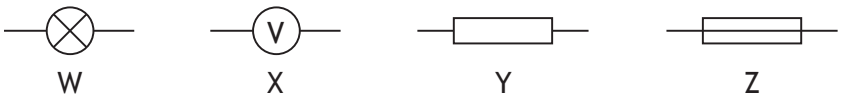
SECTION 1

1. The voltage of an electrical supply is a measure of the

A resistance of the circuit
B speed of the charges in the circuit
C power developed in the circuit
D energy given to the charges in the circuit
E current in the circuit.

2. Four circuit symbols, W, X, Y and Z, are shown.



Which row identifies the components represented by these symbols?

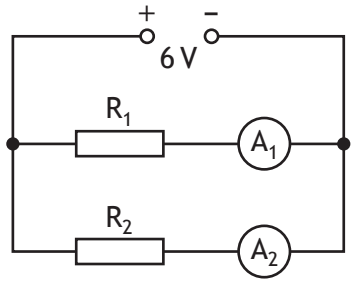
	W	*X*	*Y*	*Z*
A	battery	ammeter	resistor	variable resistor
B	battery	ammeter	fuse	resistor
C	lamp	ammeter	variable resistor	resistor
D	lamp	voltmeter	resistor	fuse
E	lamp	voltmeter	variable resistor	fuse

[Turn over

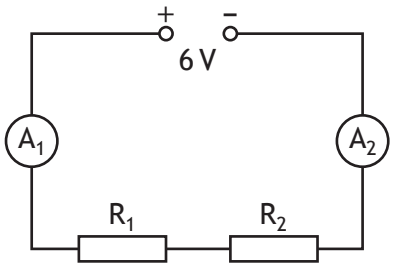
3. A student suspects that ammeter A_1 may be inaccurate. Ammeter A_2 is known to be accurate.

Which of the following circuits should be used to compare the reading on A_1 with A_2?

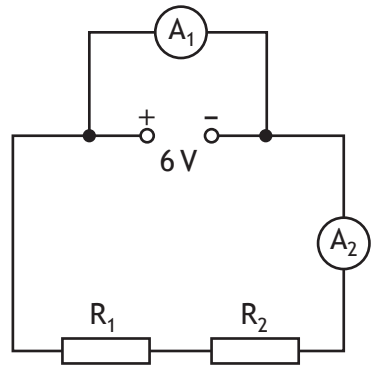
A



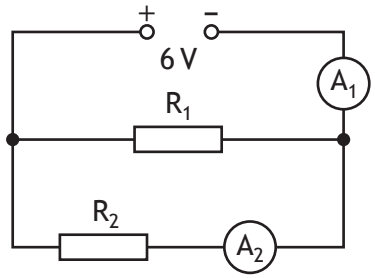
B



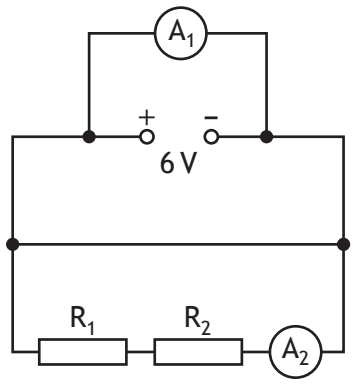
C



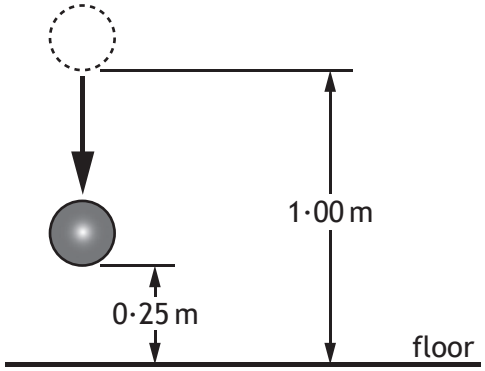
D



E



4. A ball of mass 0·50 kg is released from a height of 1·00 m and falls towards the floor.



Which row in the table shows the gravitational potential energy and the kinetic energy of the ball when it is at a height of 0·25 m from the floor?

