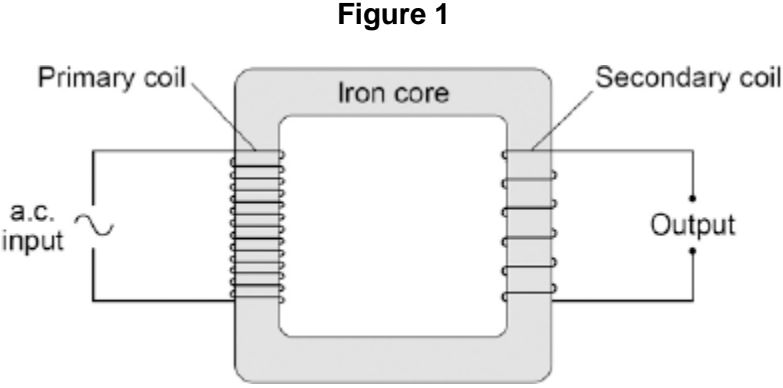


1

Figure 1 shows the construction of a simple transformer.



(a) Why is iron a suitable material for the core of a transformer?

Tick **one** box.

It is a metal.

It will not get hot.

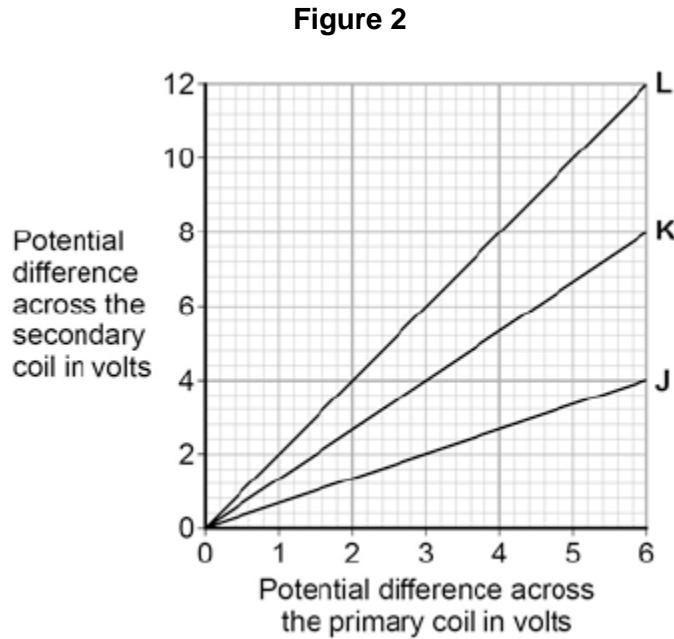
It is easily magnetised.

It is an electrical conductor.

(1)

- (b) A student makes three simple transformers, **J**, **K** and **L**.

Figure 2 shows how the potential difference across the secondary coil of each transformer varies as the potential difference across the primary coil of each transformer is changed.



How can you tell that transformer **J** is a step-down transformer?

.....

.....

(1)

- (c) Each of the transformers has 50 turns on the primary coil.

Calculate the number of turns on the secondary coil of transformer **L**.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

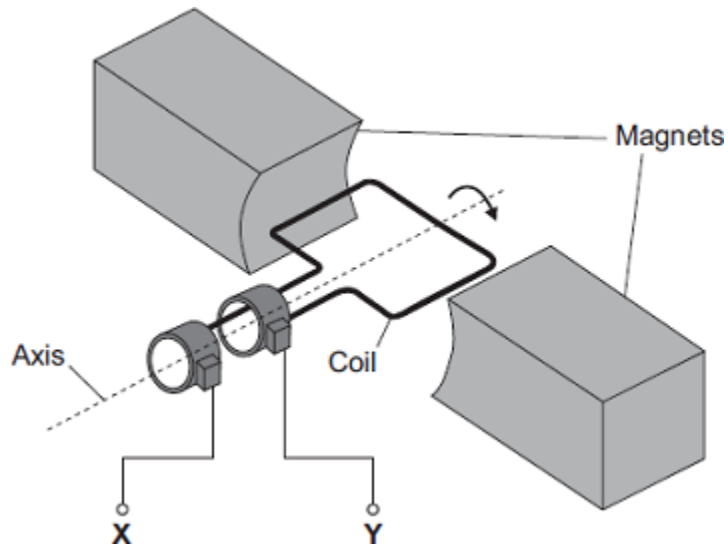
Number of turns on the secondary coil =

(3)
(Total 5 marks)

2

The diagram shows an a.c. generator.

The coil rotates about the axis shown and cuts through the magnetic field produced by the magnets.



(a) (i) A potential difference is induced between **X** and **Y**.

Use the correct answer from the box to complete the sentence.

electric	generator	motor	transformer
-----------------	------------------	--------------	--------------------

This effect is called the effect.

(1)

(ii) What do the letters a.c. stand for?

.....

(1)

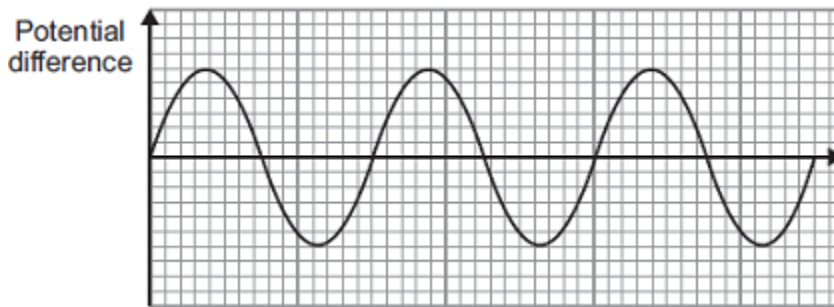
(iii) Name an instrument that could be used to measure the potential difference between **X** and **Y**.

.....

(1)

(b) **Graph 1** shows the output from the a.c. generator.

Graph 1



(i) One of the axes on **Graph 1** has been labelled 'Potential difference'.

What should the other axis be labelled?

.....

(1)

(ii) The direction of the magnetic field is reversed.

On **Graph 1**, draw the output from the a.c. generator if everything else remains the same.

(2)

(c) The number of turns of wire on the coil is increased. This increases the maximum induced potential difference.

State **two** other ways in which the maximum induced potential difference could be increased.

1

.....

2

.....

(2)

(Total 8 marks)

3

The current in a circuit depends on the potential difference (p.d.) provided by the cells and the total resistance of the circuit.

(a) Using the correct circuit symbols, draw a diagram to show how you would connect 1.5 V cells together to give a p.d. of 6 V.

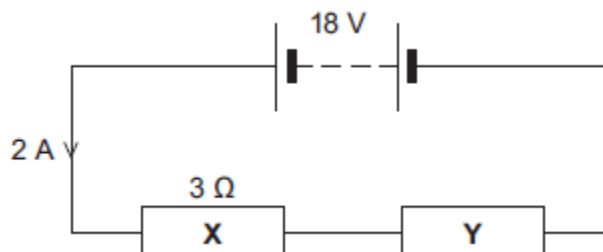
(2)

(b) **Figure 1** shows a circuit containing an 18 V battery.

Two resistors, **X** and **Y**, are connected in series.

- **X** has a resistance of 3 Ω .
- There is a current of 2 A in **X**.

Figure 1



(i) Calculate the p.d. across **X**.

.....
.....

P.d. across **X** = V

(2)

(ii) Calculate the p.d. across **Y**.

.....
.....
.....

P.d. across **Y** = V

(2)

(iii) Calculate the total resistance of **X** and **Y**.

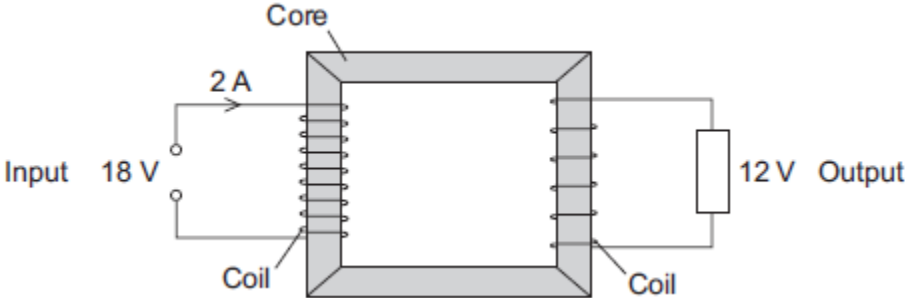
.....
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Total resistance of **X** and **Y** = Ω

(2)

(c) **Figure 2** shows a transformer.

Figure 2



(i) An 18 V battery could **not** be used as the input of a transformer.

Explain why.

.....
.....
.....
.....

(2)

(ii) The transformer is 100% efficient.

Calculate the output current for the transformer shown in **Figure 2**.

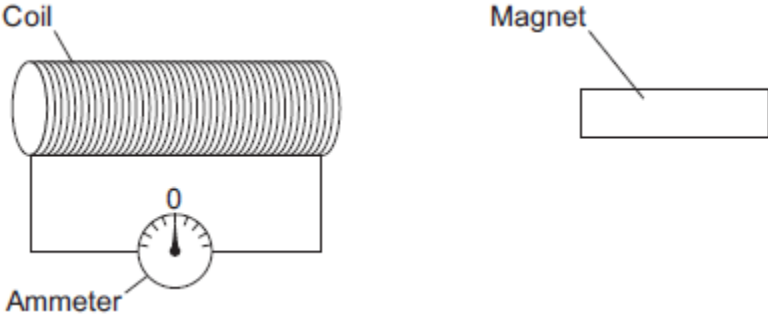
.....
.....
.....

Output current = A

(2)
(Total 12 marks)

4

The figure below shows a coil and a magnet. An ammeter is connected to the coil.



The ammeter has a centre zero scale, so that values of current going in either direction through the coil can be measured.

- (a) A teacher moves the magnet slowly towards the coil.

Explain why there is a reading on the ammeter.

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.....

.....

(6)

(b) The table below shows some other actions taken by the teacher.

Complete the table to show the effect of each action on the ammeter reading.

Action taken by teacher	What happens to the ammeter reading?
Holds the magnet stationary and moves the coil slowly towards the magnet	
Holds the magnet stationary within the coil	
Moves the magnet quickly towards the coil	
Reverses the magnet and moves it slowly towards the coil	

(4)

(c) The magnet moves so that there is a steady reading of 0.05 A on the ammeter for 6 seconds.

Calculate the charge that flows through the coil during the 6 seconds.

Give the unit.

.....
.....
.....

Charge =

(3)
(Total 13 marks)

5

If a fault develops in an electrical circuit, the current may become too great. The circuit needs to be protected by being disconnected.

A fuse or a circuit breaker may be used to protect the circuit.
One type of circuit breaker is a Residual Current Circuit Breaker (RCCB).

(a) (i) Use the correct answer from the box to complete the sentence.

earth	live	neutral
--------------	-------------	----------------

A fuse is connected in the wire.

(1)

(ii) Use the correct answer from the box to complete the sentence.

are bigger	are cheaper	react faster
-------------------	--------------------	---------------------

RCCBs are sometimes preferred to fuses because they

(1)

(iii) RCCBs operate by detecting a difference in the current between two wires.

