Mr Baker's Science-Stuff

Electromagnetic Induction

Name: _____

Class: _____

Date: _____

Time: **146 minutes**

Marks: **145 marks**

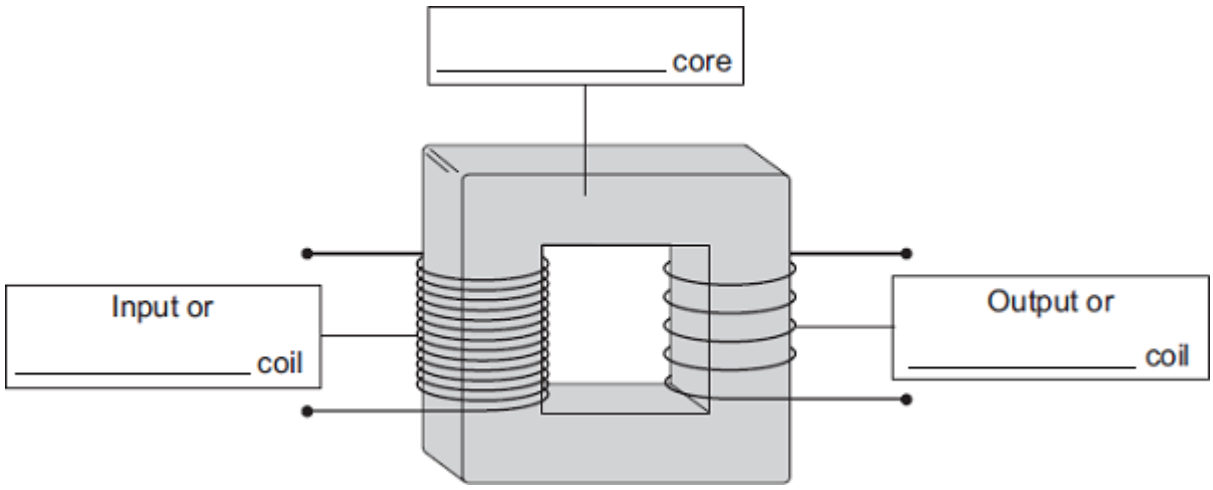
Comments:

Q1.

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

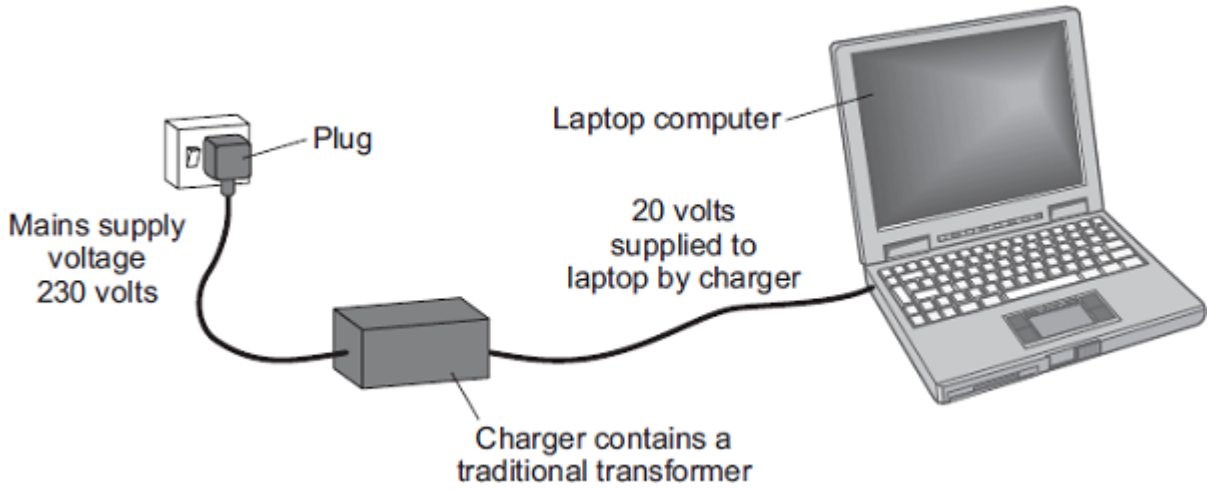
Use words from the box to label the diagram.

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.

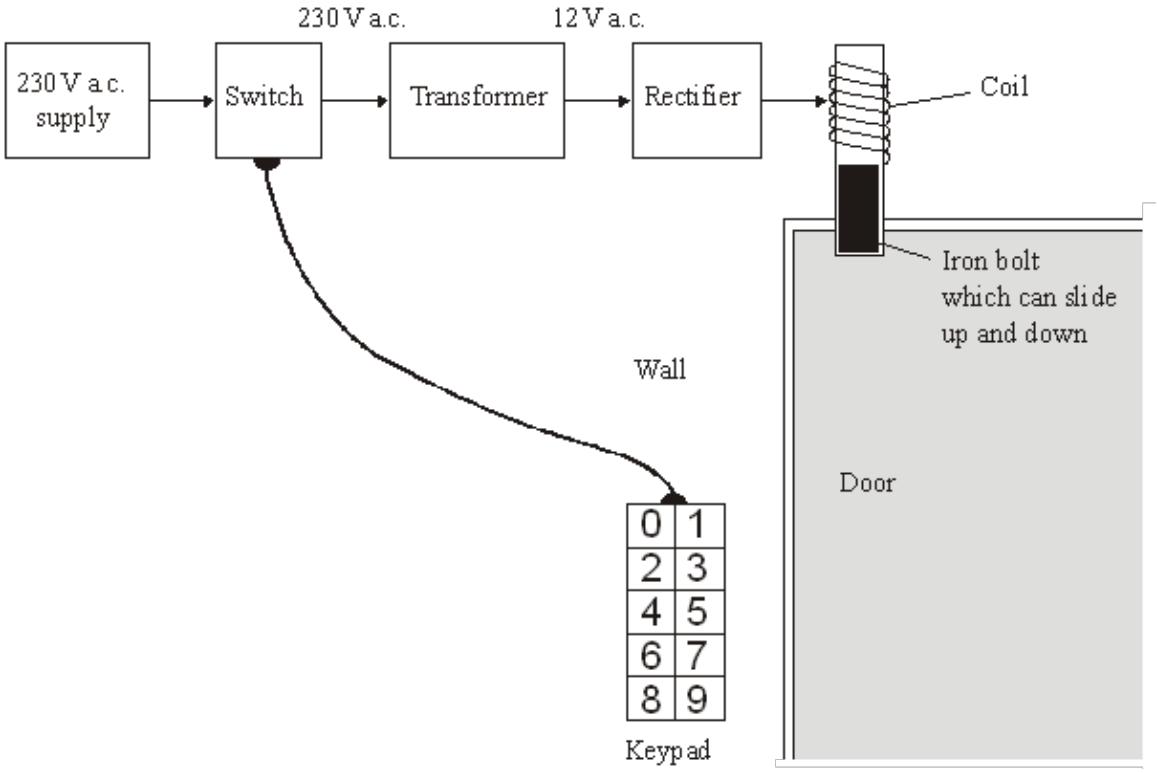
(1)

(Total 5 marks)

Q2.

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 _____ .

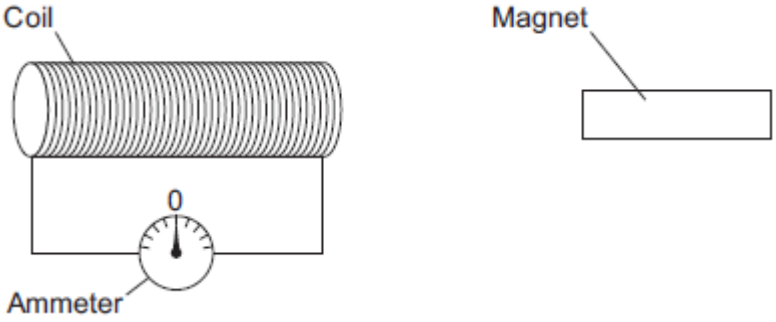
(ii) The coil _____ the iron bolt which moves _____

(3)

(Total 5 marks)

Q3.

