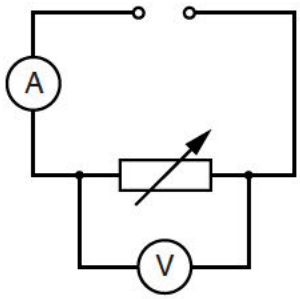
**1** Ksenia and Eva investigate five different variable resistors.

They set each variable resistor to the maximum resistance.

They keep the voltage the same and use this circuit to measure the current.




Look at their results.

| Variable resistor | Reading on ammeter in amps |
|---|---|
| A | 0.12 |
| B | 0.15 |
| C | 0.16 |
| D | 0.06 |
| E | 0.11 |

**(a) (i)** The maximum resistance for variable resistor **B** is 4.79 ohms.

Calculate the voltage to 2 significant figures.

.....

.....

.....

voltage ..... volts **[2]**

**(ii)** During the measurements the voltage was kept constant for all the variable resistors.

Which variable resistor has the **highest** resistance?

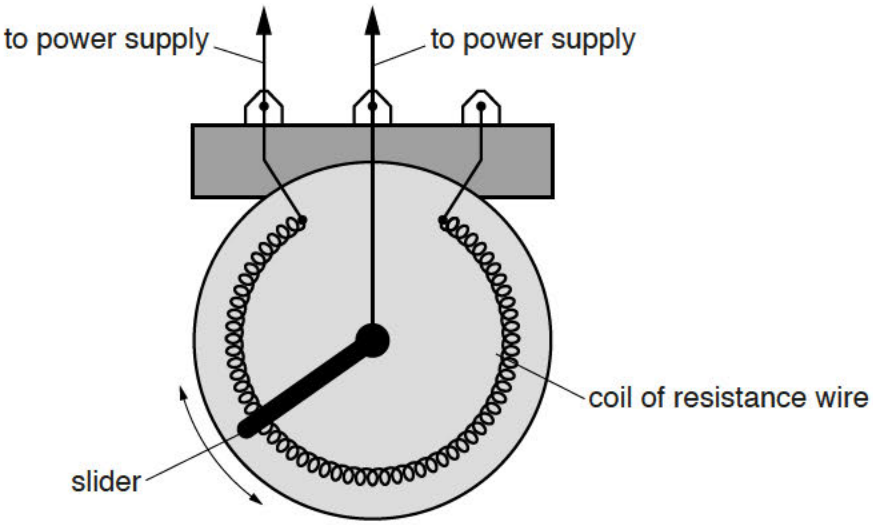
Choose from

**A**

..... **[1]**

**(b)** Ksenia looks inside variable resistor **A**.

Look at the diagram.




The slider moves around and keeps in contact with the coil of resistance wire.

Explain how this variable resistor can be moved to increase **and** decrease the current in a circuit.

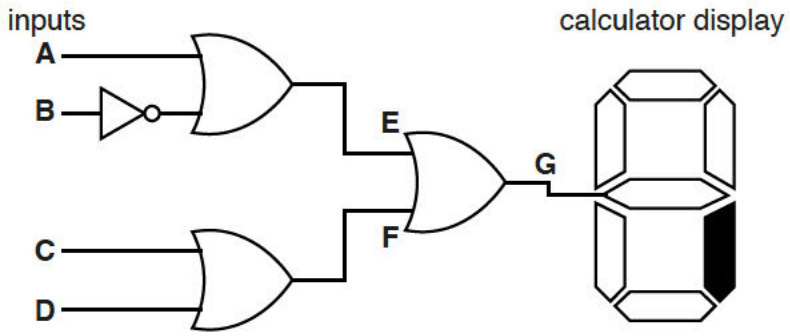
.....

.....

..... **[2]**

**2** Enzo connects logic gates together to make a logic system.

Look at the diagram.




He completes part of the truth table. The output from the logic system switches the shaded segment on the calculator display on and off.

| A | B | | | E | F | G |
|---|---|---|---|---|---|---|
| 0 | 0 | | | | | |
| 0 | 0 | | | | | |
| 0 | 0 | | | | | |
| 0 | 0 | | | | | |
| 0 | 1 | | | | | |
| 0 | 1 | | | | | |
| 1 | 0 | | | | | |
| 1 | 0 | | | | | |
| 1 | 1 | | | | | |
| 1 | 1 | | | | | |

The shaded segment is switched on for most numbers.

**calculator display**




Complete Enzo's truth table and use it to describe how his logic system is used to display a segment of the numbers.

Explain your answer using numbers that have a 1 or 0 output at G.

*The quality of written communication will be assessed in your answer to this question.*

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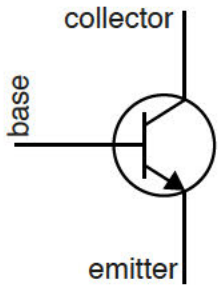
.....