Use the correct answer from the box to complete the sentence.

earth and live	earth and neutral	live and neutral
-----------------------	--------------------------	-------------------------

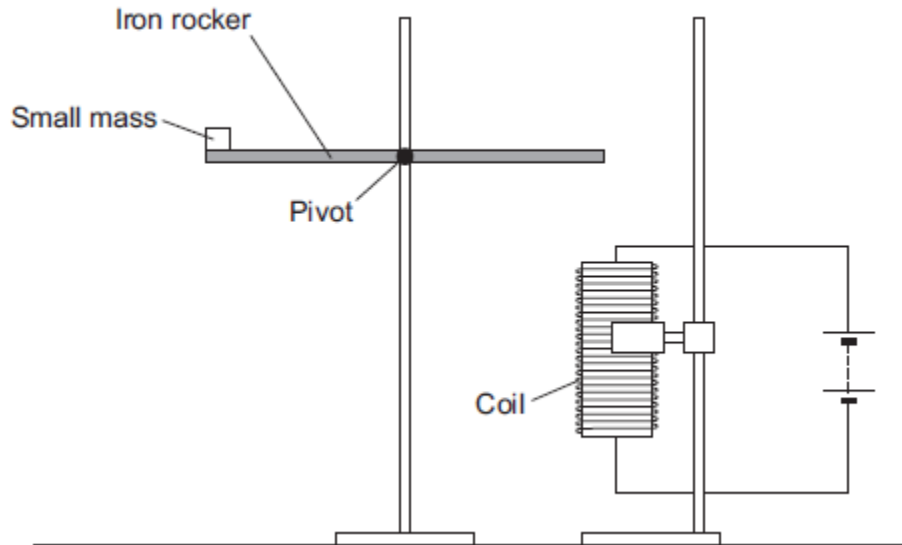
The two wires are the wires.

(1)

(b) An RCCB contains an iron rocker and a coil.

A student investigated how the force of attraction, between a coil and an iron rocker, varies with the current in the coil.

She supported a coil vertically and connected it in an electrical circuit, part of which is shown in the figure below .



She put a small mass on the end of the rocker and increased the current in the coil until the rocker balanced. She repeated the procedure for different masses.

Some of her results are shown in the table below.

Mass in grams	Current needed for the rocker to balance in amps
5	0.5
10	1.0
15	1.5
20	2.0

(i) State **two** extra components that must have been included in the circuit in the figure above to allow the data in the above table to be collected.

Give reasons for your answers.

.....

.....

.....

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.....
.....
.....
.....

(4)

(ii) A teacher said that the values of current were too high to be safe.

Suggest **two** changes that would allow lower values of current to be used in this investigation.

Change 1
.....

Change 2
.....

(2)
(Total 9 marks)

6

In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

There are two types of traditional transformer; step-up and step-down.

Describe the similarities and differences between a step-up transformer and a step-down transformer.

You should include details of:

- construction, including materials used
- the effect the transformer has on the input potential difference (p.d.).

You should **not** draw a diagram.

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Extra space

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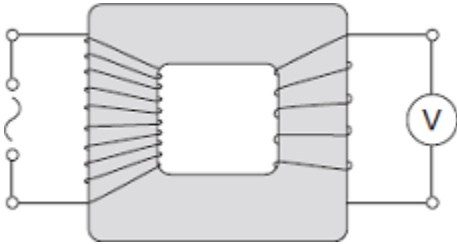
.....

(Total 6 marks)

7

The diagram shows a transformer with a 50 Hz (a.c.) supply connected to 10 turns of insulated wire wrapped around one side of the iron core.

A voltmeter is connected to 5 turns wrapped around the other side of the iron core.



(a) What type of transformer is shown in the diagram?

Draw a ring around the correct answer.

step-down

step-up

switch mode

(1)

(b) The table shows values for the potential difference (p.d.) of the supply and the voltmeter reading.

p.d. of the supply in volts	Voltmeter reading in volts
6.4	3.2
3.2	
	6.4

(i) Complete the table.

(2)

(ii) Transformers are used as part of the National Grid.

How are the values of p.d. in the table different to the values produced by the National Grid?

.....
.....

(1)

(c) Transformers will work with an alternating current (a.c.) supply but will **not** work with a direct current (d.c.) supply.

(i) Describe the difference between a.c. and d.c.

.....
.....
.....
.....

(2)

(ii) Explain how a transformer works.

.....
.....
.....
.....
.....
.....
.....
.....

(4)

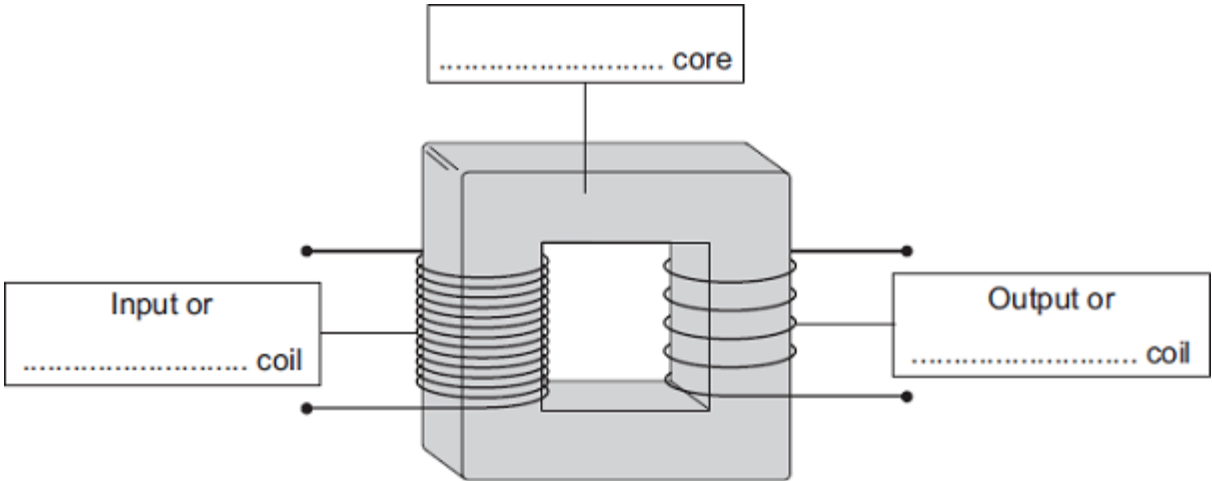
(Total 10 marks)

8

(a) The diagram shows the structure of a traditional transformer.

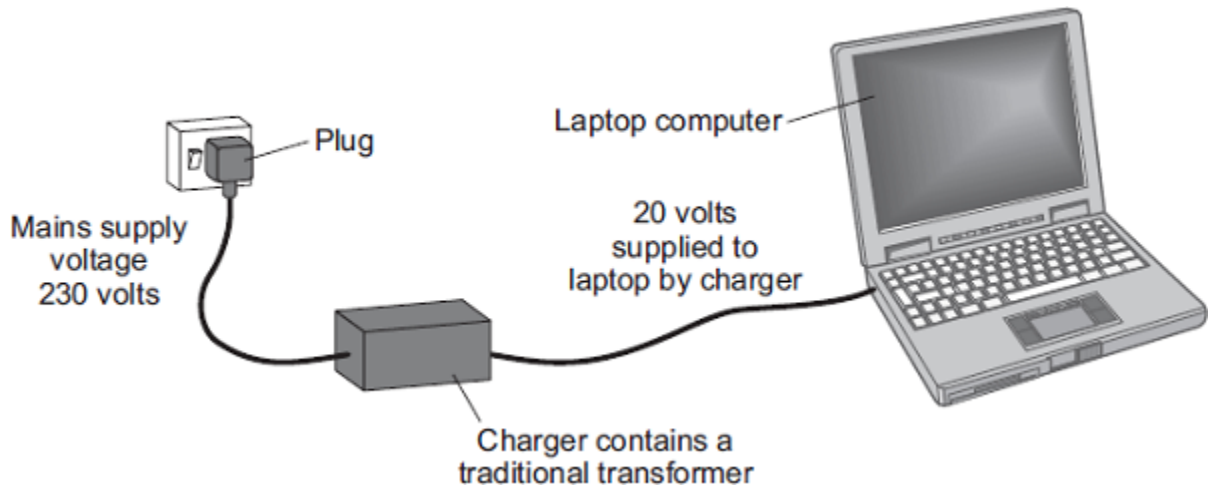
Use words from the box to label the diagram.

aluminium	brass	iron	large	primary	secondary
-----------	-------	------	-------	---------	-----------



(3)

- (b) Batteries inside laptop computers are charged using laptop chargers. The laptop charger contains a traditional transformer.



The laptop charger contains a step-down transformer.

What does a step-down transformer do?

.....
.....

(1)

- (c) Laptop batteries and mobile phone batteries can only be recharged a limited number of times. When a battery cannot be recharged, it is better to recycle the battery than to throw it away.

Draw a ring around the correct answer to complete the sentence.

The batteries are recycled mainly due to

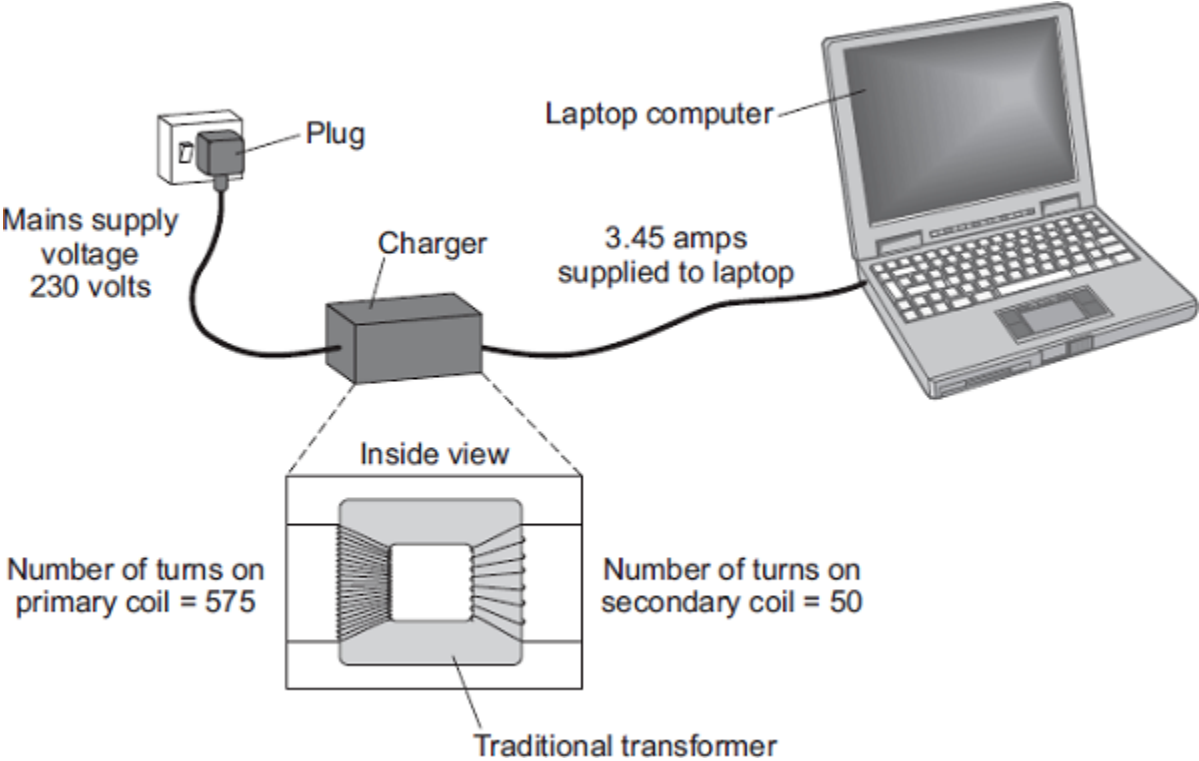
- an environmental
- a political
- a social

consideration.