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.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(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 = _____

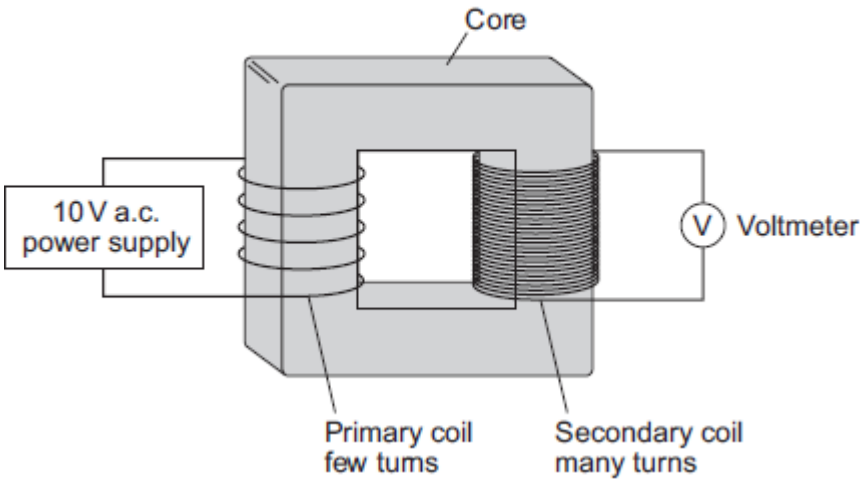
(3)

(Total 13 marks)

Q4.

Figure 1 shows a traditional transformer.

Figure 1



(a) (i) Which metal should the core of the transformer be made from?

Tick (✓) **one** box.

aluminium ☐

copper ☐

iron ☐

(1)

(ii) What would the reading be on the voltmeter shown in **Figure 1**?

Draw a ring around the correct answer.

2 V **10 V** **50 V**

Give the reason for your answer.

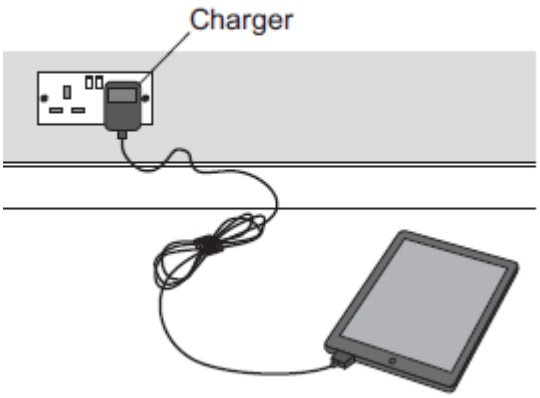
_____

_____

(2)

(b) **Figure 2** shows a tablet computer and its charger.

Figure 2



The charger contains a switch mode transformer.

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

200	**1000**	**20 000**

Switch mode transformers operate at frequencies

from 50 kHz to _____ kHz.

(1)

(ii) Give **one** advantage of a switch mode transformer over a traditional transformer.

_____

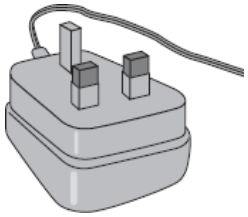
_____

(1)

(Total 5 marks)

Q5.

(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?

_____

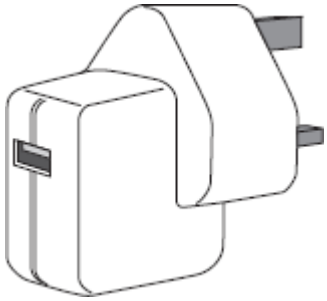
_____

(1)

(Total 5 marks)

Q6.

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.

_____

_____

_____

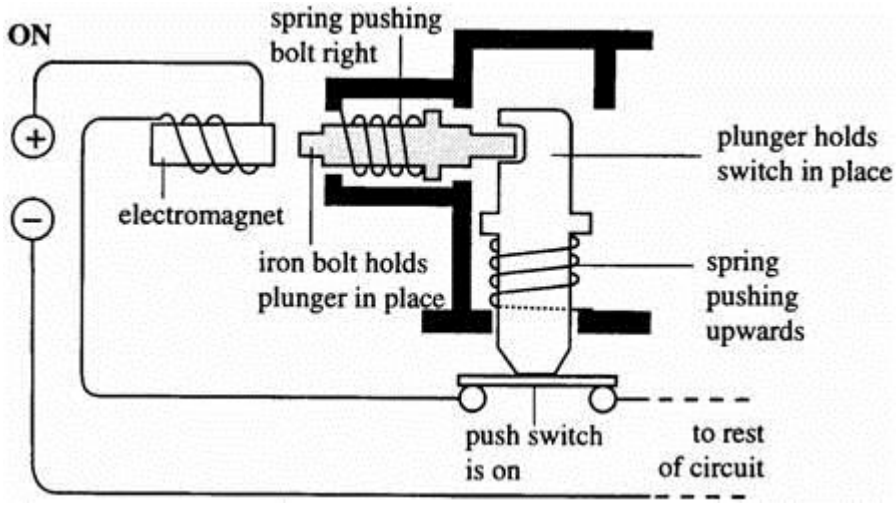
p.d. across the secondary = _____

(3)

(Total 5 marks)

Q7.

A fault in an electrical circuit can cause too great a current to flow.
Some circuits are switched off by a circuit breaker.

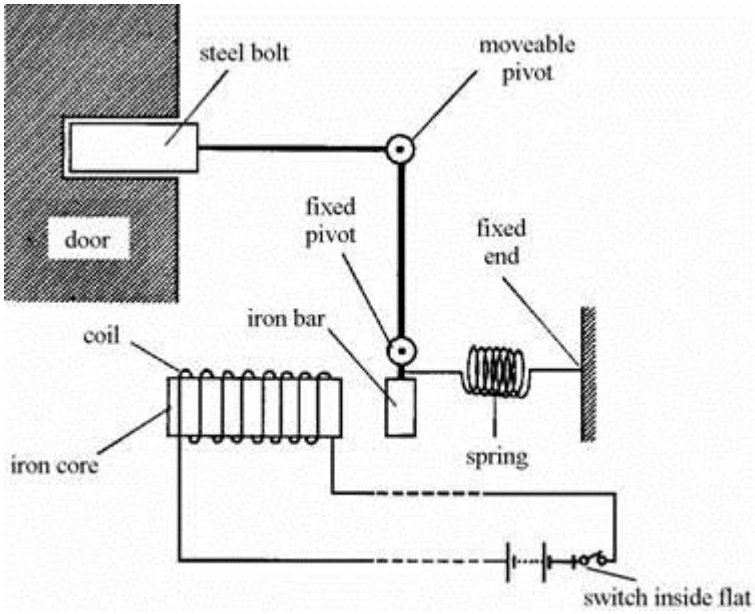


One type of circuit breaker is shown above. A normal current is flowing.
Explain, in full detail, what happens when a current which is bigger than normal flows.

(Total 4 marks)

Q8.

The diagram below shows a door lock which can be opened from a flat inside a building.



(a) Explain how the door is unlocked when the switch is closed.

_____

_____

_____

_____

(4)

(b) State **two** changes which would increase the strength of the electromagnet.

1. _____

2. _____

(2)

(c) Why is the spring needed in the lock?

_____

_____

(1)

(d) The connections to the coil were accidentally reversed. Would the lock still work?

_____

Explain your answer.

_____

_____

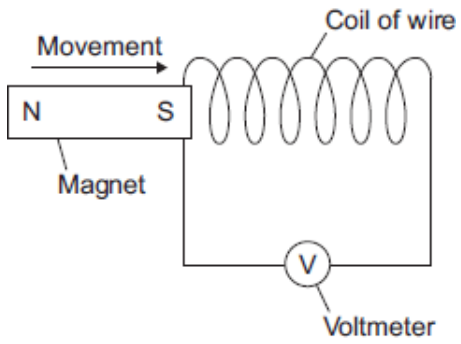
(2)

(Total 9 marks)

Q9.

Figure 1 shows a magnet moving into a coil of wire. This movement causes a reading on the voltmeter.

Figure 1



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

generated	**induced**	**produced**

Moving the magnet into the coil of wire causes a reading on the voltmeter because a potential difference is _____ across the ends of the wire.

(1)

(b) A student investigated how the number of turns on the coil of wire affects the maximum voltmeter reading. The student changed the number of turns on the coil of wire, then moved the magnet into the coil. The student recorded the maximum voltmeter reading.

To obtain valid data, suggest **two** variables that the student should control in this investigation.