	Gravitational potential energy (J)	*Kinetic energy* (J)
A	0·12	0·12
B	1·2	1·2
C	1·2	3·7
D	3·7	1·2
E	4·9	1·2

5. The pressure of a fixed mass of gas is $6{\cdot}0 \times 10^5$ Pa.

The temperature of the gas is 27 °C and the volume of the gas is $2{\cdot}5\ m^3$.

The temperature of the gas increases to 54 °C and the volume of the gas increases to $5{\cdot}0\ m^3$.

What is the new pressure of the gas?

A $2{\cdot}8 \times 10^5$ Pa

B $3{\cdot}3 \times 10^5$ Pa

C $6{\cdot}0 \times 10^5$ Pa

D $1{\cdot}1 \times 10^6$ Pa

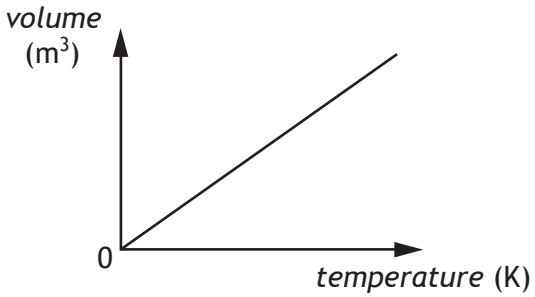
E $1{\cdot}3 \times 10^6$ Pa

[Turn over

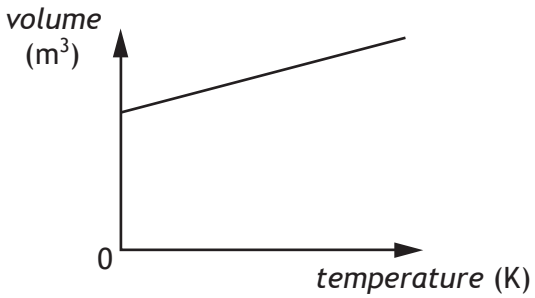
6. A student is investigating the relationship between the volume and the kelvin temperature of a fixed mass of gas at constant pressure.

Which graph shows this relationship?

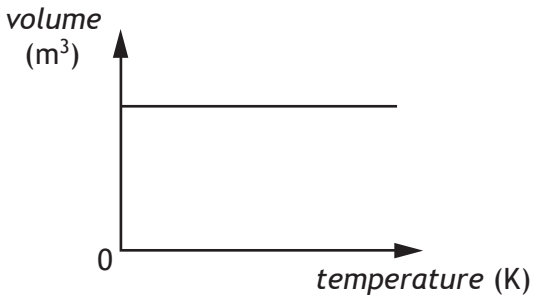
A



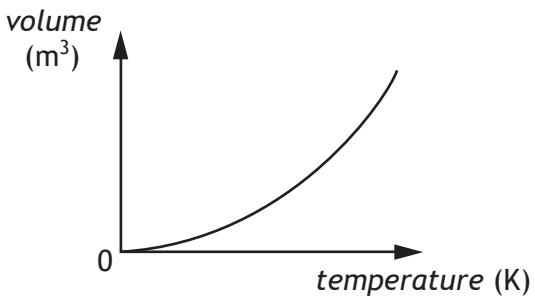
B



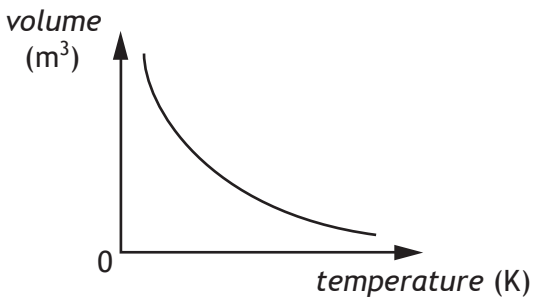
C



D



E



7. A liquid is heated from 17 °C to 50 °C. The temperature rise in kelvin is

A 33 K
B 67 K
C 306 K
D 340 K
E 579 K.

8. The period of vibration of a guitar string is 8 ms.
The frequency of the sound produced by the guitar string is

A 0·125 Hz
B 12·5 Hz
C 125 Hz
D 800 Hz
E 8000 Hz.

