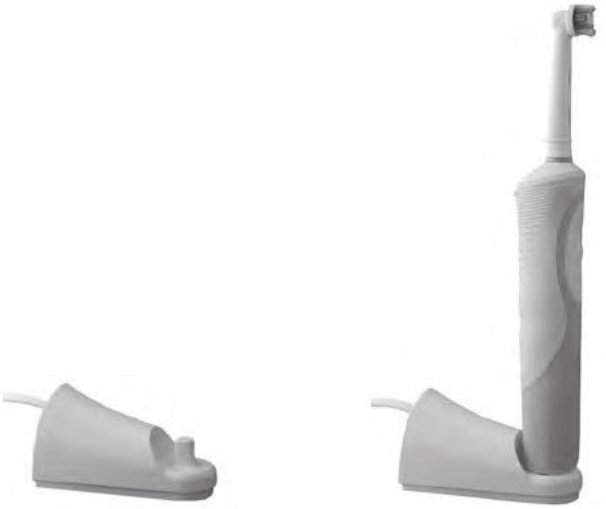
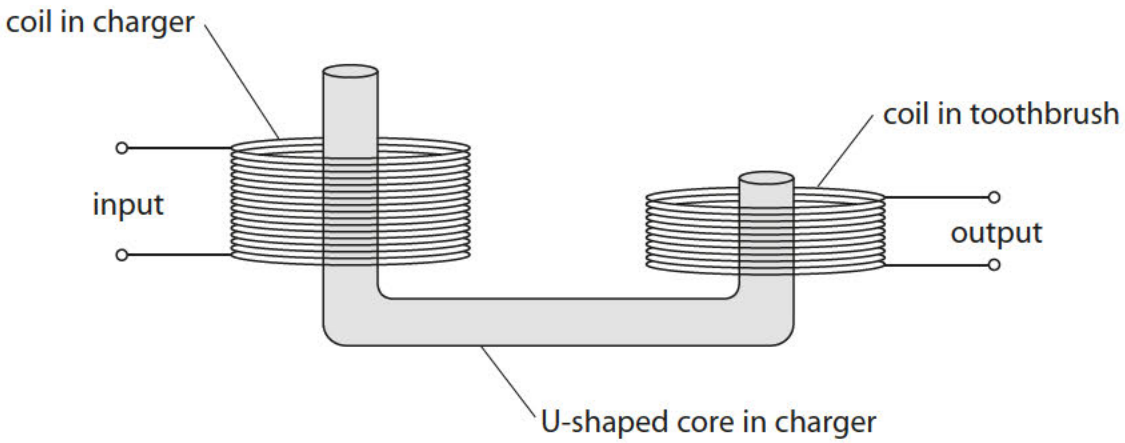
1 The photographs show how an electric toothbrush fits on its charger.



The charger and the toothbrush each have a coil of wire inside them.

The diagram shows how the two coils are linked by a U-shaped core.



This arrangement of core and coils acts as a transformer that reduces voltage.

(a) (i) Name the type of transformer that reduces voltage.

(1)

.....

(ii) Explain why the core is made of a soft magnetic material, such as iron.

(2)

.....

.....

.....

.....

.....

.....

(b) (i) State the equation linking the input (primary) and output (secondary) voltages and the turns ratio of a transformer.

(1)

(ii) The transformer has 520 primary turns and 30 secondary turns.

The input voltage to the transformer is 44 V.

Calculate the output voltage.

(2)

output voltage = ... V

(c) (i) The alternating current in the transformer has a frequency of 27 000 Hz.

The toothbrush vibrates at the same frequency when it is being charged.

Explain why these vibrations cannot be heard.

(2)

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(ii) A circuit in the toothbrush delivers regular pulses of direct current.

There is a pulse every 1.5 ms.