1. _____

_____

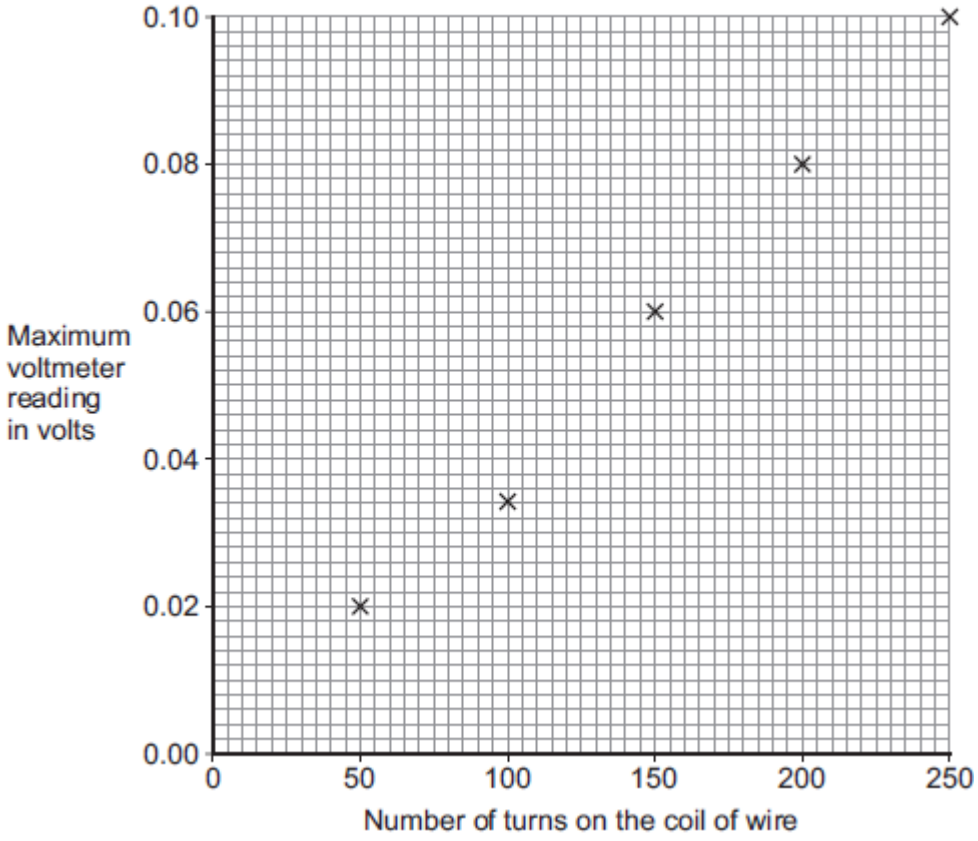
2. _____

_____

(2)

(c) The student's results are shown in **Figure 2**.

Figure 2



(i) One of the results is anomalous.
Suggest a reason for the anomalous result.

_____

(1)

(ii) Draw a line of best fit on **Figure 2**.

(1)

(d) A data-logger can automatically record and store data.

It may have been better for the student to have used a data-logger in his investigation rather than a voltmeter.

Suggest **one** reason why.

_____

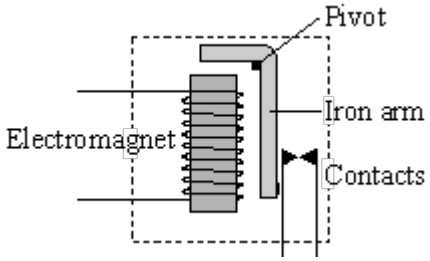
_____

(1)

(Total 6 marks)

Q10.

The diagram shows a switch that is operated by an electromagnet.

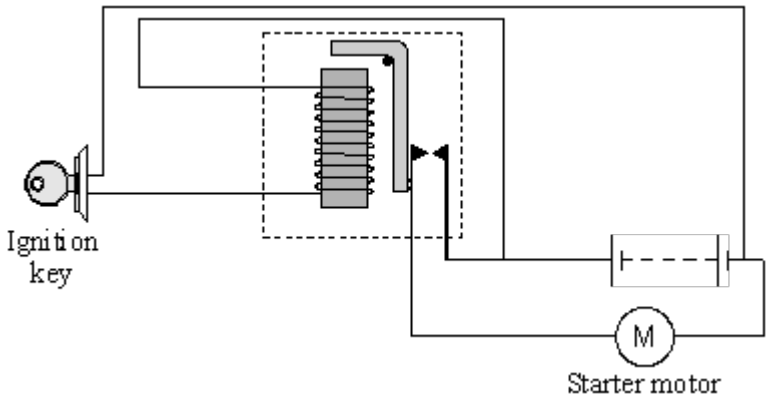


(i) What is this type of switch called?

_____

(1)

(ii) The switch is used in a car starter motor circuit.



Explain how turning the ignition key makes a current flow in the starter motor. The explanation has been started for you.

When the ignition key is turned _____

_____

_____

_____

_____

(3)

(Total 4 marks)

Q11.

(a) Name a material that could be used to make the outside case of the plug.

_____

Give a reason for your choice.

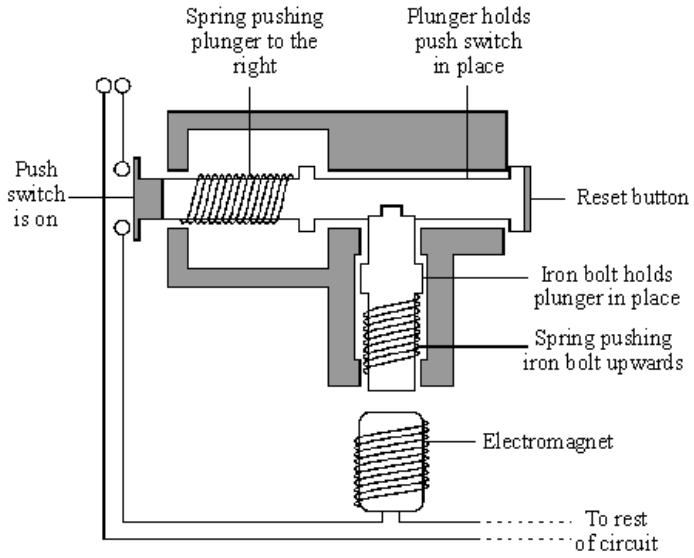
_____

_____

(2)

(b) *To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

Some electrical circuits are protected by a circuit breaker. These switch the circuit off if a fault causes a larger than normal current to flow. The diagram shows one type of circuit breaker. A normal current (15 A) is flowing.



Explain what happens when a current larger than 15A flows. The answer has been started for you.

When the current goes above 15 A, the electromagnet becomes stronger and

_____

_____

_____

_____

_____

(3)

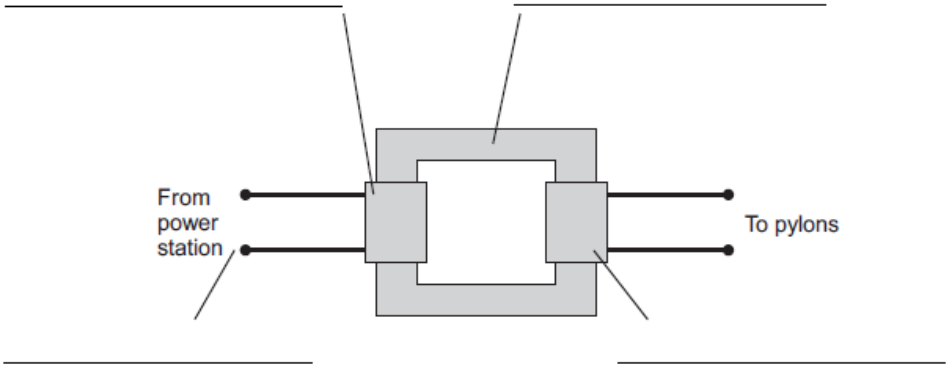
(Total 5 marks)

Q12.

Transformers are used to change potential differences (p.d.) in the National Grid.

Figure 1 shows a step-up transformer that is used at a power station.

Figure 1



(a) (i) Use words from the box to label **Figure 1**.

Input p.d.	**Iron core**	**Output p.d.**
Primary coil	**Secondary coil**	

(4)

(ii) One of the coils in **Figure 1** has a p.d. of 25 kV across it and has 1000 turns.

The other coil has a p.d. of 400 kV across it.

Calculate the number of turns on this other coil.

Number of turns = _____

(2)

(iii) Explain why a step-up transformer is used at a power station.

(3)

(b) **Figure 2** shows a mobile phone charger.

Figure 2

The charger contains a step-down transformer. A switch mode transformer is used rather than a traditional transformer.

Describe the advantages of using a switch mode transformer in the charger rather than a traditional transformer.

_____

_____

_____

_____

_____

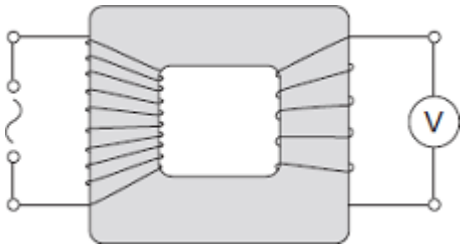
_____

(3)

(Total 12 marks)

Q13.

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.

_____

_____

_____

_____

_____

_____

_____

_____

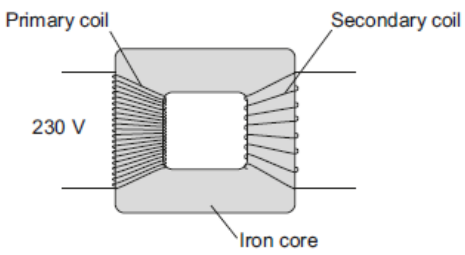
(4)

(Total 10 marks)

Q14.

Figure 1 shows the structure of a traditional transformer.