(1)
(Total 5 marks)

9

Batteries inside laptop computers are charged using laptop chargers. The laptop charger contains a traditional transformer.



- (a) The alternating current flowing through the primary coil of the transformer creates an alternating current in the secondary coil.

Explain how.

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.....

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.....

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(3)

- (b) (i) Use information from the diagram to calculate the potential difference the charger supplies to the laptop.

.....
.....
.....
.....

Potential difference = V

(2)

- (ii) Calculate the current in the primary coil of the transformer when the laptop is being charged.

Assume the transformer is 100% efficient.

.....
.....
.....
.....

Current = A

(2)

- (c) Laptop batteries and mobile phone batteries can only be recharged a limited number of times. After this, the batteries cannot store enough charge to be useful. Scientists are developing new batteries that can be recharged many more times than existing batteries.

Suggest **one** other advantage of developing these new batteries.

.....
.....
.....

(1)

(Total 8 marks)

10

(a) In the National Grid, very large step-up transformers link power stations to the transmission cables.

A transformer used for this purpose has 800 turns on its primary coil and 12 800 turns on its secondary coil. The p.d. (potential difference) across its primary coil is 25 kV.

Use the equation in the box to calculate the p.d. across its secondary coil.

$$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

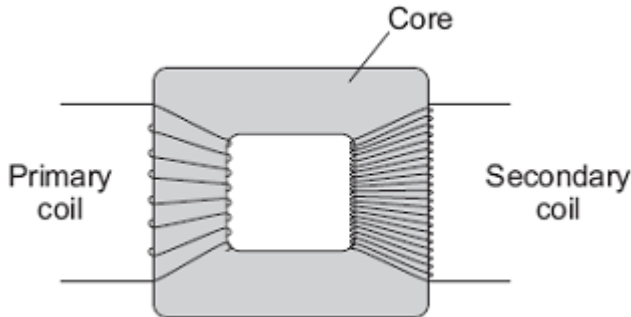
Show clearly how you work out your answer.

.....
.....

p.d. across secondary coil = volts

(2)

(b) The diagram shows the structure of a transformer.



(i) The primary and secondary coils of a transformer are made of insulated wire.

Why is this insulation necessary?

.....
.....

(1)

(ii) Why is the core made of iron?

.....
.....

(1)

(iii) Explain how the transformer works.

.....
.....
.....
.....
.....
.....

(3)

(c) Before 1926, large towns had their own local power stations. After 1926, these power stations were connected to form the National Grid.

Give **two** advantages of having a National Grid system.

1

.....

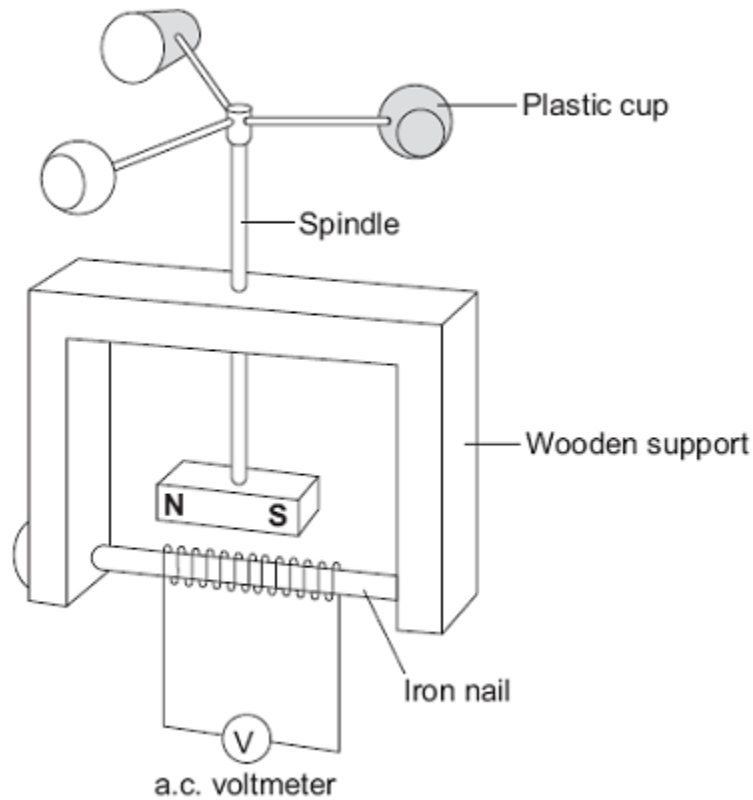
2

.....

(2)
(Total 9 marks)

11

The diagram shows a student's design for a simple wind speed gauge.



(a) Explain why the wind causes the a.c. voltmeter to give a reading. The explanation has been started for you.

The wind causes the plastic cups to turn.

.....

.....

.....

.....

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.....

.....

(3)

(b) The gauge is not sensitive enough to measure light winds.
Suggest **one** way that the design can be modified to make the gauge more sensitive.

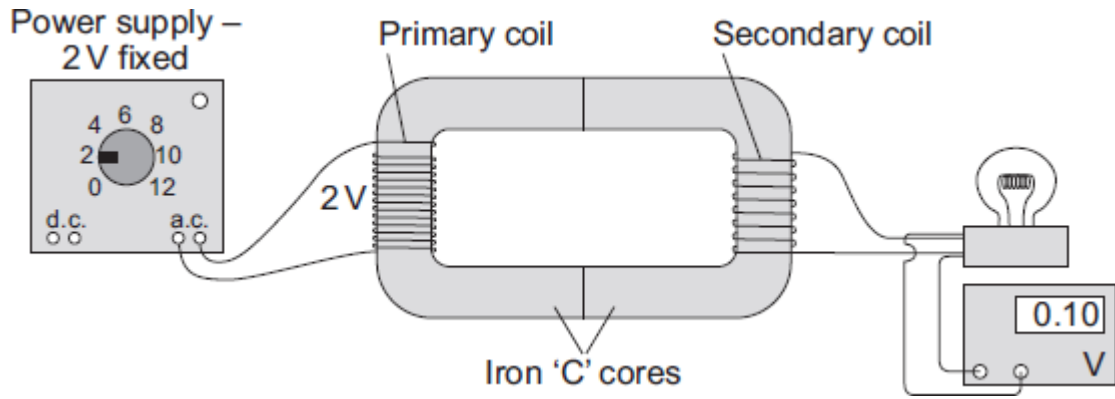
.....

.....

(1)
(Total 4 marks)

12

The diagram shows the apparatus used by a student to investigate a transformer.



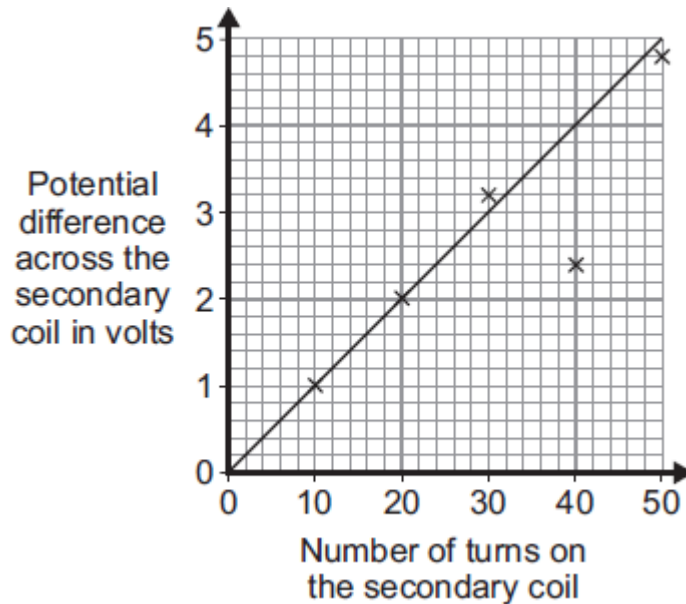
- (a) The transformer made by the student would not have worked if the core had been made from aluminium and not iron.

Why?

.....
.....

(1)

- (b) The student made changes to the number of turns used to make the secondary coil. He then measured the potential difference across the secondary coil after each change. The graph shows the student's results.



- (i) What range of values was used for the number of turns on the secondary coil?

From to

(1)

(ii) When he drew the line of best fit, the student ignored one of the data points.

Why?

.....
.....

(1)

(iii) What is the minimum number of turns needed on the secondary coil for the transformer to act as a step-up transformer?

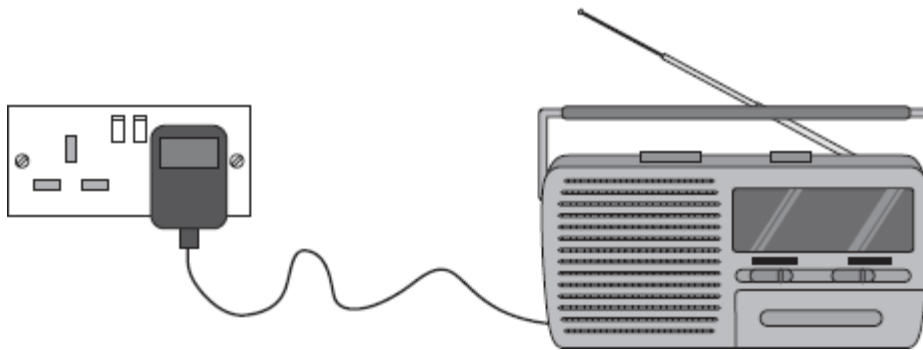
.....

Give a reason for your answer.

.....
.....

(2)

(c) A radio can be used with a 9 V battery or it can be plugged into the 230 V mains electricity supply using an adapter. The mains adapter contains a transformer.



Why must the mains adapter contain a transformer?