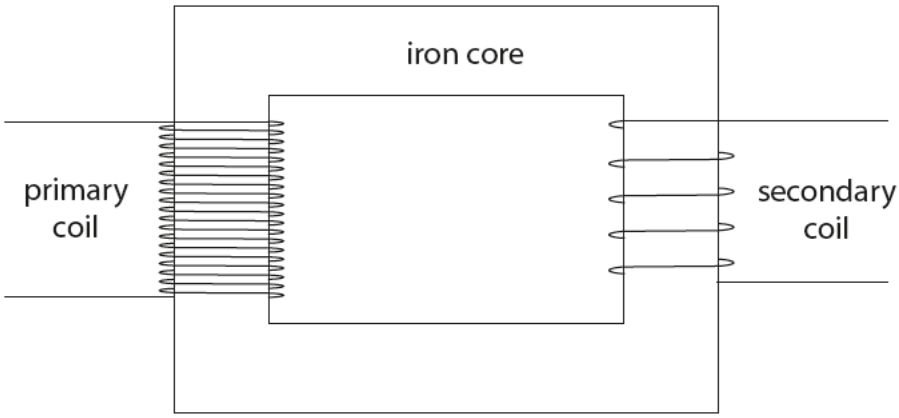
Calculate the frequency of the pulses.

(2)

frequency = ... Hz

(Total for Question 1 = 10 marks)

2 The diagram shows parts of a transformer.



(a) The input voltage to the transformer is 230 V a.c.

The output of the transformer is 25 V a.c.

There are 100 turns on the secondary coil.

(i) Name the type of transformer shown in the diagram.

(1)

.....

(ii) State the equation linking input (primary) voltage, output (secondary) voltage, primary turns and secondary turns.

(1)

(iii) Calculate the number of turns on the primary coil.

(2)

number of turns .....

(b) Explain how a transformer works.

In your answer, you should include the reasons for using

- two coils
- the iron core
- an alternating supply

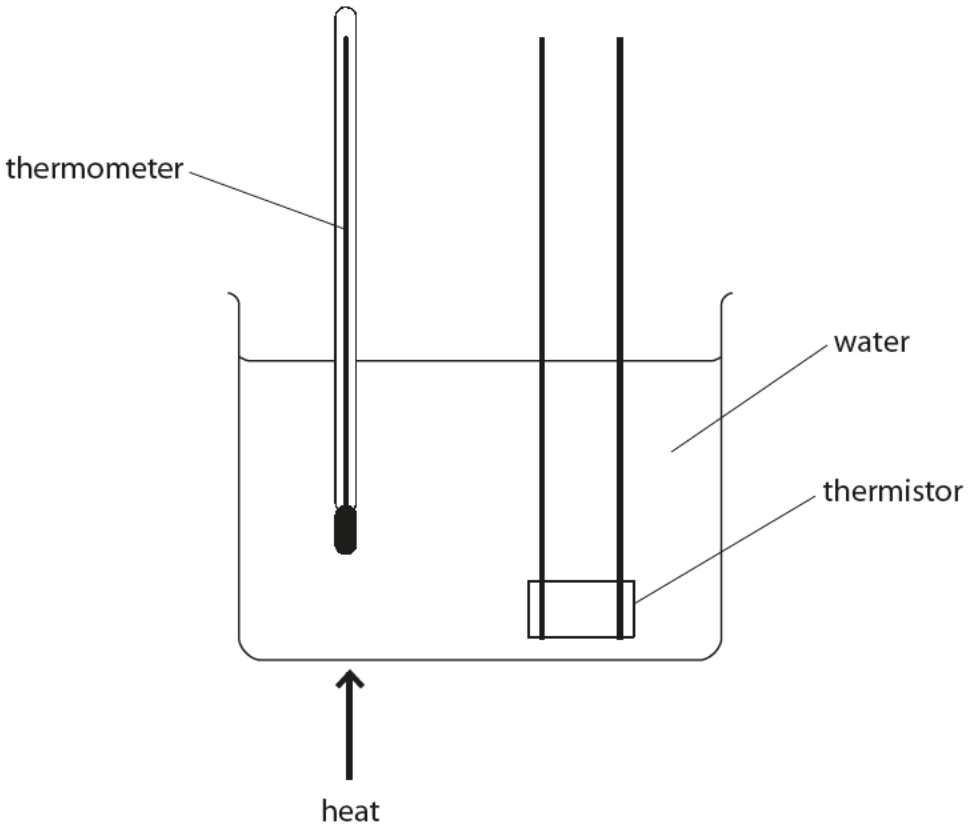
(5)

(Total for Question 2 = 9 marks)

3 A student investigates how the voltage across a thermistor varies with temperature.

The student keeps the current in the thermistor constant, but varies the temperatures between 20 °C and 100 °C.

(a) The diagram shows how the student sets up his apparatus.



Suggest three changes to this set up that would improve the accuracy of the measurement of the thermistor temperature.

(3)

1 .....

.....

2 .....

.....

3 .....