Figure 1



(a) There is an alternating current in the primary coil of the transformer.

State what is produced in the iron core.

_____

_____

(2)

(b) A transformer has only **one** turn of wire on the secondary coil.
The potential difference across the secondary coil is 11.5 V
The potential difference across the primary coil is 230 V

Calculate the number of turns on the primary coil.

_____

_____

_____

_____

Number of turns on the primary coil = _____

(2)

(c) In most transformers, the power output is less than the power input.

State why.

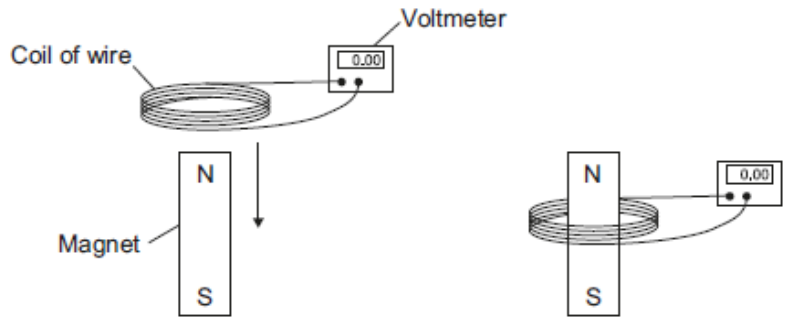
_____

_____

(1)

(d) Two students investigated how magnets can be used to produce a potential difference.
The students held a coil of wire above a magnet. The students quickly lowered the coil so that the magnet was inside the coil, as shown in **Figure 2**.

Figure 2



The students recorded the maximum potential difference for coils with different numbers of turns of wire. The results are shown in the table.

Number of turns of wire in the coil	**Maximum potential difference in volts**	
	Results from student 1	**Results from student 2**
5	0.09	0.08
10	0.20	0.15
15	0.31	0.25
20	0.39	0.33
25	0.51	0.39

(i) State the resolution of the voltmeter.

Give **one** reason why the resolution of the voltmeter is suitable for this investigation.

Resolution _____

Reason _____

_____

(2)

(ii) The two students used exactly the same equipment to carry out their investigations.
Both students recorded their results correctly.

Give the reason why student 2 got different results from student 1.

_____

_____

(1)

(iii) The students decided that even though the results were different, there was no need to repeat the investigation.

How do the results show that the investigation is reproducible?

_____

_____

(1)

(iv) State the name of the process which causes the potential difference to be produced in this investigation.

_____

(1)

(e) A transformer has been developed that can be used with many different devices.

Suggest **one** advantage of having a transformer that can be used with many different devices.

_____

_____

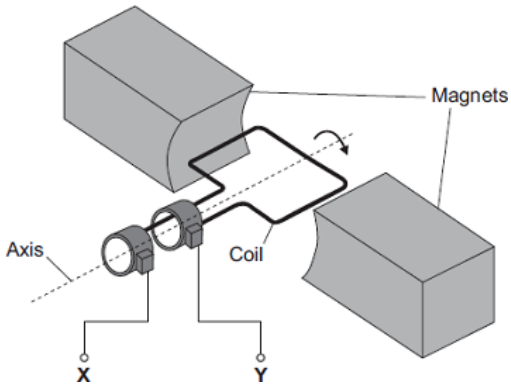
(1)

(Total 11 marks)

Q15.

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)

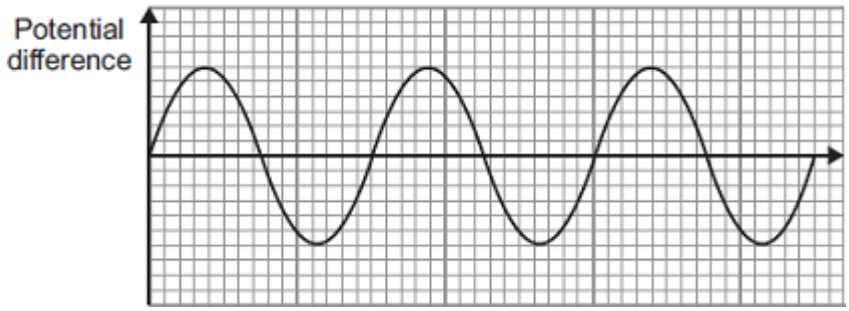
(iii) Name an instrument that could be used to measure the potential difference between **X** and **Y**.

_____

(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. _____

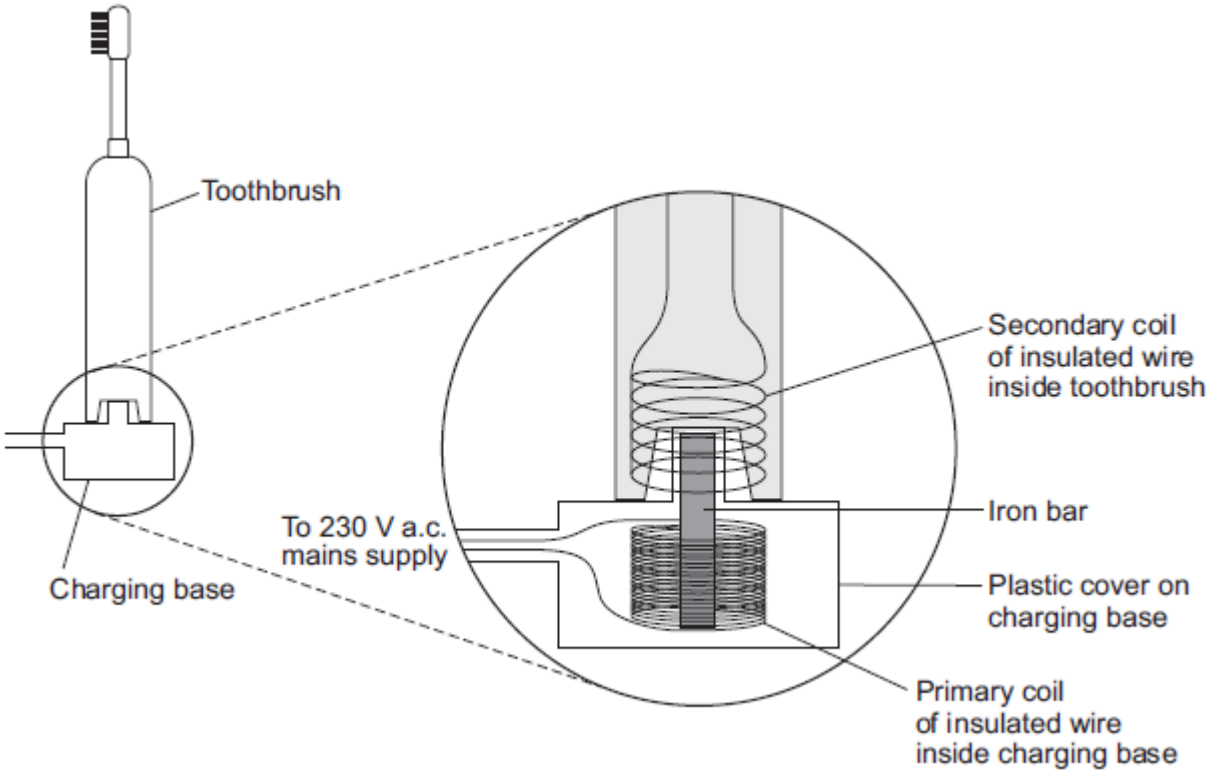
_____

(2)

(Total 8 marks)

Q16.

An electric toothbrush is charged by standing it on a separate charging base.
The diagram shows the inside of the electric toothbrush and the charging base.



(a) An alternating potential difference (p.d.) across the coil in the charging base creates an alternating current in the coil inside the toothbrush.

Explain how.

(3)

(b) When the toothbrush is being charged, the p.d. across the primary coil in the charging base is 230 V.

The charging p.d. across the secondary coil in the toothbrush is 7.2 V.

The primary coil in the charging base has 575 turns of wire on its coil.

Calculate the number of turns on the secondary coil inside the toothbrush.

Number of turns on the secondary coil = _____

(2)

(Total 5 marks)

Q17.

Waves may be either longitudinal or transverse.

(a) Describe the difference between a longitudinal and a transverse wave.

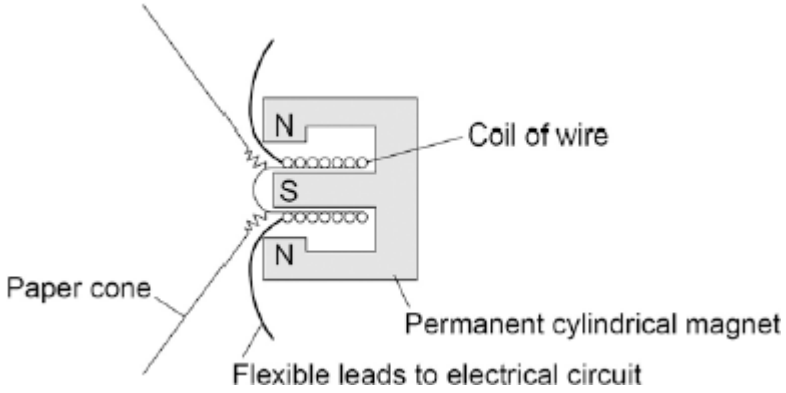
(2)

(b) Describe **one** piece of evidence that shows when a sound wave travels through the air it is the wave and not the air itself that travels.