9. A student makes the following statements about microwaves and radio waves.

I In air, microwaves travel faster than radio waves.
II In air, microwaves have a longer wavelength than radio waves.
III Microwaves and radio waves are both members of the electromagnetic spectrum.

Which of these statements is/are correct?

A I only
B III only
C I and II only
D I and III only
E II and III only

10. Which row describes alpha (α), beta (β) and gamma (γ) radiations?

	α	β	γ
A	helium nucleus	electromagnetic radiation	electron from the nucleus
B	helium nucleus	electron from the nucleus	electromagnetic radiation
C	electron from the nucleus	helium nucleus	electromagnetic radiation
D	electromagnetic radiation	helium nucleus	electron from the nucleus
E	electromagnetic radiation	electron from the nucleus	helium nucleus

11. A sample of tissue is irradiated using a radioactive source.

A student makes the following statements about the sample.

I The equivalent dose received by the sample is reduced by shielding the sample with a lead screen.

II The equivalent dose received by the sample is increased as the distance from the source to the sample is increased.

III The equivalent dose received by the sample is increased by increasing the time of exposure of the sample to the radiation.

Which of these statements is/are correct?

A I only

B II only

C I and II only

D II and III only

E I and III only

12. The half-life of a radioactive source is 64 years.

In 2 hours, $1{\cdot}44 \times 10^8$ radioactive nuclei in the source decay.

What is the activity of the source in Bq?

A 2×10^4

B 4×10^4

C $1{\cdot}2 \times 10^6$

D $2{\cdot}25 \times 10^6$

E $7{\cdot}2 \times 10^7$

13. A student makes the following statements about the fission process in a nuclear power station.

I Electrons are used to bombard a uranium nucleus.

II Heat is produced.

III The neutrons released can cause other nuclei to undergo fission.

Which of these statements is/are correct?

A I only

B II only

C III only

D I and II only

E II and III only

14. Which of the following contains two vectors and one scalar quantity?

A Acceleration, mass, displacement

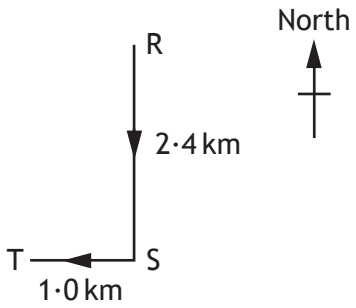
B Displacement, force, velocity

C Time, distance, force

D Displacement, velocity, acceleration

E Speed, velocity, distance

15. A vehicle follows a course from R to T as shown.



The total journey takes 1 hour.

Which row in the table gives the average speed and the average velocity of the vehicle for the whole journey?

	Average speed	*Average velocity*
A	2·6 km h^{-1} (023)	3·4 km h^{-1}
B	2·6 km h^{-1}	3·4 km h^{-1} (203)
C	3·4 km h^{-1} (203)	2·6 km h^{-1}
D	3·4 km h^{-1}	2·6 km h^{-1} (023)
E	3·4 km h^{-1}	2·6 km h^{-1} (203)

16. A force of 10 N acts on an object for 2 s.

During this time the object moves a distance of 3 m.

The work done on the object is

A 6·7 J

B 15 J

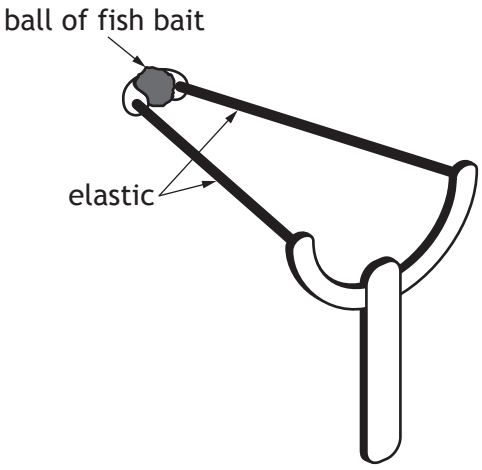
C 20 J

D 30 J

E 60 J.

17. Catapults are used by anglers to project fish bait into water.

A technician designs a catapult for this use.