.....

(b) What instrument should the student use to measure the current in the thermistor?

(1)

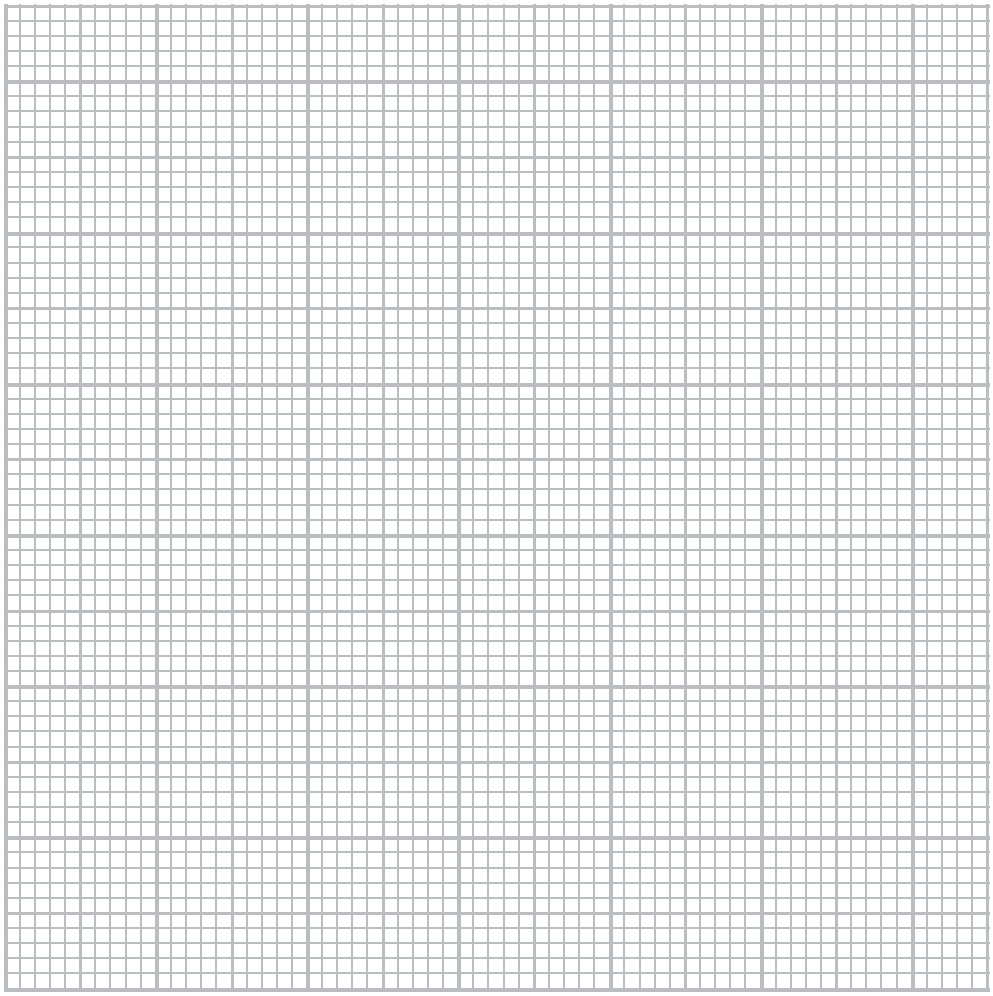
....

(c) The table shows the student's results.

Temperature in °C	Voltage in V
20	6.0
40	2.2
60	1.1
80	0.2
100	0.4

(i) Plot a graph of voltage against temperature and draw the line of best fit.

(5)



Circle the anomalous point on your graph.

(1)

(d) (i) State the equation linking voltage, current and resistance.

(1)

(ii) At room temperature the thermistor has a resistance of 680 Ω.