(1)

(c) The figure below shows the parts of a moving-coil loudspeaker.

A coil of wire is positioned in the gap between the north and south poles of the cylindrical magnet.



Explain how the loudspeaker converts current in an electrical circuit to a sound wave.

(6)

(Total 9 marks)

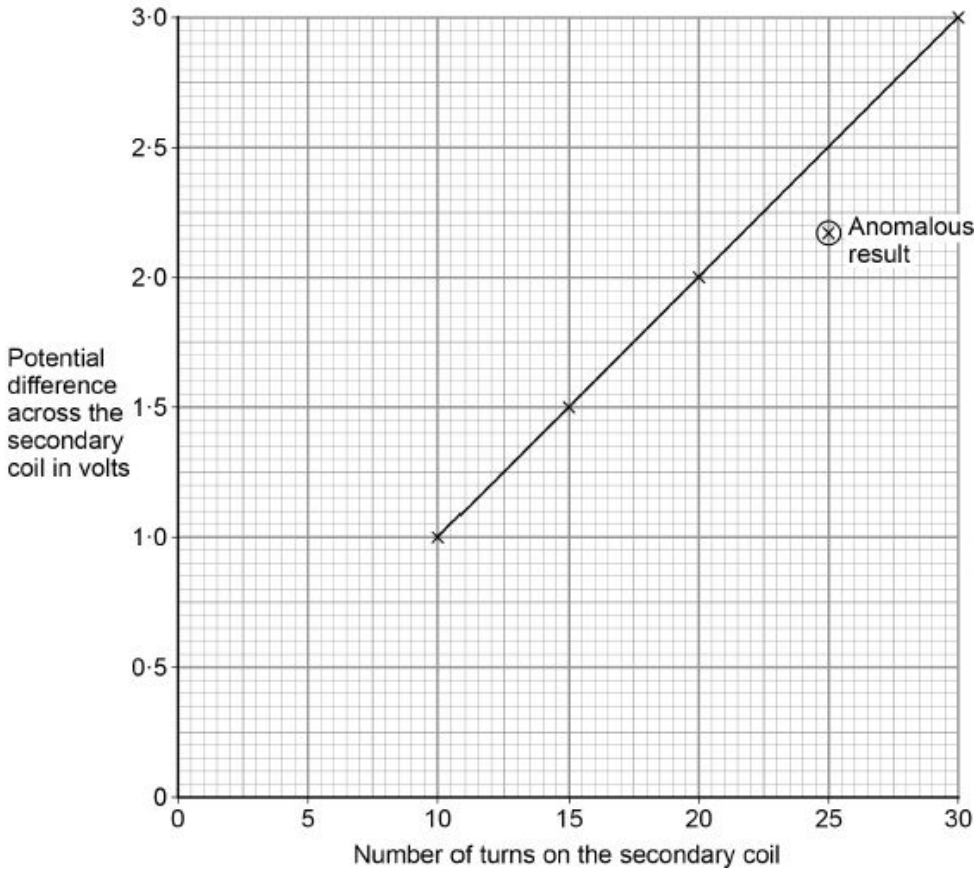
Q18.

A student used a simple transformer to investigate how the number of turns on the secondary coil affects the potential difference (p.d.) across the secondary coil.

The student kept the p.d. across the primary coil fixed at 2V.

Figure 1 shows the results collected by the student.

Figure 1



(a) **Figure 1** contains one anomalous result.

Suggest **one** possible reason why this anomalous result occurred.

_____

_____

(1)

(b) The transformer changes from being a step-down to a step-up transformer.

How can you tell from **Figure 1** that this happens?

_____

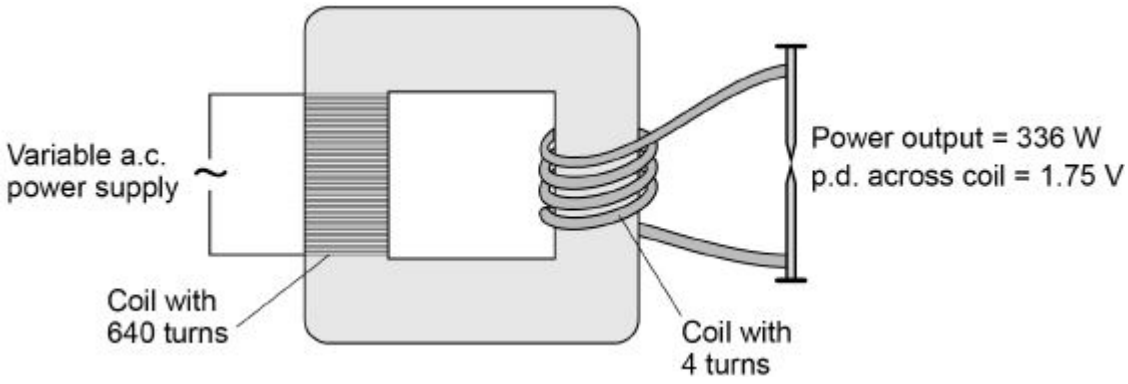
_____

(1)

A spot-welder is a device that uses a transformer to produce a large current to join sheets of metal together.

Figure 2 shows a transformer demonstrating how a large current can heat and join two nails together.

Figure 2



(c) How does the amount of infrared radiation emitted by the nails change when the power supply is switched on?

_____

_____

(1)

(d) Calculate the current from the power supply needed to provide a power output of 336 W.

Use the data in **Figure 2**.

The transformer is 100% efficient.

_____

_____

_____

_____

_____

_____

Current = _____ A

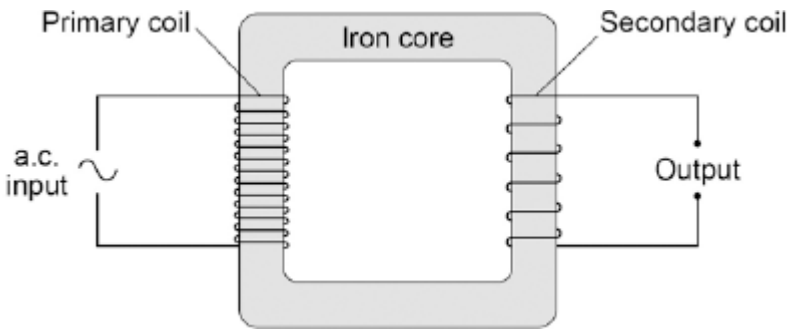
(5)

(Total 8 marks)

Q19.

Figure 1 shows the construction of a simple transformer.

Figure 1



(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. ☐

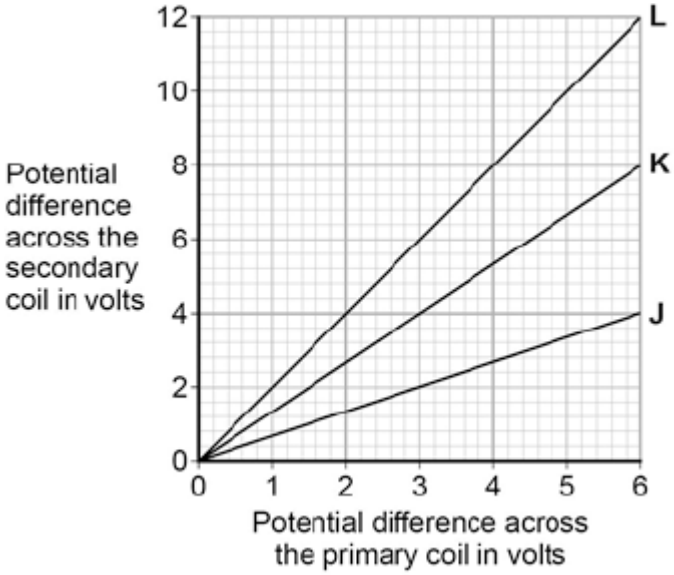
It is an electrical conductor. ☐

(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.

Figure 2



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)

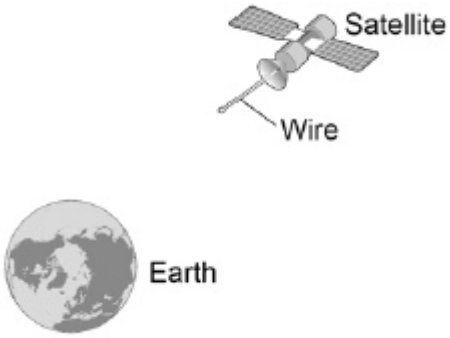
Q20.