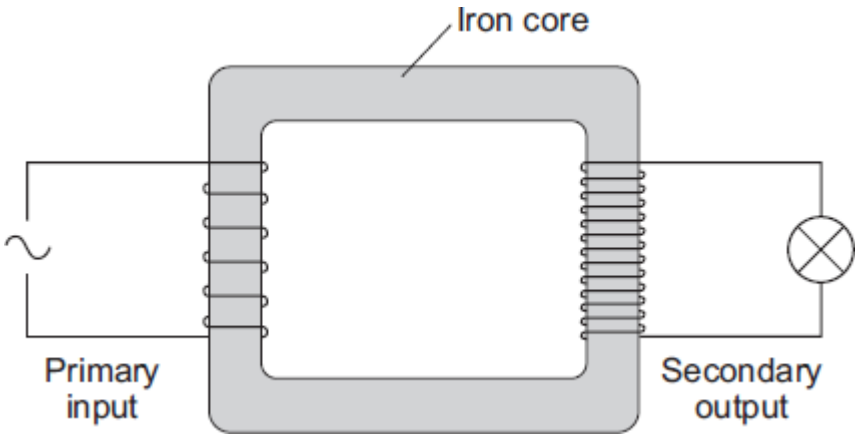
.....
.....

(1)

(Total 6 marks)

13

The diagram shows a transformer.



- (a) (i) Is the transformer in the diagram being used as a step-up transformer or as a step-down transformer?

Put a tick (✓) in the box next to your answer.

a step-up transformer

a step-down transformer

Give a reason for your answer.

.....
.....

(1)

- (ii) Why is the core made of iron?

.....
.....

(1)

- (b) The power supply to a laptop computer contains a transformer designed to change the 230 V mains input to a 15 V output. The transformer has 920 turns on its primary coil.

Use the equation in the box to calculate the number of turns on the secondary coil.

$$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

Show clearly how you work out your answer.

.....

.....

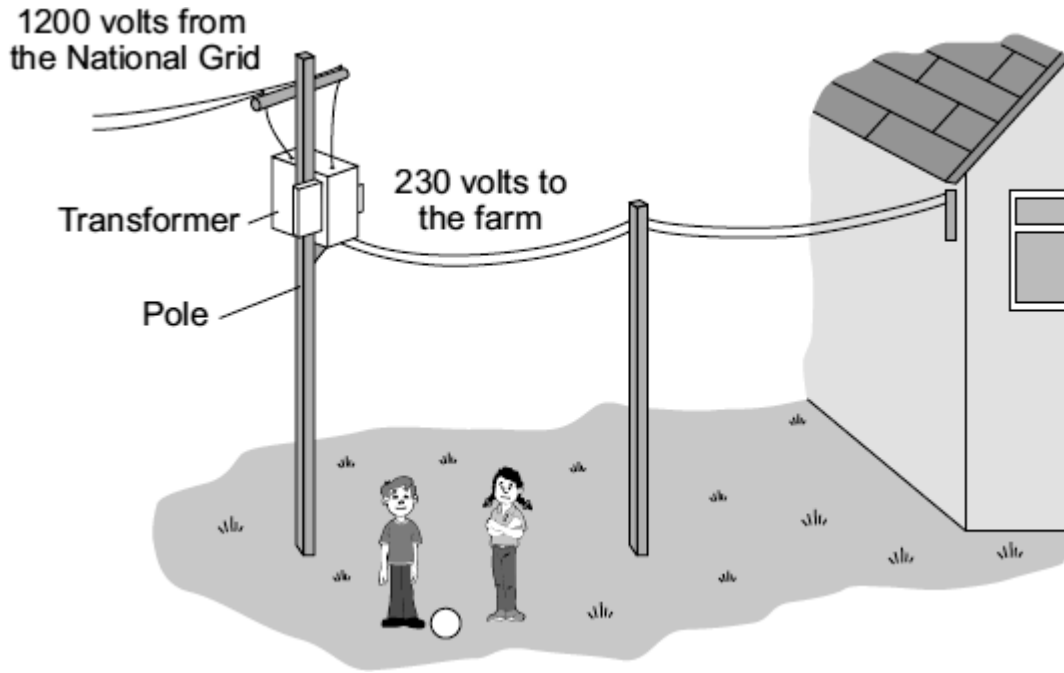
.....

Number of turns on the secondary coil =

(2)
(Total 4 marks)

14

The diagram shows part of the system used to supply a farm with electricity.



(a) The core of the transformer is made of metal.

Complete the following sentence by drawing a ring around the correct word in the box.

The metal used for the core of the transformer is

- copper.
- iron.
- steel.

(1)

(b) (i) What sort of transformer is shown in the diagram?

.....

(1)

(ii) Complete the following sentence by drawing a ring around the correct line in the box.

In this transformer, the number of turns on the secondary coil is

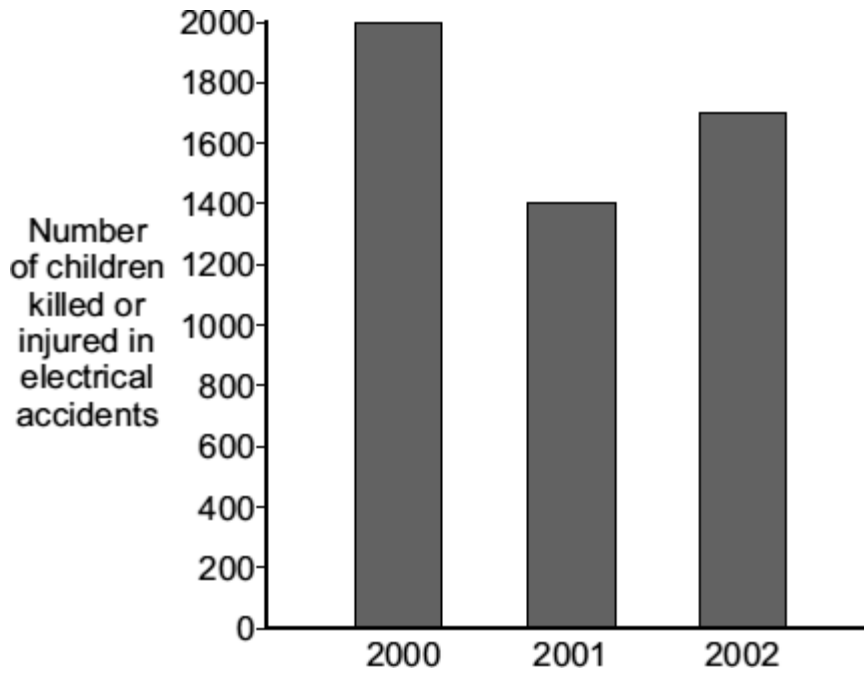
- less than
- the same as
- greater than

the number of turns on the primary coil.

(1)

(c) Transformers and other electrical equipment can be dangerous.

The following bar chart shows the numbers of children, aged 14 or under, killed or injured in electrical accidents in the UK in 2000, 2001 and 2002.



(i) In which of these years were most children killed or injured in electrical accidents?

.....

(1)

- (ii) A newspaper claims that the number of children killed or injured by electrical accidents will increase in 2011.

Which of the following gives a reason why the information given in the graph does not support this claim.

Put a tick (✓) in the box next to your answer.

The pattern shows an upward trend.

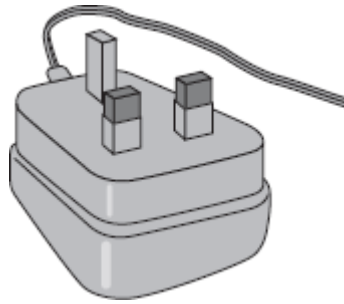
The pattern shows a downward trend.

There is no pattern.

(1)
(Total 5 marks)

15

(a) The drawing shows the plug for operating a radio from the mains.



This plug contains a transformer. There are 4600 turns on its primary coil and 200 turns on its secondary coil. The plug is used on the mains supply and has a potential difference (p.d.) of 230 V across its primary coil.

Use the equation in the box to calculate the p.d. across the secondary coil of the transformer.

$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$

Show clearly how you work out your answer.

.....

.....

.....

.....

p.d. across secondary = V

(2)

(b) The coils of the transformer are made of insulated wire.

Why is the wire insulated?

.....

.....

(1)

(c) (i) What material is the core of a transformer made from?

.....

(1)

(ii) Why is the core made from this material?

.....
.....

(1)
(Total 5 marks)

16

(a) In the National Grid, very large step-up transformers link power stations to the transmission cables.

A transformer used for this purpose has 800 turns on its primary coil and 12 800 turns on its secondary coil. The p.d. (potential difference) across its primary coil is 25 kV.

Use the equation in the box to calculate the p.d. across its secondary coil.

$$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

Show clearly how you work out your answer **and** give the unit.

.....
.....

p.d. across secondary coil =

(3)

(b) The primary and secondary coils of a transformer are made of insulated wire.

Why is this insulation necessary?

.....
.....

(1)

(c) Describe what happens when an alternating potential difference is applied across the primary coil of a transformer.

.....

.....

.....

.....

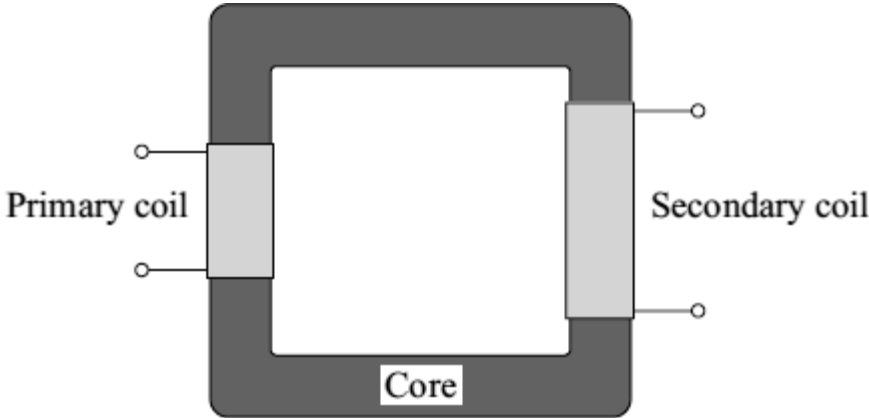
.....

.....

(3)
(Total 7 marks)

17

(a) The diagram shows the basic structure of a step-up transformer.



(i) What is the core made of?

.....

(1)

(ii) Explain how an alternating input produces an alternating output.

.....

.....

.....

.....

.....

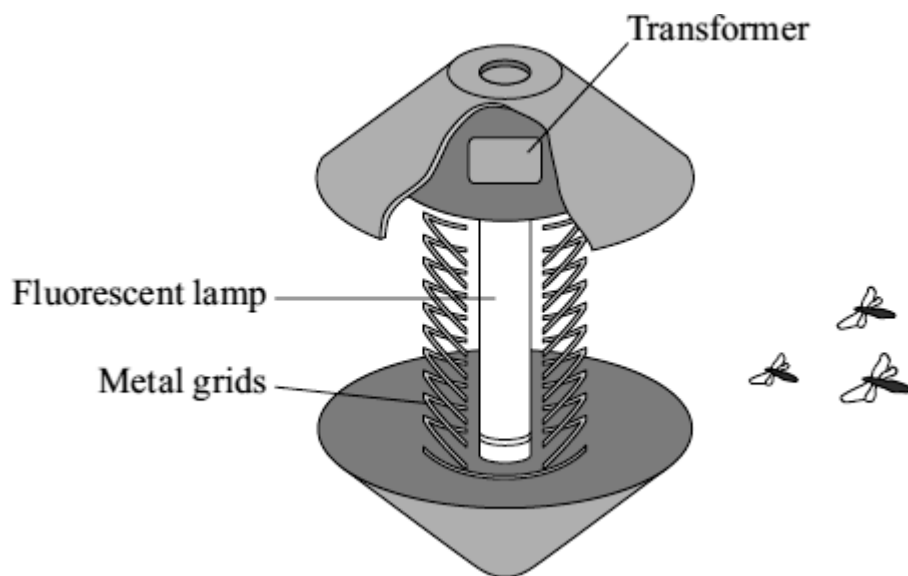
.....