Pieces of elastic of different thickness are used to provide a force on the ball.

Each piece of elastic is the same length.

The amount of stretch given to each elastic is the same each time.

The force exerted on the ball increases as the thickness of the elastic increases.

Which row in the table shows the combination of the thickness of elastic and mass of ball that produces the greatest acceleration?

	Thickness of elastic (mm)	*Mass of ball* (kg)
A	5	0·01
B	10	0·01
C	10	0·02
D	15	0·01
E	15	0·02

18. A spacecraft completes the last stage of its journey back to Earth by parachute, falling with constant speed into the sea.

The spacecraft falls with constant speed because

A the gravitational field strength of the Earth is constant near the Earth's surface

B it has come from space where the gravitational field strength is almost zero

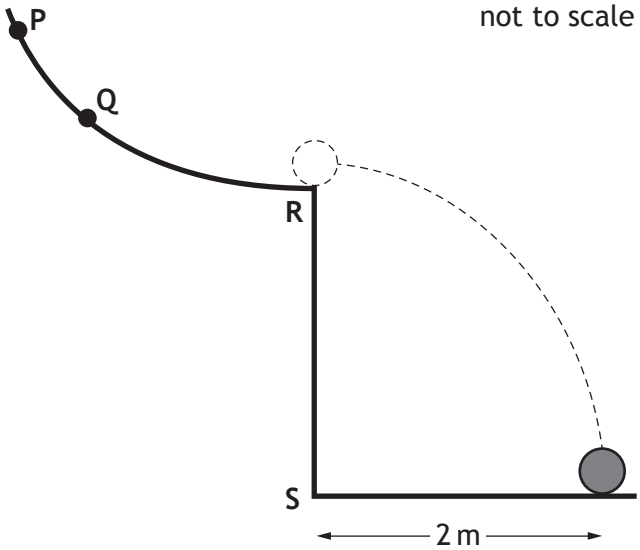
C the air resistance is greater than the weight of the spacecraft

D the weight of the spacecraft is greater than the air resistance

E the air resistance is equal to the weight of the spacecraft.

19. A ball is released from point **Q** on a curved rail, leaves the rail horizontally at R and lands 1 s later.

The ball is now released from point **P**.



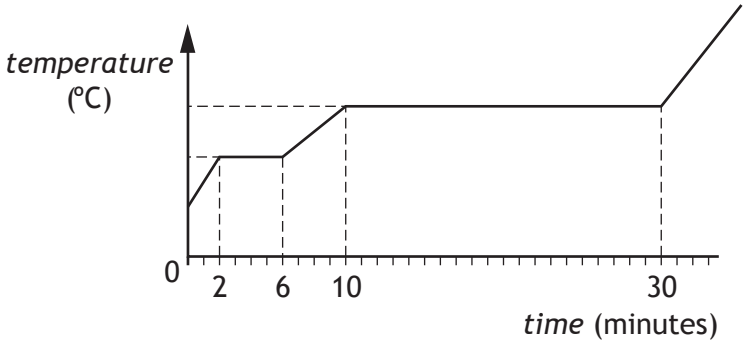
not to scale

Which row describes the motion of the ball after leaving the rail?

	Time to land after leaving rail	*Distance from S to landing point*
A	1 s	less than 2 m
B	less than 1 s	more than 2 m
C	1 s	more than 2 m
D	less than 1 s	2 m
E	more than 1 s	more than 2 m

20. A solid substance is placed in an insulated flask and heated continuously with an immersion heater.

The graph shows how the temperature of the substance in the flask changes in time.



After 5 minutes the substance is a

A solid

B liquid

C gas

D mixture of solid and liquid

E mixture of liquid and gas.