Scientists have used a satellite system to investigate the idea of generating electricity in space.

As the system orbited the Earth a 20 km copper wire was reeled out.

Before the wire snapped a current of 1 amp was induced in the wire.

Figure 1



(a) What provides the force needed to keep a satellite in orbit around the Earth?

_____

(1)

(b) Explain how a current is induced in the wire.

_____

_____

_____

_____

_____

_____

_____

_____

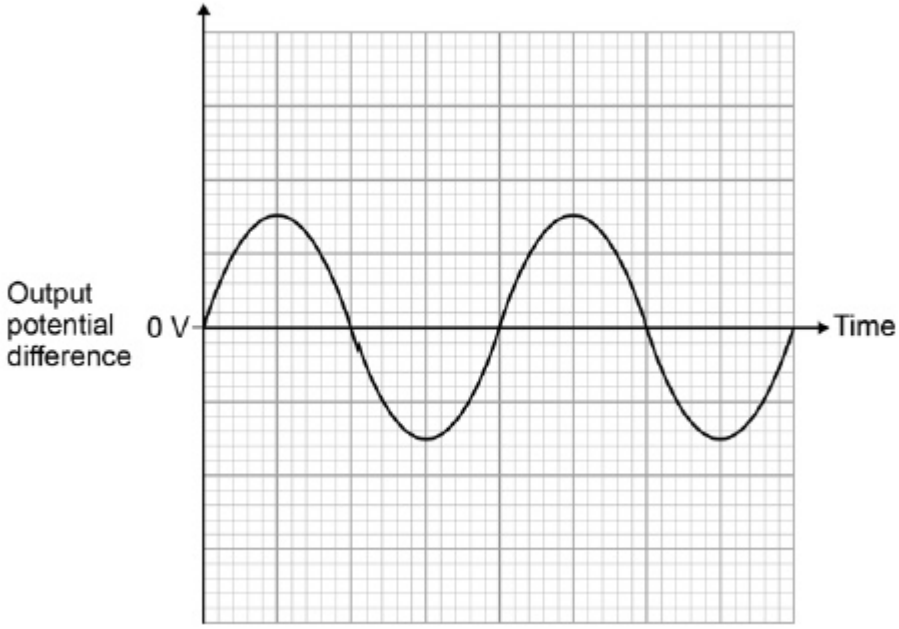
(3)

An alternator is connected to a data logger.

The data logger is connected to a computer.

Figure 2 shows how the output potential difference of the alternator varies with time.

Figure 2



(c) The coil inside the alternator now rotates at twice the frequency.

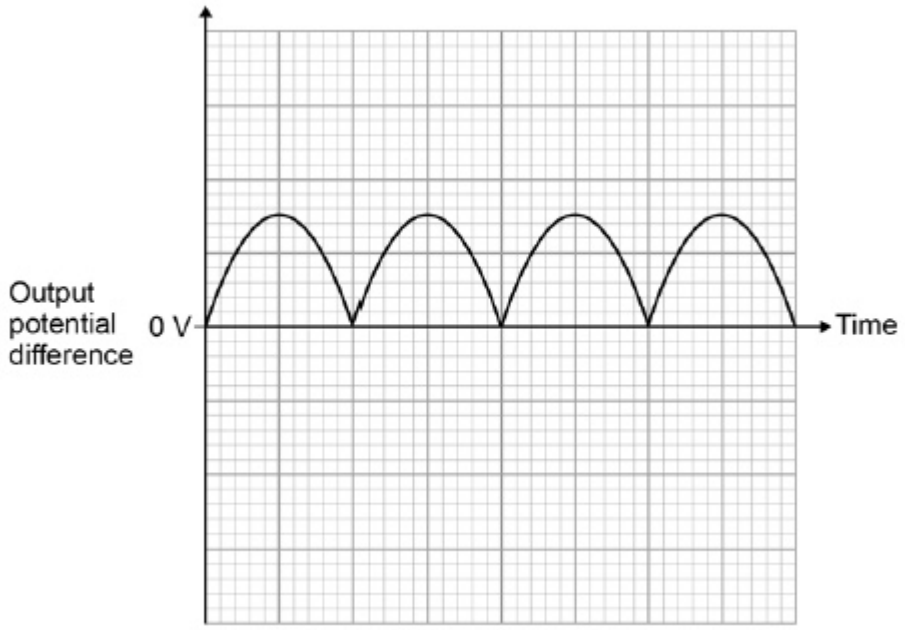
Draw on **Figure 2** to show how the output potential difference varies with time at this new frequency.

(2)

Another type of generator is now connected to the data logger and computer.

Figure 3 shows how the output potential difference varies with time for this generator.

Figure 3



(d) What name is given to this second type of generator?

_____

(1)

(e) Look at **Figure 2** and **Figure 3**.

Give one difference between the outputs from the two types of generator.

_____

_____

_____

(1)

(f) The charger used to charge the battery inside a laptop computer contains a small transformer.

The charger plugs into the mains electricity supply.

mains electricity supply = 230 V

number of turns on the primary coil of the transformer = 690

number of turns on the secondary coil of the transformer = 57

Calculate the potential difference applied by the charger across the battery inside the computer.

_____

_____

_____

_____

_____

_____

Potential difference = _____ V

(3)

(Total 11 marks)

Q1.

(a) iron

correct positions only

1

primary

1

secondary

1

(b) (it) 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]

Q2.

(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]

Q3.

(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]

Q4.

(a) (i) Iron

1

(ii) 50

ignore references to current

reason only scores if 50 chosen

1

there are more turns on the secondary coil (than the primary coil)

accept it is a step-up transformer

not more coils

1

(b) (i) 200

1

(ii) any **one** from:

- Lighter
- smaller

- use very little power / current (when switched on with no load / phone attached).

  accept more efficient

  do not accept uses no power / current

  a disadvantage of a traditional transformer is insufficient on its own

1

[5]

Q5.

(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]

Q6.

(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 ÷ 40

2

V / volt(s)

1

[5]

Q7.

electromagnet becomes stronger (*not* becomes magnetic) iron moves left – implied OK
plunger goes up push switch goes to off or circuit broken unless plunger moves down

for 1 mark each

[4]

Q8.

(a) current flows
coil / core magnetised / electromagnet activated / energised / turned on
attracts iron bar causing bolt to be pulled out

each for 1 mark

4

(b) more turns
bigger current / e.m.f
softer iron core

any two for 1 mark each

2

(c) to relock door / return iron bar / to lock door

for 1 mark

1

(d) iron bar would still be attracted / coil still magnetised so still works

for 1 mark each

yes + wrong answer

0 marks

yes + current still flows

1 mark

yes + still magnetised / iron bar still attracted

2 marks

2

[9]

Q9.

(a) induced

1

(b) any **two** from:

- use the same (strength) magnet
  same size magnet is insufficient
- the speed that the magnet is moved
  accept movement of the magnet
- the area of the turns
  same type / length of wire is insufficient
- the magnetic pole being moved towards the coil (of wire).
  use the same voltmeter is insufficient

2

(c) (i) voltmeter misread
or
number of turns miscounted
result misread is insufficient
human error is insufficient
allow the magnet was moved at a (slightly) different speed (into the coil) than for the other readings
allow spacing between the turns had changed

1

(ii) line of best fit passing through all points except (100, 0.034)
line does not need to go back to origin

1

(d) any **one** from:

- can re-check data / readings.
  accept can go back to data
- can take more readings (in a given time)
  can store data is insufficient
- easier to identify maximum value.
  automatically records data is insufficient
  accept is more accurate
  accept eliminates human error

1

[6]

Q10.

(i) relay
accept solenoid
*do **not** accept magnetic switch*

1

(ii) a current flows through the coil (of the electromagnet)
or a current flows through the electromagnet
or a (magnetic) field is produced
accept 'electricity' for 'current'
*accept the electromagnet is activated **or** magnetised **or** turned on*
*do **not** accept answer in terms of magnetic charge*

1

the (iron) arm is attracted to the electromagnet

*accept the arm pivots **or** moves towards the electromagnet*

1

the contacts are pushed together

*do **not** accept contacts attract*

1

[4]

Q11.