.....

(3)

- (b) Fly killers are used in kitchens and food stores because flying insects carry diseases which cause food poisoning.

The diagram shows the inside of one design. Insects are attracted to a fluorescent lamp. The metal grids have a high potential difference (p.d.) between them. The insects are killed as they fly between the grids.



A transformer is used in the fly killer. There is a p.d. of 230 V across the primary coil. There are 300 turns of wire on the primary coil and 4000 turns on the secondary coil.

Use the equation in the box to calculate the p.d. across the secondary coil.

$$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

Show clearly how you work out your answer.

.....

.....

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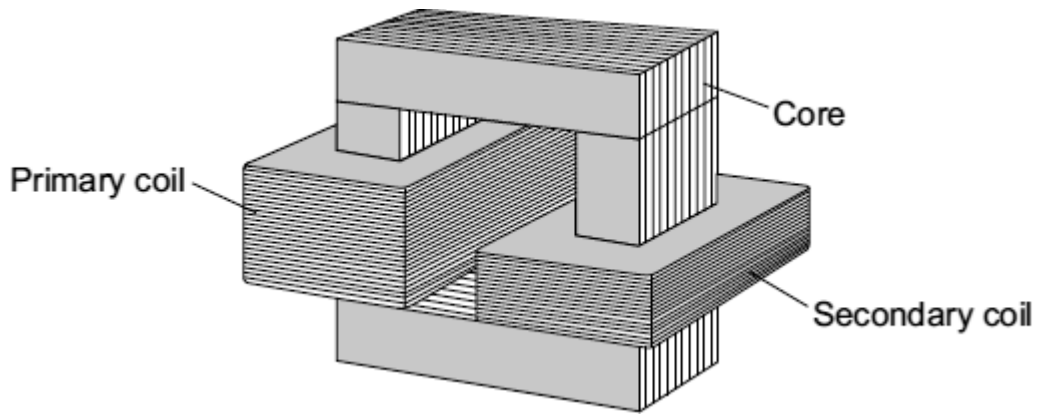
.....

.....

Potential difference =V

(3)
(Total 7 marks)

A teacher demonstrates a small transformer.



- (a) (i) What is the core made of?

Draw a ring around the correct word in the box.

aluminium	copper	iron
-----------	--------	------

(1)

- (ii) The potential difference (p.d.) across the secondary coil is less than the p.d. across the primary coil.

What sort of transformer is it?

.....

(1)

- (b) Where is a step-up transformer used as part of the National Grid?

.....

(1)

(c) The teacher writes a note about the transformer but leaves **five** spaces.

Use the correct words from the box to complete the spaces.

coil	core	current	ends	field	wire
-------------	-------------	----------------	-------------	--------------	-------------

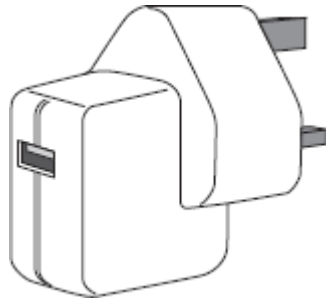
A transformer works because an alternating in the primary produces a changing magnetic in the and then in the secondary coil.

This induces an alternating potential difference across the of the secondary coil.

(5)
(Total 8 marks)

19

The diagram shows a USB power adapter which plugs into a 230 V a.c. mains socket.



The adapter contains a small step-down transformer.

(a) The core of the transformer is made of laminated soft iron.

Why is iron used?

.....
.....

(1)

(b) The coils of the transformers are made of insulated copper wire.

Why is the wire insulated?

.....
.....

(1)

- (c) There are 500 turns on one coil of the transformer and 20 000 turns on the other coil.

Use the equation in the box to calculate the p.d. across the secondary coil.

$$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

Show clearly how you work out your answer and give the unit.

.....

.....

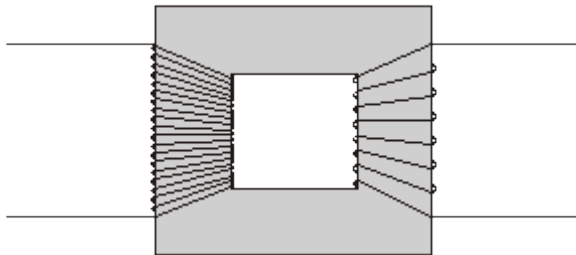
.....

p.d. across the secondary =

(3)
(Total 5 marks)

20

- (a) The basic structure of a transformer is a primary coil of insulated wire, an iron core and a secondary coil of insulated wire.



- (i) Why is the core made of iron?

.....

.....

(1)

(ii) Explain how a transformer works.

.....
.....
.....
.....
.....
.....
.....
.....

(4)

(b) A small step-down transformer is used in the charger for an electric screwdriver.

The input to the transformer is 230 V a.c. mains supply and the output is 5.75 V a.c. There are 3200 turns on the primary coil.

Use the equation in the box to calculate the number of turns on the transformer's secondary coil.

$$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

Show clearly how you work out your answer.

.....
.....

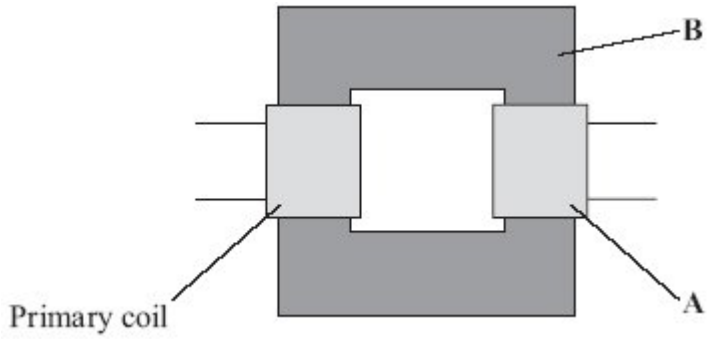
Number of turns =

(2)

(Total 7 marks)

21

(a) The diagram shows a transformer.



(i) What is part **A**?

.....

(1)

(ii) What is part **B** and what is it made of?

.....
.....

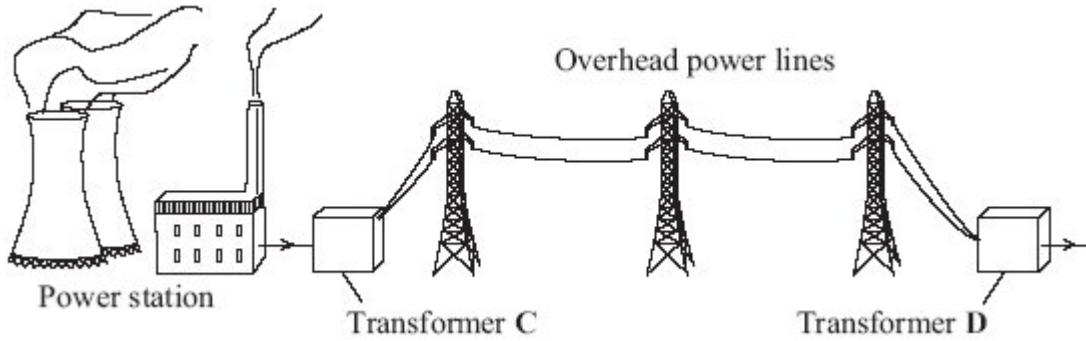
(2)

(iii) When there is an alternating current in the primary coil, what is produced in part **B**?

.....
.....

(2)

(b) Transformers are used in the National Grid. The diagram shows part of the National Grid.



Complete the **two** spaces in the sentence.

Transformer **C** is a transformer and transformer **D** is
a transformer.

(1)

(c) This is an item from a newspaper.

Health at risk from power lines?
Are high voltage power lines a health risk to people who live near them?
Some scientists think that scientific evidence shows that they are.
Other scientists do not think that the scientific evidence supports this conclusion.

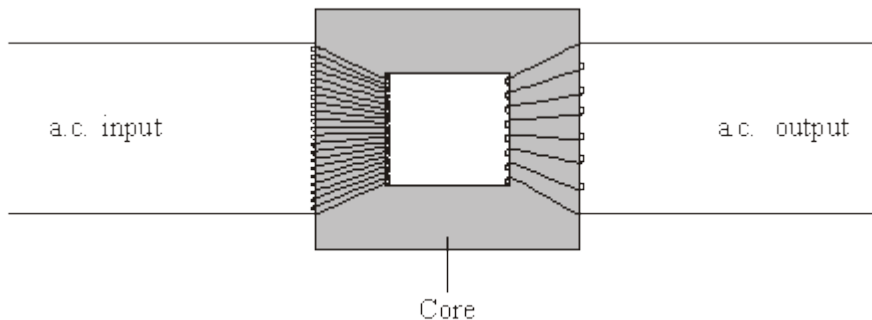
Which **two** suggestions would reduce the possible risk to people's health?
Put a tick (✓) in the box next to your answers.

- Do not build new houses near to existing power lines.
- Move the power lines so that they take the shortest routes.
- Move each power station to the centre of the nearest city.
- Build new power lines away from where people live.
- Use more transformers in the National Grid.

(2)
(Total 8 marks)

22

(a) The diagram shows a transformer.



- (i) Is the transformer in the diagram being used as a step-up transformer or as a step-down transformer?

Put a tick (✓) in the box next to your answer.

a step-up transformer

a step-down transformer

Explain your answer.

.....
.....

(1)

- (ii) Why is insulated wire, and not uninsulated wire, used to make the coils?

.....
.....

(1)

- (iii) Why is the core made of iron?

.....
.....

(1)

- (b) A transformer has 500 turns on its primary coil and 7500 turns on its secondary coil. The potential difference across the primary coil is 150 volts.

Use the equation in the box to calculate the potential difference across the secondary coil.

$$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

Show clearly how you work out your answer.

.....
.....
.....

Potential difference across the secondary coil = volts

(2)

(c) Step-down transformers are used between power lines and people's houses.

Explain why.

.....
.....
.....

(2)

(d) Before 1926, large towns had their own local power stations. After 1926, these power stations were connected to form the National Grid.

Explain the advantage of having a National Grid system.

.....
.....
.....
.....