[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF YOUR QUESTION AND ANSWER BOOKLET]

Detailed Marking Instructions for each question

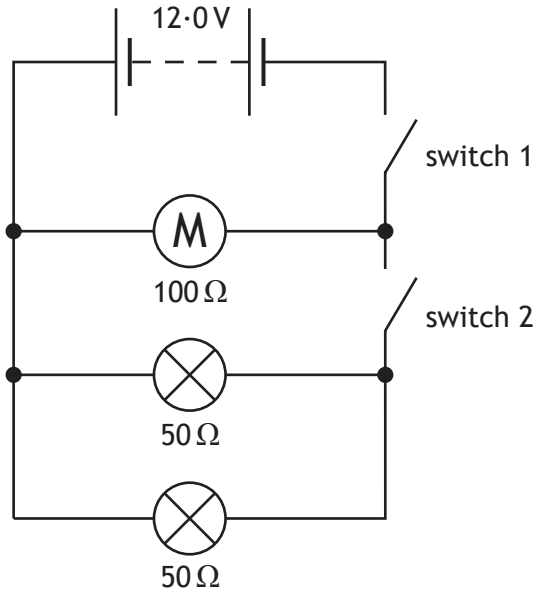
Section 1

Question	Answer	Max Mark
1.	D	**1**
2.	D	**1**
3.	B	**1**
4.	C	**1**
5.	B	**1**
6.	A	**1**
7.	A	**1**
8.	C	**1**
9.	B	**1**
10.	B	**1**
11.	E	**1**
12.	A	**1**
13.	E	**1**
14.	A	**1**
15.	E	**1**
16.	D	**1**
17.	D	**1**
18.	E	**1**
19.	C	**1**
20.	D	**1**

MARKS | DO NOT WRITE IN THIS MARGIN

1. A toy car contains an electric circuit which consists of a 12·0 V battery, an electric motor and two lamps.

The circuit diagram is shown.



(a) Switch 1 is now closed.

Calculate the power dissipated in the motor when operating. **3**

Space for working and answer

MARKS DO NOT WRITE IN THIS MARGIN

1. (continued)

(b) Switch 2 is now also closed.

(i) Calculate the total resistance of the motor and the two lamps. **3**

Space for working and answer

(ii) One of the lamps now develops a fault and stops working.
State the effect this has on the other lamp.
You **must** justify your answer. **2**

Total marks 8

[Turn over

Section 2

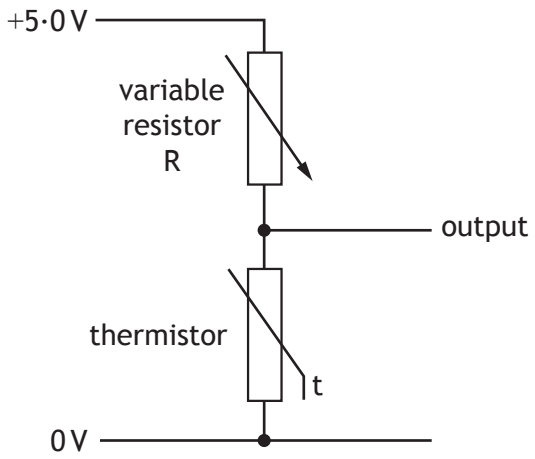
Question			Answer	Max Mark	Additional Guidance
1.	(a)		$P = \frac{V^2}{R}$ (1) $= \frac{12 \cdot 0^2}{100}$ (1) $= 1 \cdot 44$ W (1)	3	Accept 1, 1·4, 1·44 Do not accept: 1·40 Alternative methods: $I = \frac{V}{R}$ $= \frac{12 \cdot 0}{100}$ $= 0 \cdot 12$ (A) $P = IV$ $= 0 \cdot 12 \times 12$ $= 1 \cdot 44$ W OR $P = I^2 R$ $= 0 \cdot 12^2 \times 100$ $= 1 \cdot 44$ W (1) mark for both formulae (1) mark for both substitutions (1) mark for final answer and unit

Question			Answer	Max Mark	Additional Guidance
	(b)	(i)	$\frac{1}{R_T}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}$ (1) $\frac{1}{R_T}=\frac{1}{100}+\frac{1}{50}+\frac{1}{50}$ (1) $\frac{1}{R_T}=\frac{1}{20}$ $R_T=20\Omega$ (1)	3	If wrong equation used eg $R_T=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}$ then zero marks Accept *imprecise* working towards a final answer $\frac{1}{R_T}=\frac{1}{100}+\frac{1}{50}+\frac{1}{50}=20\ \Omega$ ↑ accept Can be answered by applying product over sum method twice. Accept: $\frac{1}{R_T}=\frac{1}{100}+\frac{1}{25}$