(a) plastic or rubber

accept any named plastic
*do **not** accept wood*

1

it is a (good) insulator **or** it is a poor conductor

ignore mention of heat if in conjunction with electricity

1

(b) *The answer to this question requires ideas in good English in a sensible order with correct use of scientific terms. Quality of written communication should be considered in crediting points in the mark scheme.*

Maximum of 2 marks if ideas not well expressed.

pulls iron bolt down **or** attracts the iron bolt **or** moves bolt out of plunger

answers in terms of charges attracting
or repelling gain no credit

1

plunger pushed / moved to the right (by spring) **or** plunger released

1

push switch opens / goes to off / goes to right

accept circuit is broken

for maximum credit the points must follow a logical sequence

*3 correct points but incorrect sequence scores **2** marks only*

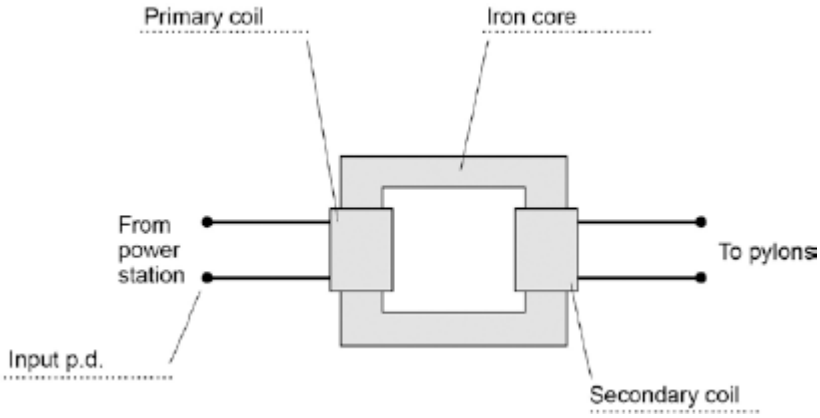
ignore reset action

1

[5]

Q12.

(a) (i)



1
1
1
1

(ii) 16 000

allow 1 mark for correct substitution

ie 400 ÷ 25 = n ÷ 1000

2

(iii) p.d. increased (by transformer at power station)

do not accept energy increased

1

so current decreases

1

this reduces energy / power loss (in cables)

allow heat for energy

allow increases the efficiency

*do **not** accept no energy losses*

1

(b) smaller / lighter

1

uses little power / energy

1

when left switched on with no load applied

dependent on second marking point

1

[12]

Q13.

(a) step-down

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]

Q14.

(a) a magnetic field

accept electromagnetic field
heat is insufficient

1

that is alternating / changing

1

(b) 20

*allow **1** mark for correct substitution, ie*

$$\frac{230}{11.5}$$

provided no subsequent step

2

(c) (most) transformers are not 100% efficient

allow energy / power is lost to the surroundings
allow energy / power is lost as heat / sound
power is lost is insufficient

1

(d) (i) 0.01 (V)

1

because there is a change in p.d. each time (the number of turns changes)

allow because all the results (to 2 decimal places) are different

accept if results were to 1 decimal place, there might not be a difference

1

(ii) student 2 moved the coil more slowly (than student 1)

accept student 2 moved the coil at a different speed to student 1

do not accept student 2 moved the coil faster (than student 1)

1

(iii) both sets of results show the same pattern

accept trend for pattern

results are similar is insufficient

results follow a pattern is insufficient

1

(iv) (electromagnetic) induction

accept it is induced

do not accept electric / magnetic induction

1

(e) any **one** from:

- more economical / cheaper for the consumer

  allow more convenient

- easier/cheaper to replace if broken/lost

  allow in case one gets lost

- since fewer transformers need to be made less resources are used

  allow fewer plug sockets are needed

  allow fewer transformers are needed

  environmentally friendly is insufficient

1

[11]

Q15.

(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]

Q16.

(a) an alternating current through the primary coil (in the charging base)

it must be clear which coil is being referred to

1

causes a changing / alternating magnetic field in / around the (iron) bar

1

which induces an (alternating) p.d. across the secondary coil (in the toothbrush)

accept induces an (alternating) current in the secondary coil

1

(b) 18

*allow **1** mark for correct substitution, ie*

$$\frac{230}{7.2} = \frac{575}{n_s}$$

2

[5]

Q17.

(a) in a longitudinal wave the oscillations / vibrations are parallel to the direction of energy transfer.

accept wave travel for energy transfer throughout

1

in a transverse wave the oscillations / vibrations are perpendicular to the direction of energy transfer.

1

(b) accept any sensible suggestion eg a vibrating drum skin does not move the air away to create a vacuum (around the drum)

1

(c) **Level 3 (5–6 marks):**
A detailed explanation linking variations in current to the pressure variations of a sound wave, with a logical sequence.

Level 2 (3–4 marks):
A number of relevant points made, but not precisely. A link between the loudspeaker and
a sound wave is made.

Level 1 (1–2 marks):
Some relevant points but fragmented with no logical structure.

0 marks:
No relevant content.

Indicative content

the current in the electrical circuit is varying

the current passes through the coil

the coil experiences a force (inwards or outwards)

reversing the current reverses the force

the size of the current affects the size of the force

the varying current causes the coil to vibrate

the (vibrating) coil causes the cone to vibrate

the vibrating cone causes the air molecules to move

the movement of the air molecules produces the pressure variations in the air needed for
a sound wave

the air molecules bunch together forming compressions and spread apart forming rarefactions

6

[9]

Q18.

(a) any **one** from:

- too few turns / coils on the secondary

  allow number of turns / coils on the primary was increased

- p.d. across the primary was reduced

  ignore human error

1

(b) the p.d. (across the secondary) goes above 2V

allow p.d. across secondary is higher than p.d. across primary after 20 turns

1

(c) it increases (until the nails reach a constant temperature)

1

(d) $\frac{640}{4} = \frac{V_p}{1.75}$

1

$V_p = \frac{640 \times 1.75}{4}$

1

V_p = 280 (V)

1

280 × I_p = 336

allow their calculated
$V_p \times I_p = 336$

1

I_p = 1.2 (A)

allow an answer that is consistent with their calculated value of V_p

1

or

336 = I_s × 1.75 (1)

$I_s = \frac{336}{1.75}$ (1)

I_s = 192 (A) (1)

$I_p = 192 \times \frac{4}{640}$ (1)

allow

I_p = their calculated $I_s \times \frac{4}{640}$

I_p = 1.2 (A) (1)

allow an answer that is consistent with their calculated value of I_s

*an answer of 1.2 (A) scores **5** marks*

[8]

Q19.

(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 $\frac{V_p}{V_s} = \frac{6}{12}$

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]

Q20.

(a) gravity

1

(b) as the wire moves through the Earth's magnetic field

1

a potential difference is induced between the ends of the wire

1

the wire must be part of a complete circuit

1

(c) new trace shows:

twice the frequency

1

twice the amplitude

1

(d) dynamo

dc generator is insufficient

1

(e) the alternator pd changes polarity, the 2nd type of generator does not

1

(f) $\frac{230}{V_s} = \frac{690}{57}$

1

$V_s = \frac{230 \times 57}{690}$

1

$V_s = 19$ (V)

*an answer of 19 (V) scores **3** marks*

1

[11]

Q1.

(a) The vast majority of candidates gained all three marks by correctly labelling the transformer.

(b) Most candidates gained the mark. Of the remainder, common errors were confusion between current and p.d. or examiners were presented with a list.

(c) Almost all the candidates gained the mark here.

Q2.

(a) A third of candidates gained the mark by recognising the correct transformer.

(b) A third of candidates knew that a.c. stands for alternating current.

(c) (i) Most candidates recognised that when a current flows in a coil, the coil becomes a magnet.

(ii) Two thirds of candidates gained both marks by recognising that the coil attracts the iron bolt which moves upwards.

Q3.

(a) This question was quite well done, with some almost 'text-book' answers. Although only a small minority scored all six marks, around three-quarters of students scored at least two marks, usually for mentioning the 'magnetic field' and the 'current produced'. There were, however, a small number of confused answers relating to the motor effect. Having answered the question, a significant number of students went on to explain what would happen if the magnet were withdrawn / moved faster / moved slower etc.

(b) Half of the students scored at least two of the four marks. A common mistake was not relating the actions to the original movement of the magnet, so that comparisons of size and direction of current were not made.

(c) This was answered well, with nearly all students achieving both marks for the calculation, and nearly two-thirds scoring the mark for the correct unit.

Q4.

(a) (i) Just over three quarters of the students scored this mark.

(ii) More than half of the students chose the correct voltage. Only one third of students scored the second mark for giving a correct reason. Common errors included students stating that there were more coils on the secondary coil, rather than there being more turns on the secondary coil; and students multiplying the number of turns on the primary coil by the potential difference across the primary coil to come up with 50 V.

(b) (i) Just under half of the students scored this mark.

(ii) Many students suggested that an advantage of a switch mode transformer was that you could switch it on or off, or you could switch it to a different

frequency. Only a quarter of the students scored this mark.

Q5.

(a) This calculation was completed correctly by three quarters of candidates. Those who did not have the correct calculation frequently did not show a full substitution into the equation and so lost the compensatory mark.

(b) Considering how many times this question has been asked, the answers given were poor. Most responses were in terms of electrocution and energy loss.