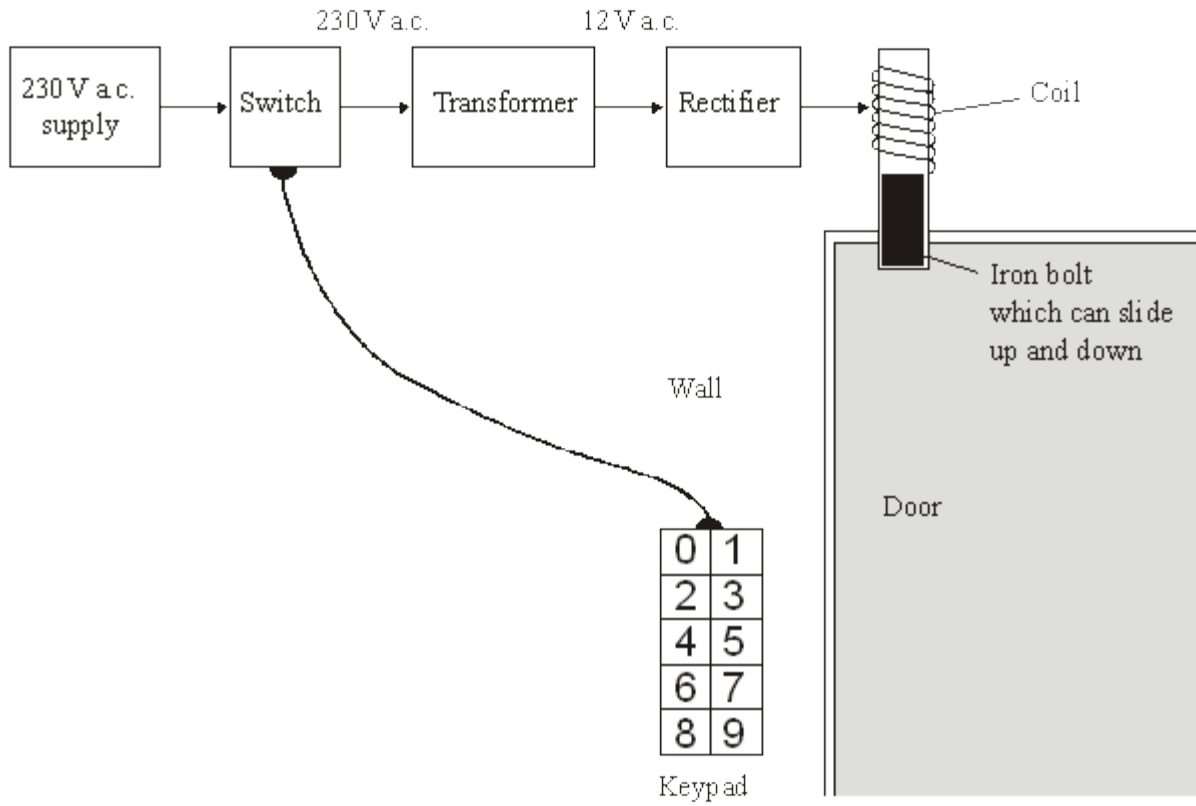
(2)

(Total 9 marks)

23

The diagram shows the design for a remotely controlled door bolt.

When the correct numbers are entered into the keypad the transformer switches on. Then the door can be opened.



(a) What kind of transformer is shown in the diagram?

.....

(1)

(b) What does the abbreviation a.c. stand for?

.....

(1)

(c) Complete the sentences using the correct words from the box.

attracts	downwards	magnet	reflects	repels
sideways	switch	transformer	upwards	

- (i) When a current flows in the coil, the coil becomes a
- (ii) The coil the iron bolt which moves

(3)
(Total 5 marks)

24

(a) This notice is on the back of a television set.



The transformer used in the television set has 75 turns on its primary coil. The potential difference (p.d.) across the primary coil is 230 volts and the p.d. across the secondary coil is 32 200 volts.

Use the equation below to calculate the number of turns on the secondary coil.

$$\frac{\text{p.d. across primary}}{\text{p.d. across secondary}} = \frac{\text{number of turns on primary}}{\text{number of turns on secondary}}$$

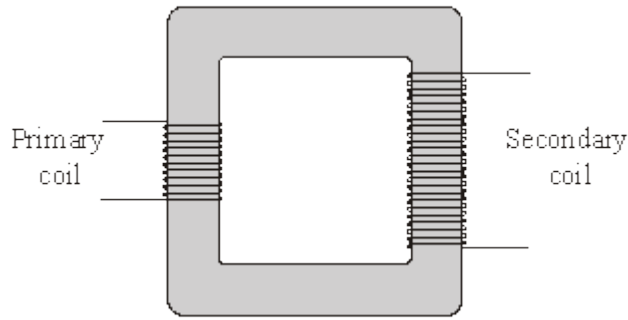
Show clearly how you work out your answer.

.....
.....
.....

Number of turns on the secondary coil =

(2)

(b) The diagram shows the structure of a transformer.



Explain how the transformer works.

.....

.....

.....

.....

.....

.....

(3)
(Total 5 marks)

25

A transformer is used to reduce the 230 V a.c. mains to the 12 V supply required for the lighting system. The transformer has 1150 turns on its primary coil.

Calculate the number of turns on the secondary coil of the transformer. Show clearly how you work out your answer.

.....

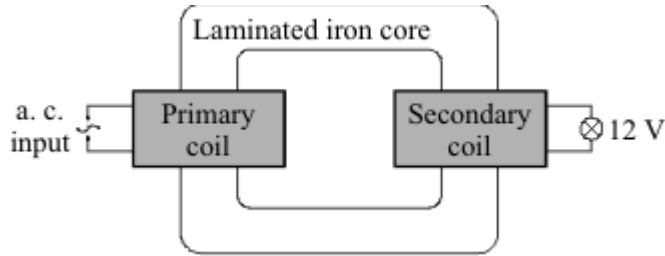
.....

.....

number of turns on the secondary coil =

(2)
(Total 2 marks)

- (a) The diagram represents a simple transformer used to light a 12 V lamp. When the power supply is switched on the lamp is very dim.



- (i) Give **one** way to increase the voltage at the lamp without changing the power supply.

.....

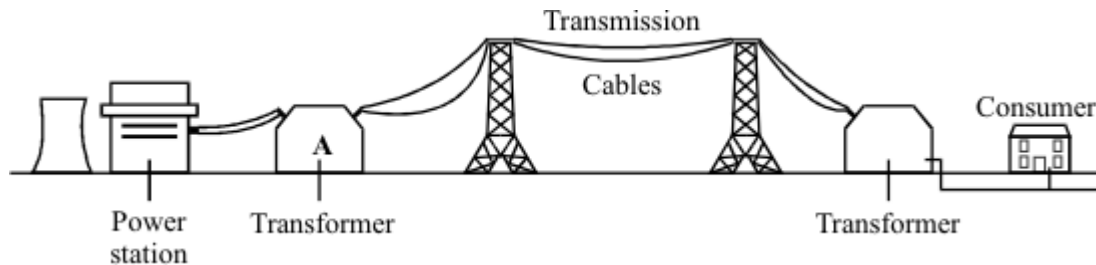
(1)

- (ii) What is meant by the iron core being *laminated*?

.....

(1)

- (b) Electrical energy is distributed around the country by a network of high voltage cables.



- (i) For the system to work the power is generated and distributed using alternating current rather than direct current. Why?

.....

(1)

- (ii) Transformers are an essential part of the distribution system. Explain why.

.....

(2)

(iii) The transmission cables are suspended high above the ground. Why?

.....

(1)

(c) The power station generates 100 MW of power at a voltage of 25 kV. Transformer **A**, which links the power station to the transmission cables, has 44 000 turns in its 275 kV secondary coil.

(i) Write down the equation which links the number of turns in each transformer coil to the voltage across each transformer coil.

.....

.....

(1)

(ii) Calculate the number of turns in the primary coil of transformer **A**. Show clearly how you work out your answer.

.....

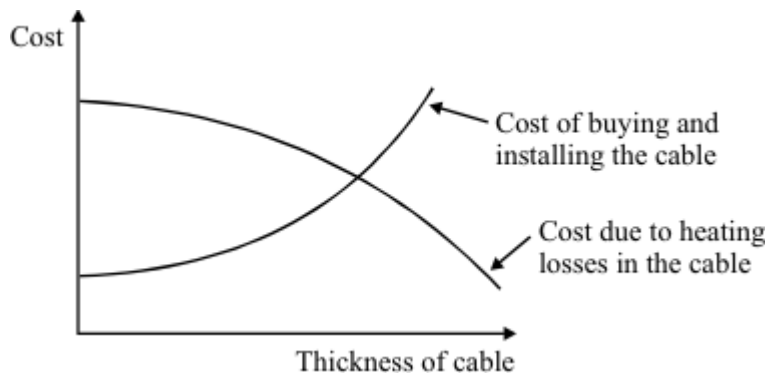
.....

.....

Number of turns =

(2)

(d) The diagram shows how the cost of transmitting the electricity along the cables depends upon the thickness of the cable.



(i) Why does the cost due to the heating losses go down as the cable is made thicker?

.....

(1)

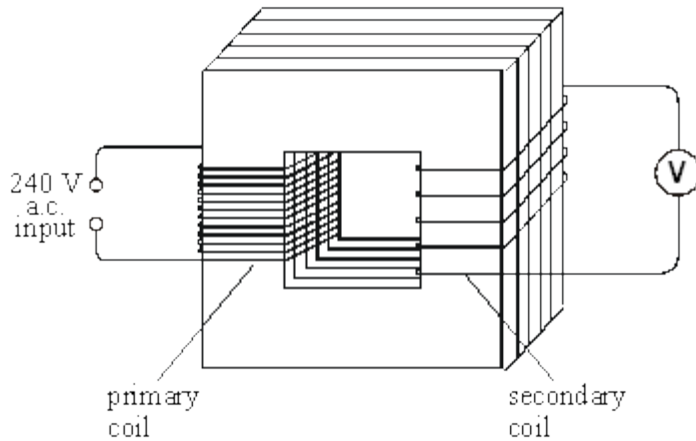
(ii) By what process is most heat energy lost from the cables?

.....

(1)
(Total 11 marks)

27

The diagram below shows a transformer.



(i) Name the material used to make the core of the transformer.

.....

(1)

(ii) The primary coil has 48 000 turns and the secondary coil 4000 turns.

If the input voltage is 240 V a.c., calculate the output voltage.

.....

.....

Answer V

(2)

(iii) Explain how the use of such a transformer could be adapted to transform a low voltage into a higher voltage.

.....

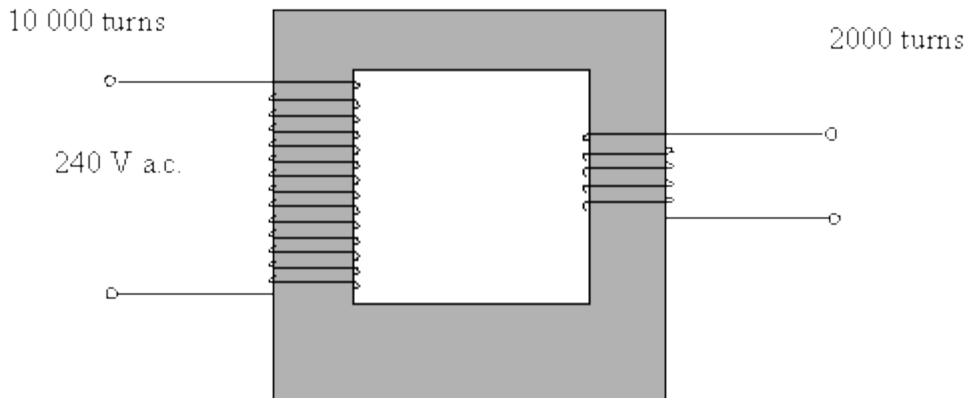
.....