Question			Answer	Max Mark	Additional Guidance
		(ii)	**Effect:** The other lamp: • remains lit • stays on • is the same brightness • gets brighter • is not affected (1) **Justification:** The current still has a path through the other lamp. (1) OR The current in the other lamp is the same (only acceptable if other lamp stays same brightness) (1) OR The current in the other lamp is greater (only acceptable if other lamp gets brighter) (1) OR It has the same voltage / 12 V (across it) (1) OR The lamps are connected in parallel (1)	**2**	First mark can only be awarded if a justification is attempted Effect correct + entire justification correct (2) Effect correct + justification incorrect (1) Effect correct + no justification (0) Incorrect effect regardless of justification (0) If the effect is not stated (0) regardless of justification Do not accept: Other lamp gets dimmer

MARKS DO NOT WRITE IN THIS MARGIN

2. A thermistor is used as a temperature sensor in a circuit to monitor and control the temperature of water in a tank. Part of the circuit is shown.



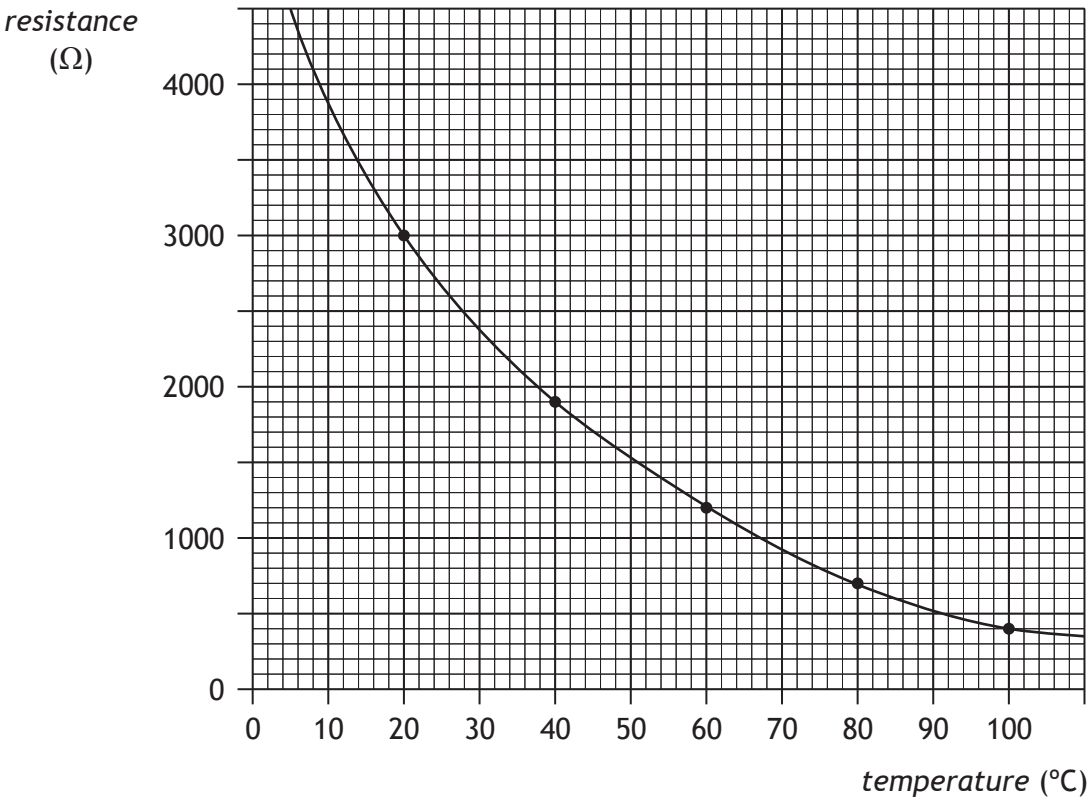
(a) (i) The variable resistor R is set at a resistance of 1050 Ω.