.....

.....

..... **[6]**

**3** The NPN transistor is the basic building block of electronic components.




The currents flowing through the transistor terminals are $I_c$ $I_b$ and $I_e$.

Here are the currents of different transistors.

| $I_b$ in mA | $I_c$ in mA | $I_e$ in mA |
|---|---|---|
| 2 | 0 | ..... |
| 4 | 100 | ..... |
| 8 | 120 | ..... |

**(a)** Calculate the **three** missing values for $I_e$ and put your answers in the table.

**[1]**

(b) Look at the sizes of the currents $I_b$ and $I_c$ in the table.

(i) Describe, in general, how $I_b$ is different to $I_c$.

.....

..... [1]

(ii) Explain this difference.

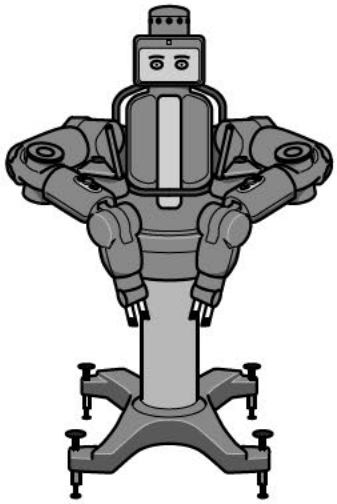
.....

.....

.....

..... [2]

**(c)** Baxter is a new type of robot made by Rethink Robotics.



Baxter can carry out repetitive tasks in manufacturing.

It can work alongside humans.

Baxter is able to sense and react to its environment.
Its developers say it has 'common sense'.

Society needs to make choices about the acceptable uses of new technologies like Baxter.

Write about the advantages **and** disadvantages of Baxter.

.....

.....

.....

.....

.....

..... **[3]**

**4** Symbols are used to represent electronic components.

**(a)** Look at the two different electronic components.



**LDR** **thermistor**

For each component, describe what causes the resistance to change **and** how the resistance changes.

**LDR** .....

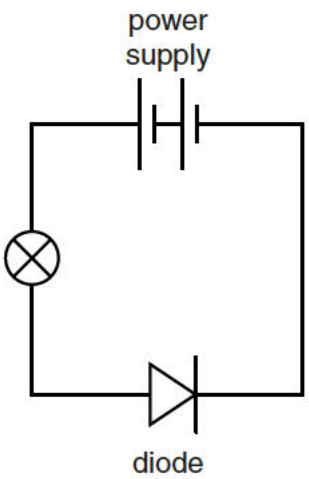
.....

**Thermistor** .....

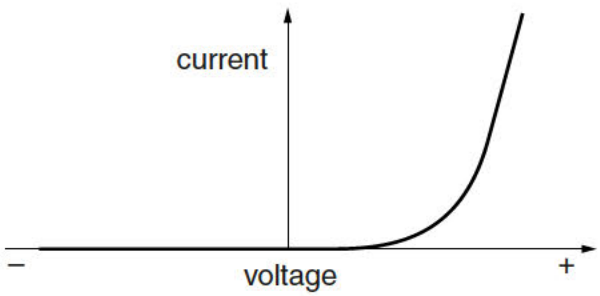
.....

**[2]**

**(b)** The diagram shows a circuit with a silicon diode.




Look at the current-voltage graph for this diode.




Use the graph to explain why the current passes through this diode.

.....

.....