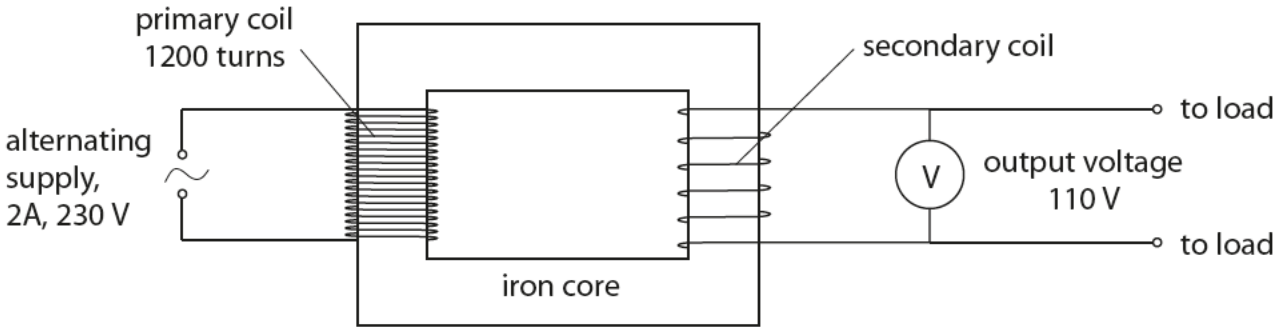
The voltage across it is 5.9 V.

Show that the current in the thermistor is about 8.5 mA.

(3)

(Total for Question 3 = 14 marks)

4 The diagram shows a transformer that is 100% efficient.



(a) (i) State the equation linking input power and output power for the transformer.

(1)

(ii) Calculate the output current of the transformer.

(2)

output current = ... A

(b) (i) State the equation linking input voltage, output voltage and turns ratio for the transformer.

(1)

(ii) Calculate the number of turns on the secondary coil of the transformer.

(2)

number of turns = ...

(c) Explain how a transformer works.

In your answer, you should include the reasons for using

- two coils
- an iron core
- an alternating supply

(5)

(Total for Question 4 = 11 marks)

5 A student has some LEDs connected in a circuit. They emit light of different colours.

(a) (i) The different colours of light are waves which must have

(1)

☒ **A** the same amplitude in free space

☒ **B** the same frequency in free space

☒ **C** the same speed in free space

☒ **D** the same wavelength in free space

(ii) When an LED is on, it shows that

(1)

☒ **A** there must be alternating current in the circuit

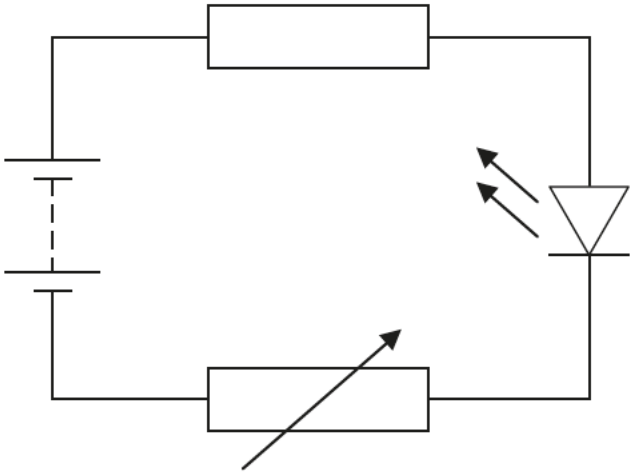
☒ **B** there must be a current in the circuit

☒ **C** there is a fault in the LED

☒ **D** a fuse has blown

(b) An LED needs a minimum voltage to make it emit light.

The student investigates this minimum voltage using the circuit shown.



(i) The student uses a voltmeter to measure the voltage across the LED.

Add this voltmeter to the circuit diagram.

(2)

(ii) The student gradually increases the voltage across the LED and records the minimum voltage at which the LED emits light.

The results for some different LEDs are shown in the table.

Colour of light from LED	Minimum voltage in V
Red	1.7
Blue	3.6
Yellow	2.1
Orange	2.0
Green	3.0

Display the results of the student's investigation on the grid.

(4)

(iii) The student concludes:



The minimum voltage depends on the wavelength of the light emitted.

Evaluate the student's conclusion.

(2)

.....

.....

.....

.....

(Total for Question 5 = 10 marks)

6 Electrical energy can be transmitted using a high voltage of 132 kV.



(a) A voltage of 132 kV is the same as

(1)

☒ **A** 132 V

☒ **B** 1320 V

☒ **C** 132 0 V

☒ **D** 132 0 V

(b) Using a high voltage increases the

(1)

☒ **A** current in the wires

☒ **B** efficiency of transmission

☒ **C** energy lost as heat

☒ **D** resistance of the wires

(c) The high voltage can be reduced using a

(1)

☒ **A** generator

☒ **B** magnet

☒ **C** transformer

☒ **D** transmitter

(Total for Question 6 = 3 marks)