Calculate the resistance of the thermistor when the voltage across the thermistor is 2·0 V. **4**

Space for working and answer

2. (a) (continued)

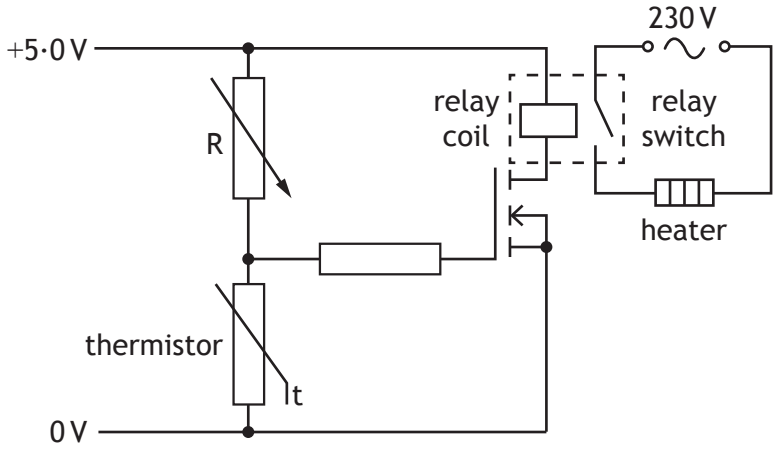
(ii) The graph shows how the resistance of the thermistor varies with temperature.



Use the graph to determine the temperature of the water when the voltage across the thermistor is 2·0 V. **1**

2. (continued)

(b) The circuit is now connected to a switching circuit to operate a heater.



(i) Explain how the circuit operates to switch on the heater when the temperature falls below a certain value. **3**

(ii) The resistance of the variable resistor R is now increased.

What effect does this have on the temperature at which the heater is switched on?

You **must** justify your answer. **3**

Total marks 11

Question			Answer	Max Mark	Additional Guidance
2.	(a)	(i)	$V_2 = V_S - V_1 = 3{\cdot}0$ (V) $I = \frac{V_2}{R}$ $= \frac{3{\cdot}0}{1050}$ $= (2{\cdot}857 \times 10^{-3}$ A) $R_1 = \frac{V_1}{I}$ $= \frac{2{\cdot}0}{2{\cdot}857 \times 10^{-3}}$ $= 700\ \Omega$	4	(1) mark for 3·0 (V) If no attempt at subtraction is seen then MAX (1) mark for equation If subtraction is incorrect treat as arithmetic error. (1) mark for Ohm's Law (even if only seen once) (1) mark for both substitutions (1) mark for final answer including units Allow correct intermediate rounding of the current but check calculation of final answer s.f. range: 1-4 Alternative methods: 1 mark for 3·0 V (1) If no attempt at subtraction is seen then MAX (1) mark for equation If subtraction is incorrect treat as arithmetic error. $R_1/R_2 = V_1/V_2$ (1) $R_1/1050 = 2{\cdot}0/3{\cdot}0$ (1) $R_1 = 700\ \Omega$ (1) OR $V_2 = \left(\frac{R_{th}}{R_V + R_{th}}\right) \times V_S$ (1) $2{\cdot}0 = \left(\frac{R_{th}}{1050 + R_{th}}\right) \times 5{\cdot}0$ (2) $R_{th} = 700\ \Omega$ (1)

Question			Answer	Max Mark	Additional Guidance
		(ii)	80 °C	**1**	Or answer consistent with 2(a)(i) Unit required +/- half box tolerance
	(b)	(i)	(As R_{th} increases,) V_{th} increases (1) (When V_{th} = 2·0 V or V reaches switching voltage,) MOSFET/transistor turns **on** (1) Relay switches **on** (the heater). (1)	**3**	(3) independent marks Look for: • voltage across thermistor increases • MOSFET/transistor switches **on** / activates • Relay switches **on** / activates / switch closes
		(ii)	Temperature decreases (1) Resistance of **thermistor** must be greater / increase (1) to switch **on** MOSFET / transistor (1)	**3**	First mark can only be awarded if a justification is attempted Effect correct + justification correct (3) Effect correct + justification partially correct (2) Effect correct + justification incorrect (1) Effect correct + no justification (0) Incorrect or no effect stated regardless of justification (0)