(1)
(Total 4 marks)

28

(a) An appliance in a house has a transformer. The transformer is used to reduce the voltage to the level needed by the appliance.

The diagram shows the transformer.



(i) Name the material used for the core of the transformer.

.....

(1)

(ii) The transformer has 10 000 turns on the input side and 2000 turns on the output side. If the mains voltage of 240 volts is applied to the input, calculate the output voltage. You may find the following information helpful:

$$\frac{\text{output voltage}}{\text{input voltage}} = \frac{\text{number of turns on output coil}}{\text{number of turns on input coil}}$$

.....
.....
.....
.....

(3)

(b) Explain, in terms of magnetic fields, how a transformer works.

.....
.....
.....
.....
.....
.....

(4)

- (c) A 12 V car battery is connected to the input leads of the transformer. It is hoped to reduce the voltage to 2.4 V in order to run a small motor. When the output voltage is measured it is found to be zero.

Explain why the output voltage is zero.

.....

.....

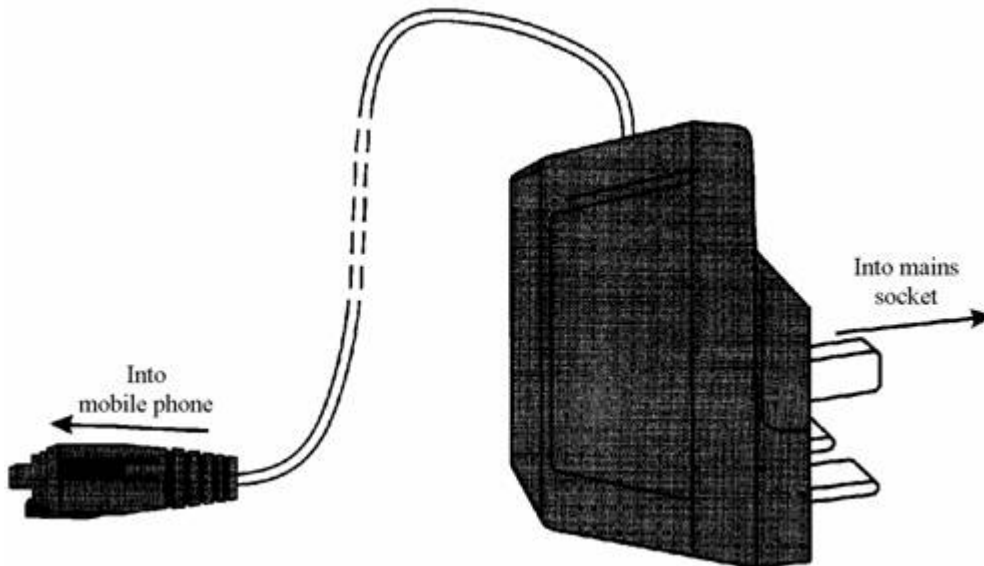
.....

.....

(2)
(Total 10 marks)

29

- (a) The drawing shows a small transformer used to recharge the battery in a 4.2 V mobile phone from a 230 V mains supply.



Explain how you know that this is a *step-down* transformer.

.....

.....

(1)

- (b) A transformer consists of an insulated coil of wire, called the primary coil, on one side of a core. Another coil of insulated wire, called the secondary coil, is on the other side.

Give **two** features of the *core*.

1

2

(2)
(Total 3 marks)

Mark schemes

- 1** (a) It is easily magnetised. 1
- (b) p.d. across the secondary coil is smaller (than p.d. across the primary coil) 1
- (c) ratio $\frac{V_s}{V_p} = \frac{6}{12}$
accept any other correct ratio taken from the graph 1
- $\frac{6}{12} = \frac{50}{N_p}$
use of the correct turns ratio and substitution or correct transformation and substitution 1
- $N_p = 100$
allow 100 with no working shown for 3 marks 1
- [5]**
- 2** (a) (i) generator 1
- (ii) alternating current 1
- (iii) voltmeter / CRO / oscilloscope / cathode ray oscilloscope 1
- (b) (i) time 1
- (ii) peaks and troughs in opposite directions 1
- amplitude remains constant
dependent on first marking point 1
- (c) any **two** from:
- increase speed of coil
 - strengthen magnetic field
 - increase area of coil
- do not accept larger* 2
- [8]**
- 3** (a) *attempt to draw four cells in series* 1

correct circuit symbols

circuit symbol should show a long line and a short line, correctly joined together

example of correct circuit symbol:



1

(b) (i) 6 (V)

allow 1 mark for correct substitution, ie

$V = 3 \times 2$ scores 1 mark

provided no subsequent step

2

(ii) 12 (V)

ecf from part (b)(i)

$18 - 6$

or

$18 -$ their part (b)(i) scores 1 mark

2

(iii) 9 (Ω)

ecf from part (b)(ii) correctly calculated

$3 +$ their part (b)(ii) / 2

or

$18 / 2$ scores 1 mark

provided no subsequent step

2

(c) (i) need a.c.

1

battery is d.c.

1

(ii) 3 (A)

allow 1 mark for correct substitution, ie

$18 \times 2 = 12 \times I_s$ scores 1 mark

2

[12]

4

(a) there is a magnetic field (around the magnet)

1

(this magnetic field) changes / moves

1

and cuts through coil

accept links with coil

1

so a p.d. induced across coil

1

the coil forms a complete circuit

1

so a current (*is induced*)

1

(b) ammeter reading does not change

must be in this order

accept ammeter has a small reading / shows a current

1

zero

1

greater than before

accept a large(r) reading

1

same as originally but in the opposite direction

accept a small reading in the opposite direction

1

(c) 0.30

allow 1 mark for correct substitution, ie $0.05 = Q / 6$

2

C / coulomb

allow A s

1

[13]

5

(a) (i) live

1

(ii) react faster

1

(iii) live and neutral

1

(b) (i) ammeter

1

to measure current

accept to measure amps

1

plus any **one** from:

- variable resistor (1)
to vary current (1)
accept variable power supply
accept change or control
- switch (1)
to stop apparatus getting hot / protect battery
or
to reset equipment (1)
- fuse (1)
to break circuit if current is too big (1)

2

(ii) any **two** from:

- use smaller mass(es)
- move mass closer to pivot
- reduce gap between coil and rocker
- more turns (on coil) *coil / loop*
- iron core in coil
accept use smaller weight(s)

2

[9]

6

Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks

No relevant / correct content.

Level 1 (1–2 marks)

Either there is an attempt at a description of the construction of a transformer

or

a correct statement of the effect of one type of transformer on the input p.d.

Level 2 (3–4 marks)

There is a description of the construction of a transformer

and

a correct statement of the effect of one type of transformer on the input p.d.

Level 3 (5–6 marks)

There is a clear description of the construction of a transformer

and

there is a correct description of how transformers affect the input p.d.

details of construction:

extra information

a (laminated) core

core is made from a magnetic material / iron

2 coils

the coils are made from an electrical conductor / copper

the coils are covered in plastic / insulation

the coils are (usually) on opposite sides

step-up transformer has more turns on secondary coil than (its) primary (or vice versa)

step-down transformer has fewer turns on secondary coil than (its) primary (or vice versa)

effect on input p.d. :

step-up transformer, the output p.d. is greater (than the input p.d.)

accept voltage for p.d.

step-down transformer, the output p.d. is lower (than the input p.d.)

7

(a) step-down

6

[6]

1

- (b) (i) 1.6
correct order only 1
- 12.8 1
- (ii) values of p.d. are smaller than 230 V 1
- (c) (i) a.c. is constantly changing direction
accept a.c. flows in two / both directions
accept a.c. changes direction(s)
a.c. travels in different directions is insufficient 1
- d.c. flows in one direction only 1
- (ii) an alternating current / p.d. in the primary creates a changing / alternating magnetic field 1
- (magnetic field) in the (iron) core
current in the core negates this mark
accept voltage for p.d. 1
- (and so) an alternating p.d. 1
- (p.d.) is induced across secondary coil 1

[10]

8

- (a) iron
correct positions only 1
- primary 1
- secondary 1
- (b) (i) decreases the p.d.
accept it would increase current
accept voltage for p.d.
the voltage goes from 230(V) to 20(V) is insufficient
*do **not** accept decreases current / energy / power*
*do **not** accept decreases p.d. / voltage and current* 1

(c) an environmental

1

[5]

9

(a) (the alternating current creates) a changing / alternating magnetic field

1

(magnetic field) in the (iron) core

*accept that links with the secondary coil
current in the core negates this mark*

1

(causing a) potential difference (to be) induced in / across secondary coil

accept voltage for p.d.

1

(b) (i) 20

allow 1 mark for correct substitution, ie $\frac{230}{V_s} = \frac{575}{50}$

or $\frac{V_s}{230} = \frac{50}{575}$

2

(ii) 0.3

or

correct calculation using $230 \times I_p = \text{their (b)(i)} \times 3.45$

allow 1 mark for correct substitution, ie

$$230 \times I_p = 20 \times 3.45$$

allow ecf from (b)(i) for 20

OR

substitution into this equation $\frac{I_p}{I_s} = \frac{N_s}{N_p}$

2

(c) any **one** from:

- fewer (waste) batteries have to be sent to / buried in land-fill
- the soil is polluted less by batteries in land-fill
- fewer (waste) batteries have to be recycled
- fewer batteries have to be made
- less raw materials are used in making batteries
- customers have to replace their batteries less often
longer lifetime is insufficient
- customers have to buy fewer (replacement) batteries
it costs less is insufficient

1

[8]

10

(a) 400 000

allow 1 mark for correct substitution ie

$$\frac{25000}{?} = \frac{800}{12800}$$

or

$$\frac{25}{?} = \frac{800}{12800}$$

2

(b) (i) any **one** from:

do not accept any response in terms of heat insulation, safety or electric shock

- (so that there is) no short circuit
- (so that the) current goes around the coil
do not accept electricity for current
- (so that the) current does not enter the core

1

(ii) (easily) magnetised (and demagnetised)

accept '(it's) magnetic'

do not accept 'because it's a conductor'

1

(iii) alternating current in the primary (coil)

1

produces a changing magnetic field (in the core)

1

this induces an (alternating) potential difference across the secondary (coil)

1

(c) any **two** from:

- if the (local) power station breaks down / fails / demand / load exceeds supply
- electricity / power can be switched from elsewhere in the system / from other power station(s)
- electricity can be generated in places remote from customers
- (in total) fewer power stations are needed
- power available in rural / remote areas
- National Grid allows for (better) control of supply and demand

2

[9]