..... **[2]**

**[Total: 4]**

**5** Many electronic devices contain logic gates.

**(a)** One type of logic gate is a NOR gate.

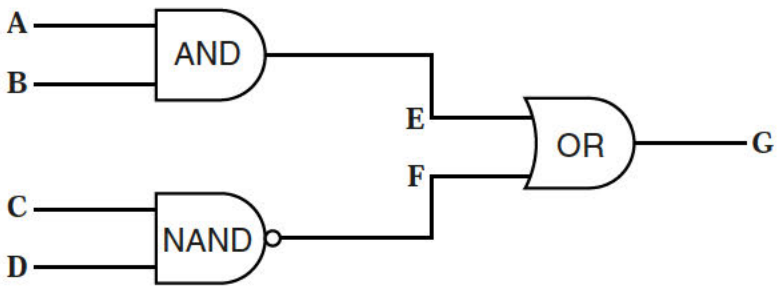



Complete the truth table for a NOR gate

| X | Y | Z |
|---|---|---|
| 0 | 0 | |
| 0 | 1 | |
| | 0 | |
| | | |

**[2]**

**(b)** Logic gates can be combined together.



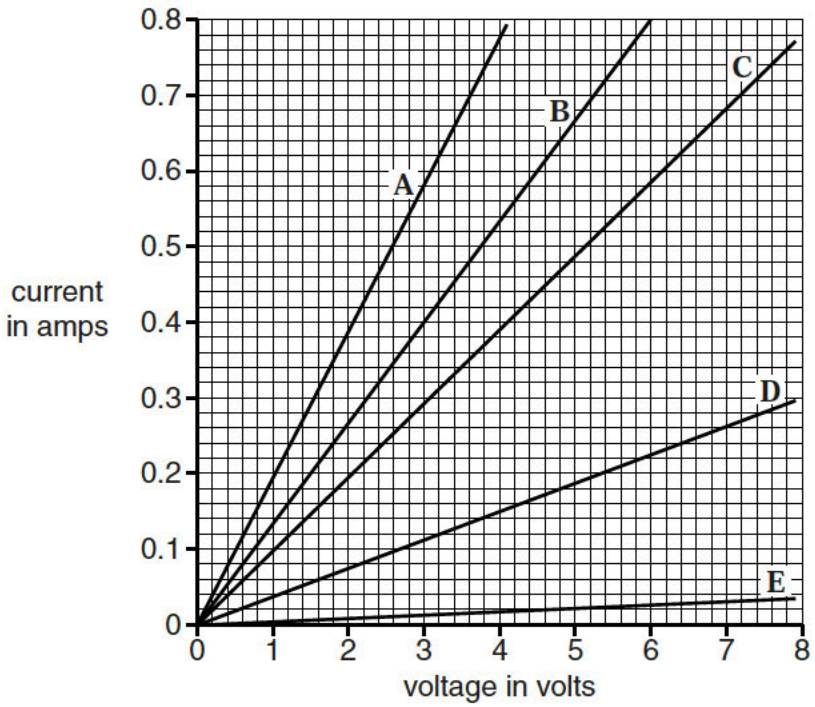

Look at part of the truth table for this combination of gates.

| A | B | | | E | F | G |
|---|---|---|---|---|---|---|
| 0 | 0 | | | | | |
| 0 | 1 | | | | | |
| 1 | 0 | | | | | |
| 1 | 1 | | | | | |

Complete the missing spaces in this truth table. **[2]**

**[Total: 4]**

**6** George draws a current-voltage graph for five different ohmic conductors.




**(a)** Calculate the resistance of conductor **B**.

.....

.....

resistance ..... ohms **[2]**

**(b)** All the ohmic conductors are made from the same material.

They have the same cross sectional area.

They are all different lengths.

Use the graph to write down the letter of the conductor with the longest length.

answer .....

Explain your answer.

.....

.....

.....

**[2]**

(c) George investigates a metal filament bulb.

George tries to explain how the resistance changes when the bulb is switched on. He uses the model below.

> Current in a conductor is the flow of charge carriers called protons.
>
> The charge carriers collide with the atoms (ions) in the conductor.
>
> This makes the atoms vibrate less which
>
> - causes an increase in collisions, decreasing the resistance
> - increases the temperature of the conductor.

George has made three mistakes in his model.

State the three mistakes he has made and write down the corrections.

.....

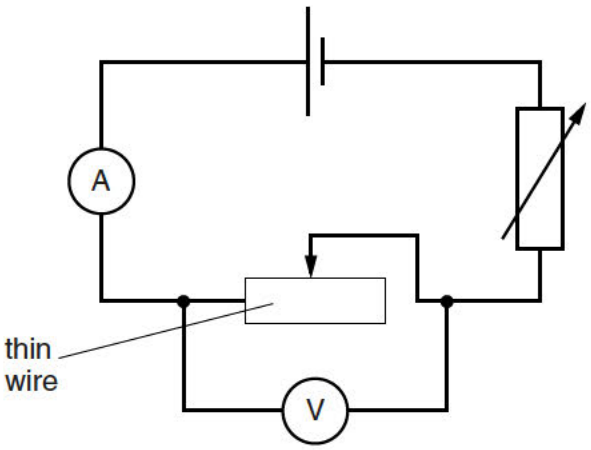
.....

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..... [2]

