Root-mean-square p.d. = ...

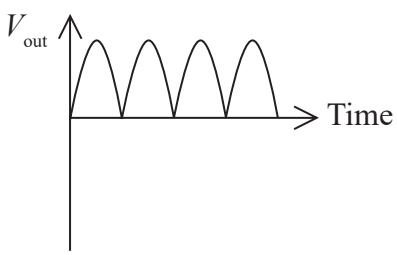
(b) It is possible to convert alternating currents and p.d.s, to direct currents and p.d.s using diodes.

The power supply provides an input V_{in} to the circuit shown. The circuit includes four diodes D_1, D_2, D_3 and D_4 and a resistor R. The circuit produces an output potential difference V_{out}.



A graph of V_{in} against time and a corresponding graph of V_{out} against time are shown below.



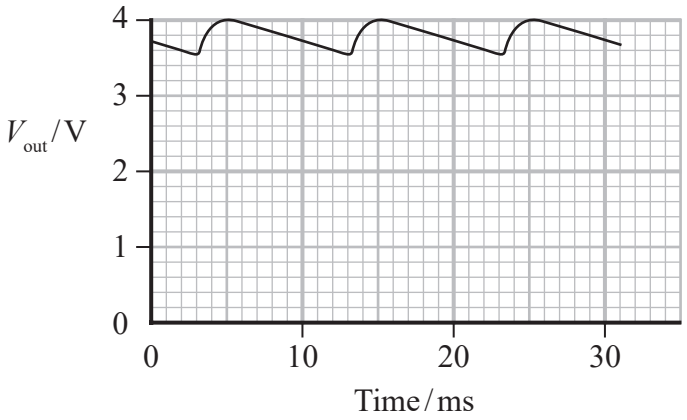


(i) Explain the operation of this circuit. Your answer should refer to D_1, D_2, D_3 and D_4.

(3)

(ii) A capacitor is added between points X and Y in the circuit.

The new graph of V_{out} against time is shown below.



Determine a value for the capacitance of the capacitor.

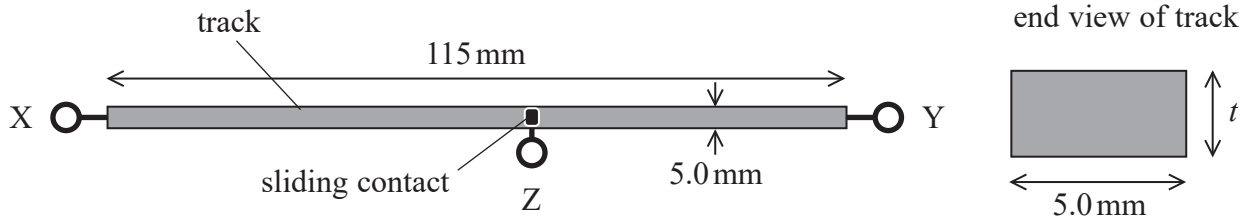
resistance of R = 2.2 kΩ

(3)

Capacitance = ...

(Total for Question 14 = 8 marks)

18 A potential divider circuit may contain a component known as a potentiometer. One type of potentiometer consists of a track with terminals X and Y at either end. There is a sliding contact that can move along the track connected to a terminal Z as shown.



The length of the track is 115 mm and the width is 5.0 mm.

(a) The resistance of the track between terminal X and terminal Y is 12.0 kΩ.

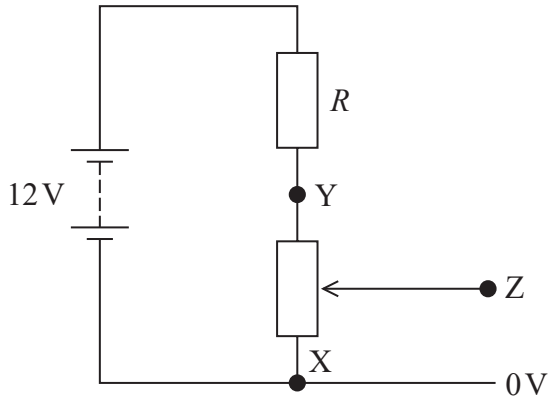
Calculate the thickness t of the track.

resistivity of track material = 0.49 Ω m

(3)

t = ...

(b) The potentiometer is used to monitor the displacement of a moving tool on a machine in a production line. The tool is attached to the sliding contact. The potentiometer is connected to a resistor of resistance R and a potential difference is applied as shown. The tool moves through a maximum displacement of 60 mm from end X, producing a maximum potential difference of 5.0 V between Z and X.



(i) Show that the potential difference between X and Y is about 10 V.

(2)

(ii) Calculate the value of R.

(3)

$R =$ .....

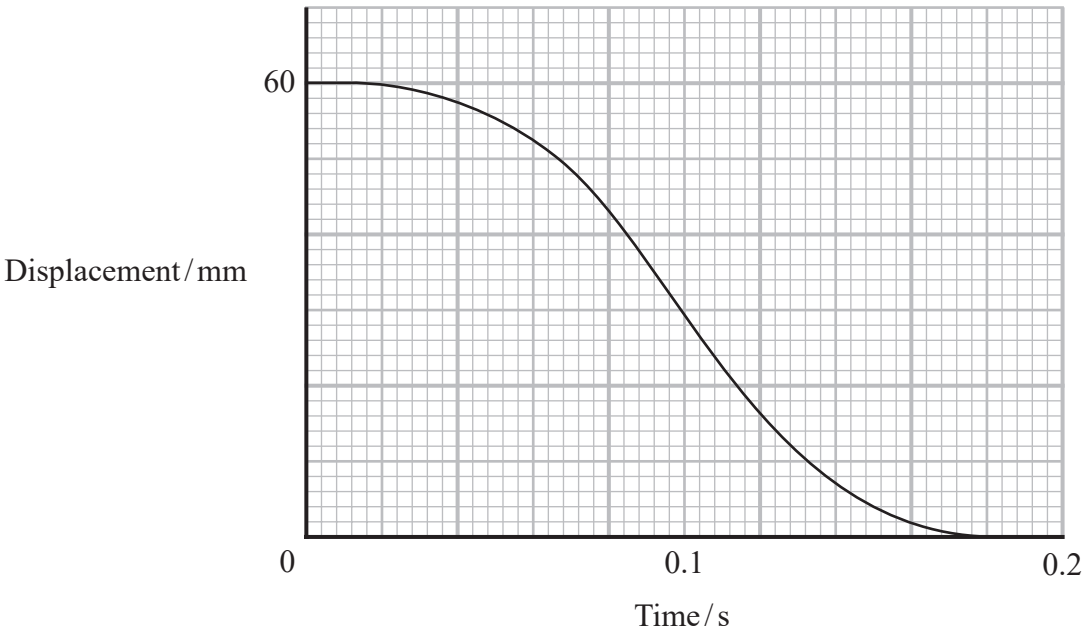
(iii) When the circuit is assembled, using the correctly calculated resistance value and a battery of e.m.f. 12 V, it is found that the maximum output from the potentiometer is slightly less than 5.0 V.

Explain why the maximum output is slightly less than predicted.

(3)

(iv) The tool on the machine should not travel with a speed any larger than $0.8\,m\,s^{-1}$.

The graph shows how the displacement varies with time for the downward stroke of the moving tool.



Deduce whether this speed is exceeded by the moving tool.

(4)

(Total for Question 18 = 15 marks)

TOTAL FOR PAPER = 90 MARKS