11

(a) which causes the magnet to turn / spin / rotate

1

(magnetic) field / lines of force / flux rotate(s) / move(s) / through / in / cut(s) the coil
do not credit the idea that movement 'creates' the magnetic field

1

potential difference / p.d. / voltage induced across the coil
do not credit just 'current induced'

1

(b) any **one** from:

- more powerful / stronger / lighter magnet
do not credit 'a bigger magnet'
- larger / more / bigger / lighter cups / with a bigger surface area
- longer arms
- lubricate the spindle
- add more turns to the coil

1

[4]

12

(a) aluminium cannot be magnetised

accept aluminium is not magnetic

"it" refers to aluminium

do not accept aluminium is not easily magnetised

reference to conduction and aluminium negates mark

iron can be magnetised is insufficient

1

- (b) (i) 10 to 50
either order 1
- (ii) (data is) anomalous
*accept does **not** fit the pattern*
it is an error is insufficient 1
- (iii) 21
accept 22
*do **not** accept any fraction of a turn ie 20.1* 1
- secondary p.d. (just) larger than primary p.d.
accept output (just) larger than input/2V
- or**
there must be more turns on the secondary coil than primary coil
*do **not** accept coil for turns* 1
- (c) to reduce/step-down the (input) p.d./voltage
mains p.d. is too high is insufficient
step-down transformer is insufficient
*answers in terms of changing/ stepping-up current **or** fuse blowing*
***or** not working with 230 volts are insufficient*
any mention of step-up negates mark
*stepping down both voltage/p.d. **and** current negates mark* 1

[6]

13

- (a) (i) step-up
both parts required
more turns on the secondary / output (coil)
*do **not** accept coils for turns*
'secondary output is greater than primary input' is insufficient 1
- (ii) (easily) magnetised (and demagnetised)
accept (it's) magnetic
it's a conductor negates answer 1

(b) 60

allow 1 mark for correct substitution, ie $\frac{230}{15} = \frac{720}{N_s}$

2

[4]

14

(a) iron

accept any unambiguous correct indication

1

(b) (i) step-down (transformer)

do **not** accept down step or a description

1

(ii) less than

accept any unambiguous correct indication

1

(c) (i) 2000

1

(ii) There is no pattern.

1

[5]

15

(a) 10

allow 1 mark for correct substitution ie $\frac{230}{V_s} = \frac{4600}{200}$

2

(b) any **one** from:

- to prevent short circuiting
- to ensure that the current flows / goes round the coil
- to prevent the current entering the core

do **not** accept electrocution

do **not** accept electricity for current

answers including heat / energy loss negate mark

1

(c) (i) (soft) iron

do **not** accept 'steel'

1

(ii) can be magnetised

because it is magnetic

answers including it's a conductor negate mark

1

[5]

16

(a) 400 000

allow 1 mark for correct substitution ie

$$\frac{25000}{?} = \frac{800}{12800}$$

or

$$\frac{25}{?} = \frac{800}{12800}$$

2

volt(s) / V

an answer 400 gains 2 marks

an answer 400 kilovolts / kV gains 3 marks

although the unit mark is independent to gain 3 marks it must be consistent with the numerical value

1

(b) any **one** from:

*do **not** accept any response in terms of heat insulation, safety or electric shock*

- (so that there is) no short circuit
- (so that the) current goes round the coil
*do **not** accept electricity for current*
- (so that the) current does not enter the core

1

(c) (the alternating p.d. in the primary causes) an (alternating) current in the primary

reference to the current in the core negates this mark

1

(causes an) alternating / changing (magnetic) field in the (iron) core

1

induces (alternating) p.d. across the secondary (coil)
accept in / through or similar for across
accept current for p.d.
accept output (coil) for secondary (coil)
to gain 3 marks the sequence must be correct

1

[7]

17

(a) (i) (laminated soft) iron
do not accept steel

1

(ii) produces a magnetic field
accept magnetic flux

which is alternating / changing / varying

and which induces / produces an alternating / changing potential
difference across the secondary coil

accept current / voltage

3

(b) 3067 (V)

allow all 3 marks for 3060 to 3070 (V)

$$V = \frac{230 \times 4000}{300} \text{ gains 2 marks}$$

$$\frac{230}{V} = \frac{300}{4000} \text{ gains 1 mark}$$

3

[7]

18

(a) (i) iron

1

(ii) step-down (transformer)

1

(b) any **one** from:

- after the power station
- after the generator
- before the power lines
- before the pylons

1

- (c) each correct (1)
in its correct place

current

coil

field

core

ends

5

[8]

19

- (a) (it is) magnetic

or will carry (an alternating) magnetic field

or magnetises and demagnetises (easily)

reference to conduction negates the mark

1

- (b) so the current / electricity does not flow through the iron / core

accept 'so the current / electricity / wires do not short (circuit)'

responses in terms of heat insulation negate the mark

ignore references to safety

1

- (c) 5.75 or 5.8 or 6(.0)

allow for 1 mark either

$$\frac{230}{p.d.} = \frac{20\,000}{500}$$

or

$$p.d. = 230 \div 40$$

2

V / volt(s)

1

[5]

20

- (a) (i) (quickly) becomes magnetized

or (quickly) loses its magnetism

or 'it's (a) magnetic (material)'

any reference to conduction of electricity/heat nullifies the mark

1

(ii) any **four** from:

- insulation prevents electricity/current flowing through the iron/core
or 'insulation so electricity/current only flows in the wires/turns/coils'
- alternating current/a.c. in the primary (coil)
- produces a changing magnetic field (in the iron/core)
- (and hence magnetic) field in the secondary (coil)
- induces/generates/produces an alternating potential difference/p.d./voltage across the secondary (coil)
- (and hence) alternating current/a.c. in the secondary (coil)

4

(b) 80 (turns)

or credit (1) for any equation which if correctly evaluated would give 80 example

example

$$\frac{230}{5.75} = \frac{3200}{\text{number of turns}}$$

2

[7]

21

(a) (i) secondary(coil) / output (coil)

do not accept just coil

1

(ii) core

do not accept for either mark it is made out of iron ore

1

(laminated soft) iron

allow 1 mark for 'it is made out of iron core'

1

(iii) magnetic field

accept magnetism / magnetic force

1

(which is) changing / alternating

direction (of field) changes / strength (of field) varies

scoring second mark is dependent on first mark

1

- (b) ...step-up step-down ...
both in the correct order 1
- (c) Do not build new houses 1
- Build new power lines away
deduct 1 mark for any other(s) to a minimum total of (0) 1

[8]

22

- (a) (i) step-down (transformer) because fewer turns on the output/secondary (coil)
no credit for just 'step-down transformer'
accept '...less turns...'
do not credit '...fewer coils...'
or 'the p.d. across the input / primary will be greater than the p.d. across the output / secondary' 1
- (ii) to prevent a short (circuit)(through the turns of wire or through the core
do not credit references to safety or heat (insulation) 1
- (iii) (easily) magnetised (and demagnetised)
accept '(it's) magnetic'
do not accept 'because it's a conductor' 1
- (b) 2250
correct substitution
 eg $\frac{150}{p.d. across secondary} = \frac{500}{7500}$ gains 1 mark
or appropriate transformation
 eg (p.d. across secondary =) $\frac{\text{number of turns on secondary}}{\text{number of turns on primary}}$
x p.d. across primary gains 1 mark 2

(c) any **two** from:

- to reduce the voltage / p.d. (of the domestic supply)
or to reduce to 230 V
allow 'to reduce to 240 V'
*do **not** credit 'reduce current to 230V'*
- higher voltage difficult to insulate
- higher voltage (would) result in (fatal) electric shock
***not** just 'less dangerous'*
- domestic appliances are not designed for (very) high voltage (input) / (are designed) for 230V
*do **not** credit 'to increase efficiency' / 'to save energy' do **not** credit just 'it's safer'*

2

(d) any **two** (1) each

- if the (local) power station breaks down / fails / demand / load exceeds supply

or words to that effect
- electricity / power can be switched from elsewhere in the system / from other power station(s)
or words to that effect
- electricity can be generated in places remote from customers
or words to that effect
- (in total) fewer power stations are needed
- power available in rural / remote areas
- National Grid allows for (better) control of supply and demand
*do **not** credit just cheaper / more efficient / safer*

1

1

[9]

23

(a) step-down (transformer)

1

(b) alternating current

accept minor misspellings but
*do **not** credit 'alternative current'*

1

(c) (i)(ii) magnet

attracts

upwards

correct order essential

accept 'up'

3

[5]

24

(a) 10 500

allow 1 mark for $75 \times 32\,200 \div 230$

2

(b) any **three** from:

- alternating current (a.c.) in the primary (coil)
- produces a **changing** magnetic field / flux (in the core)
- which is made of (laminated soft) iron
- this induces
must be idea of inducing something in the secondary coil
- an alternating potential difference across the secondary coil
accept voltage for potential difference

3

[5]

⁶⁰
25

allow 1 mark for correct transformation

2

[2]

26

(a) (i) **one** of the following:

- increase number of turns on the secondary coil
- decrease number of turns on the primary coil

1

- (ii) constructed in (thin) layers 1
- (b) (i) transformers only work with a c 1
- (ii) used to increase **or** decrease **or** change voltage **or** current
 reducing the energy **or** heat **or** power loss (along the cables) 1
- or** reduce to safe domestic level
must be consistent with first answer 1
- (iii) (several metres of) air gives good electrical
 insulation (between cables and earth)
or reduce chance of earthing **or** sparks **or** arcing
or to avoid people touching it 1
- (c) (i) $\frac{\text{voltage across primary}}{\text{voltage across secondary}} = \frac{\text{no of turns in primary}}{\text{no of turns in secondary}}$
- accept* $\frac{VP}{VS} = \frac{NP}{NS}$
- or** $\frac{Vin}{Vout} = \frac{Nin}{Nout}$ 1
- (ii) $N_p = 4000$
- $\frac{25(000)}{275(000)} = \frac{NP}{44000}$ *for 1 mark* 2
- (d) (i) resistance of cable decreases 1
- (ii) convection (to the air)
or
 conduction (to the air)
not radiation 1

[11]

- 27** (i) iron
for 1 mark 1
- (ii) 20
gains 2 marks
- else working
gains 1 mark 2
- (iii) reverse input/output
for 1 mark
- or** increase secondary turns 1
- [4]**

- 28** (a) (i) Iron
for 1 mark 1
- (ii) $V/240 = 2000/10\ 000$
 $V = 48$
 V
for 1 mark each 3
- (b) changing current in primary causes changing (magnetic) field in core links to secondary inducing voltage (emf) in secondary (**NOT** current) secondary voltage/current is alternating
for 1 mark each 4
- (c) magnetic field not changing/no electromagnetic induction because direct current
for 1 mark each 2
- [10]**

- 29** (a) output voltage less than (the) input voltage
or p.d. across output less than p.d. across input or output is (only) 4.2 V (whereas) the input is 230V or WTTE (words to that effect) 1

(b) any **two** from

(made of soft) iron

laminated

or designed to reduce eddy currents

or made of thin slices with slices of insulating material between them

core(s) joined to make a ring

2

[3]