(c) (i) Most candidates scored this mark although 'copper' was a fairly common incorrect response.

(ii) Fewer candidates knew why iron is used, with many responses given in terms of electrical conduction.

Q6.

(a) Just over half of the candidates gave a correct answer. Many candidates still seem to think that iron is used because it is a good electrical conductor.

(b) A large number of candidates thought the wire was insulated to stop energy losses or for safety purposes. Incorrect answers also showed many candidates think that potential difference flows. Only just over a third of candidates were able to give an acceptable answer.

(c) Nearly half of the candidates scored full marks. Those candidates who struggled either did not know which coil was the primary and which was the secondary, or were unable to rearrange the equation.
A significant number of candidates did not know that the unit for p.d. is the volt.

Q7.

The weaker candidates found difficulty in gaining marks, their writing was not coherent and lacking in relevant detail. Of the more able candidates a surprisingly large number had clearly studied the diagram, worked out how it worked and then offered reasonably precise answers to gain three or four of the marks.

Q9.

(a) Only just over one third of the students scored this mark.

(b) A small minority of the students scored both marks but just over half of the students scored one mark. Many students suggested changes in material or thickness of the wire. It was also common to see students controlling the size of the magnet, but not the strength of it. A fair proportion of students' answers suggested that using the same voltmeter should be a control variable. Some students did not appreciate that the number of turns on the coil was the independent variable, despite this being clearly stated in the question.

(c) (i) Nearly one third of the students scored this mark. Many students did not give enough detail in their answer, referring to human error but not stating what that human error was. A number of students did not read the question properly and either gave a definition of the term anomaly or indicated which the anomalous point was.

(ii) This question was generally answered well, with most of the students drawing the line well. A larger proportion of students did not attempt this question compared to questions which involved ticking a box or writing on a line, suggesting that these students did not read the question.

(d) Just under two thirds of the students scored the mark, with the majority of the correct answers mentioning the improved accuracy of using a data-logger in this situation. A fair number of students suggested that a data logger would eliminate anomalies, failing to realise that anomalies in this investigation could be caused by a change in speed of the movement of the magnet as well as human errors in mis-reading the voltmeter or miscounting the coils.

Q10.

Foundation Tier

This question was poorly answered. In this question few could name the switch or explain the operation of a relay in the car starter motor circuit. Common errors included the belief that the electromagnet became 'charged' or that a current would flow from the coil to the iron arm and subsequently into the motor.

Higher Tier

In part (i) many candidates were unable to name the switch as a relay. In part (ii) many candidates were able to explain the process by which the car starter ignition system worked, although the precision of the answers was sometimes poor. A significant minority of candidates seemed to think that the iron arm would conduct electricity into the motor circuit.

Q11.

Foundation Tier

The responses in part (a) was mostly worthy of credit.

(b) There were abundant clues in both the stem of the question and the labels on the diagram to start candidates on the correct sequence. However, rather too many candidates started their answers with the iron bolt moving upwards with the result that they were unable to logically explain the working of the circuit breaker.

Higher Tier

This question was particularly well answered by most candidates.

(a) Most candidates gained both marks in this part but some gave heat insulation and failed to mention electrical insulation.

(b) There were some excellent answers to this part but a minority of candidates were unable to explain how this type of circuit breaker works.

Q12.

(a) (i) Nearly all of students were able to label the parts of the transformer correctly, thus scoring four marks. Of the remainder, there was a fairly even split between three, two and one mark, with very few failing to score a mark.

(ii) More than four-fifths of students used the correct equation and were confident

in the manipulation of the data thus achieving the correct answer. The most common error was incorrect re-arrangement of the equation after correct substitution. There were some students who failed to score marks by mis-copying data, eg substituting 100 instead of 1000.

(iii) Some good answers, giving full and complete explanations, were seen, enabling around two-fifths of students to gain all three marks. A further two-fifths were able to pick up one or two marks, the most common omission being the reduction in the current. Some spoilt an otherwise good response by talking of 'wasting electricity' rather than energy.

(b) Whilst very many were aware of the convenience offered by the switch mode transformer, answering in terms of it being lighter and / or smaller than a traditional transformer, fewer answered in terms of its power use. Although some knew that it uses less power very few allied this advantage to the situation where it is left switched on even though no load is applied. Consequently, around half of students scored one mark. Of the remaining students, quite a number suggested that the transformer was needed to convert ac to dc.

Q13.

(a) Most students recognised the transformer illustrated as being a step-down transformer.

(b) (i) Most students were able to complete a table with values of potential difference from the input and output of the transformer.

(ii) Most students knew that the values of potential difference produced by the National Grid were larger than those given in the question.

(c) (i) Only half of the students gave an adequate description of the difference between a.c and d.c., for example, 'a.c. flows in two directions whereas d.c. only flows in one direction'. A quarter of students scored zero. Their explanations often used 'ways' instead of 'directions' and referred to 'positive' and 'negative'.

(ii) The explanation of how a transformer works was poorly answered with more than a third of students scoring zero out of four.

Many answers only referred to the number of turns on each coil. Very few students mentioned the changing magnetic field in the primary coil and others stated that there was a current in the core.

Q14.

Foundation

(a) Less than a quarter of students realised that a magnetic field was produced, whereas other students thought that a current or p.d. was produced in the iron core. It was not common for students to gain the mark for realising that the magnetic field produced would be changing.

(b) This calculation was handled well by students, with just under three quarters gaining both marks.

(c) Many students confused the loss of power with it being a step-down transformer. The most common way of students gaining the mark was for noting that energy is

transferred by heating. Just under one fifth of students answered correctly.

(d) (i) Few students were able to correctly identify the resolution, although many more students were along the right lines, with an answer of 2 decimal places occurring regularly. The reason for this being appropriate was less well answered with many students answering how they knew that this was the resolution, rather than answering the question of why this was a suitable resolution for this experiment. Just under a fifth of students gained marks on this question.

(ii) Just under one tenth of students correctly stated why the results were different.

(iii) Slightly more than a tenth of students answered this question correctly. Many students thought that a lack of anomalous results made the experiment reproducible, or just the fact that two students had carried out the experiment made it reproducible. Many students just quoted numbers given in the table.

(iv) Induction was clearly something which students struggled with, and the question was only attempted by about two thirds of students. Only a few students knew the name of the process.

(e) Just over half of students were able to suggest an advantage of the transformer. It was not uncommon for those who got the question wrong to have just repeated the stem of the question.

Higher

(a) Approximately two thirds of students realised that a magnetic field was produced, whereas other students thought that a current or p.d. was produced in the iron core. Only about a quarter of students realised that the magnetic field produced would be changing.

(b) This calculation was handled well by students, with the vast majority gaining both marks.

(c) Many students confused the loss of power with it being a step-down transformer. The most common way of students gaining the mark was for noting that energy is transferred by heating. Just under four tenths of students answered correctly.

(d) (i) Many students struggled to identify the correct resolution, although some were along the right lines, with answers of 2 decimal places or 0.00 occurring regularly. The reason for it being appropriate was less well done with many students answering how they knew that this was the resolution, rather than answering the question of why this was a suitable resolution for this experiment. Less than half of students gained marks on this question.

(ii) About a third of students answered this question correctly. Many students stated that part of the equipment being used was different, despite the stem of the question clearly stating that the two students used exactly the same equipment.

(iii) Just over a third of students answered this question correctly. Many students thought that similar results made it reproducible, rather than there being a similar pattern in results.

(iv) Fewer than half the students stated the correct process.

(e) Over two thirds of students suggested a correct advantage. Unrewarded responses frequently just repeated the stem of the question.

Q16.

(a) Students often showed that they had a basic idea of the ideas involved in the operation of a transformer. They were, however, unable to put together a coherent explanation that included the necessary detail. Reference was usually made to currents and magnetic fields but it was not always appreciated that they needed to be 'alternating'. Many answers included basic errors, such as currents flowing in the iron bar, and it was rare to see references to voltages/ currents being induced in the secondary coil rather than 'created'. Answers often lacked clarity. It was, for example, not always possible to identify which coil was being referred to. Consequently, nearly half the students failed to score on this question. This question had the largest number of un-attempted responses in the exam paper.

(b) This calculation was answered well with four fifths of the students scoring full marks.

Q18.

(a) Many students had the correct idea, but imprecise detail such as 'wrong number of turns' or 'number of turns was miscounted' were insufficient to score the mark.

(b) Many students tried to answer the question from a general knowledge about transformers, rather than using information from the graph, and so did not gain credit.

(c) Most of the answers were correct. A very small number of students wrote 'hotter' but made no reference to infrared or thought it was just a temperature increase.

(d) This question involved a two stage calculation, a new feature of the examination. Nearly 33 % of students knew the equations to use and how to use them, scoring all five marks. A further 35% of students correctly used one equation to give a partially correct answer, scoring three marks.