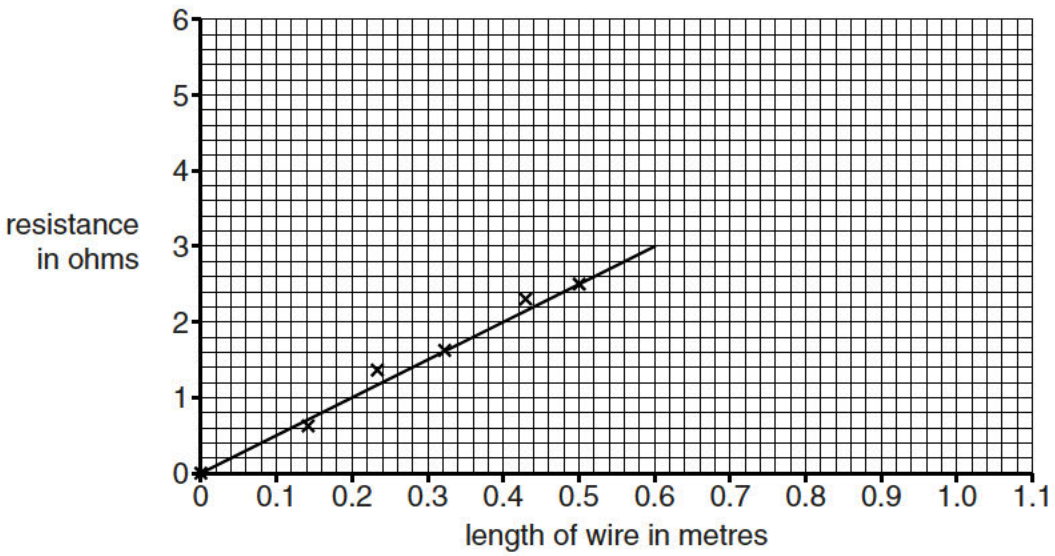
[Total: 6]

7 Ronin and Kiri use an electric circuit to investigate the resistance of a thin wire.




**(a)** Ronin changes the length of the wire. He calculates the resistance for each length.

He plots a graph of his results.




**(i)** Calculate the current for a **1.0 m** length of wire, when the voltage across it is 0.75 V.

.....

.....

.....

current ..... amps **[3]**

**(ii)** The voltage across the thin wire is kept fixed at 0.75V.

Describe the relationship between the current in the thin wire and its length.

.....

..... **[1]**

**(b)** Kiri repeats the investigation with a **thinner** wire.

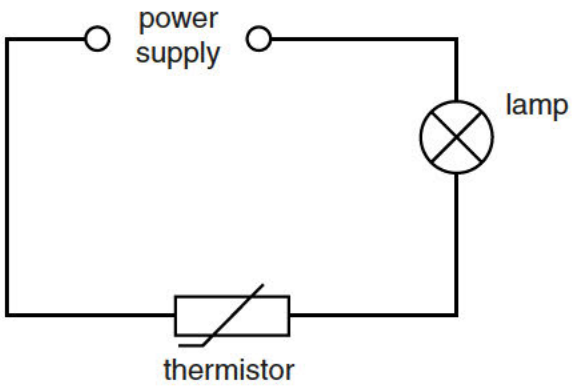
She keeps all the other factors the same.

Draw a line on the graph to show how the resistance of the thinner wire changes as the length increases. **[1]**

**[Total: 5]**

**8 (a)** Trevor and Una connect different circuits.

Look at the circuit Trevor connects.




He gently heats the thermistor.

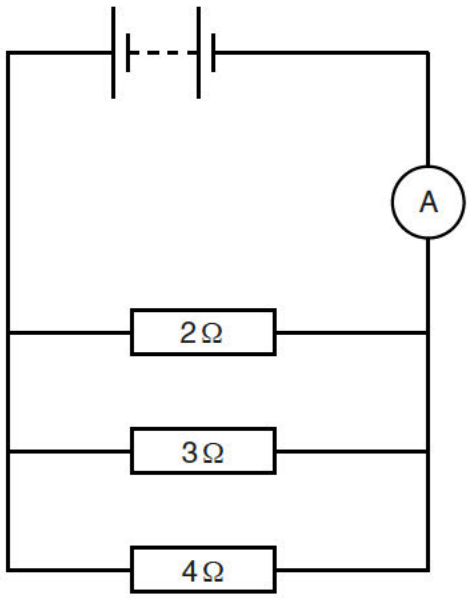
Describe and explain how heating the thermistor affects the brightness of the lamp.

.....

.....

..... **[2]**

**(b)** Look at the circuit Una connects.




**(i)** Calculate the **total** resistance for this arrangement of resistors.

.....

.....

.....

.....

answer ..... Ω **[2]**

**(ii)** The battery voltage is 4 V.

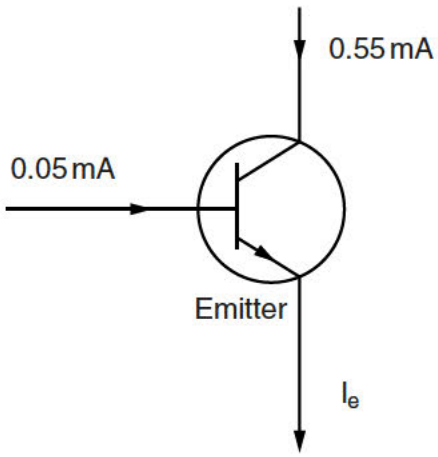
Calculate the current supplied by the battery.

.....

.....

answer ..... A **[2]**

**(c)** Look at the diagram of an NPN transistor.




Calculate the current flowing from the emitter, $I_e$.

.....

.....

answer ..... mA **[1]**

**[Total: 7]**