PEARSON EDEXCEL IGCSE PHYSICS · 4PH1

PHYSICS



EXAM QUESTION PACK

SECTION 6: MAGNETISM AND ELECTROMAGNETISM (PACK 2)

SCORE	PERCENTAGE
/189	%

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Q1.

Diagram 1 shows a loop of wire connected to a power supply.

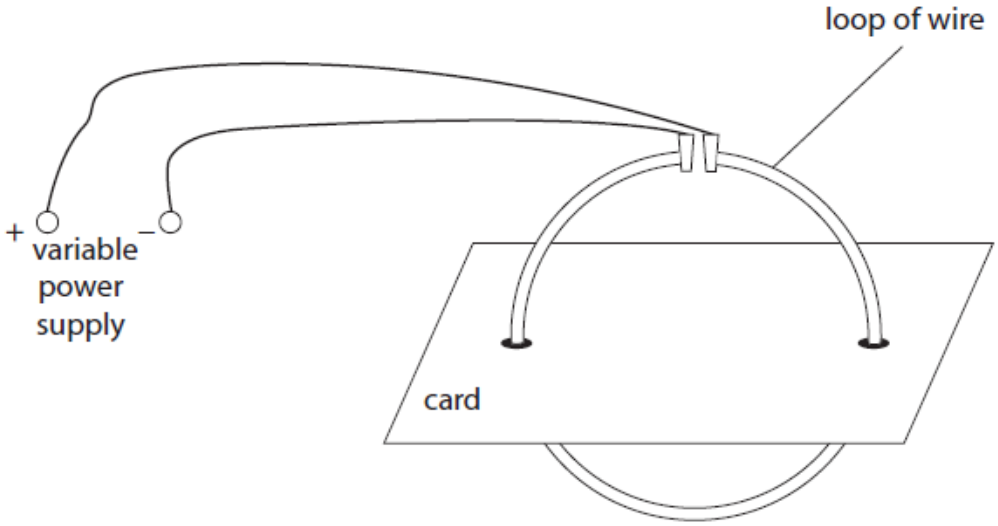


Diagram 1

(a) Describe how to find the shape of the magnetic field produced by the loop of wire.

(3)

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(b) Diagram 2 shows the view from above the card with two cross-sections of the loop of wire.

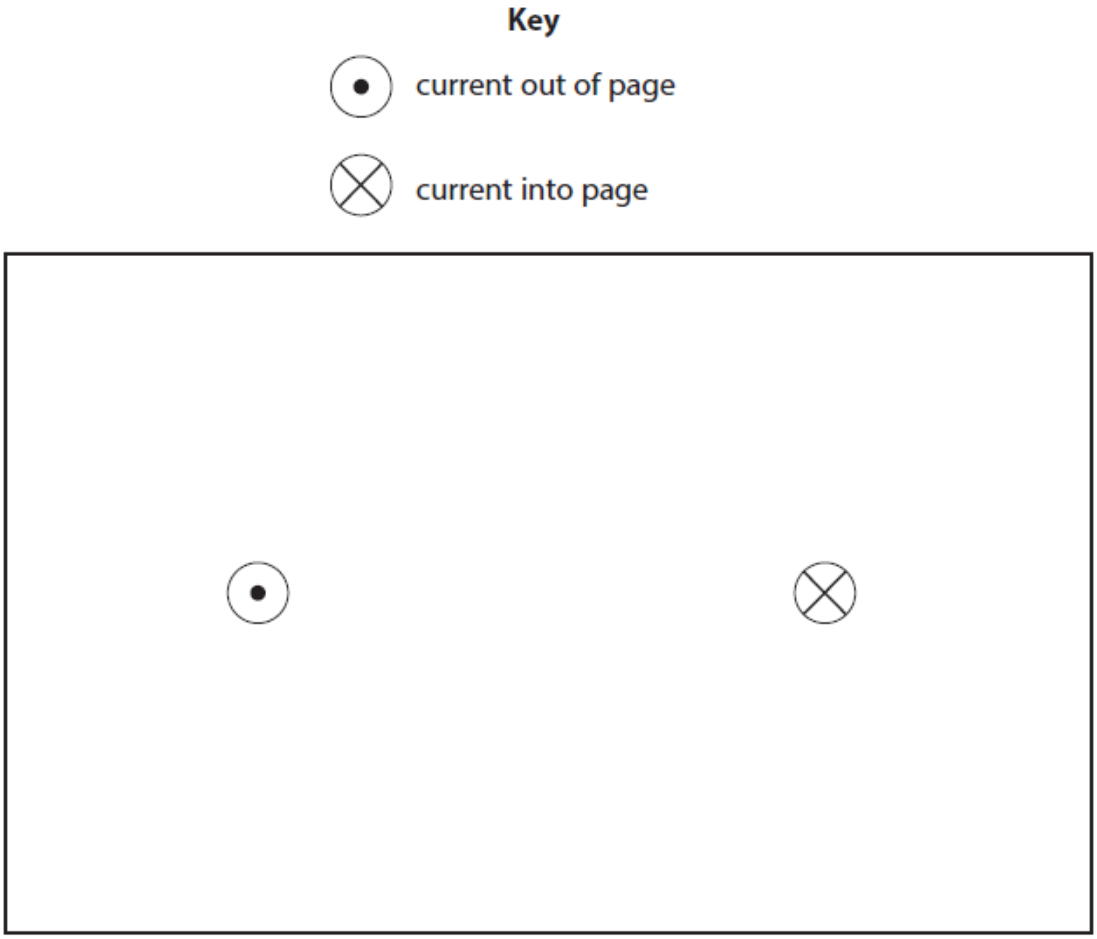
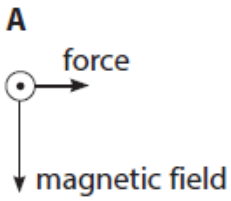


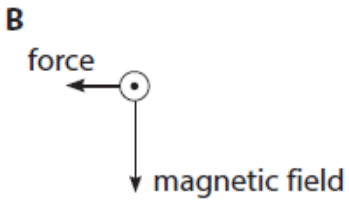
Diagram 2

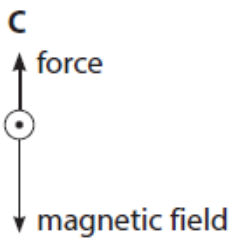
On diagram 2, draw the magnetic field produced by the two cross-sections of the loop of wire.

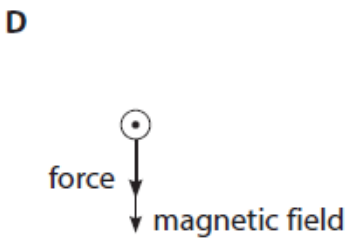
(4)

(c) (i) These diagrams show the magnetic field acting on a cross-section of wire when the current in the wire is out of the page.









Which diagram shows the correct direction of the force acting on the cross-section of wire due to the magnetic field?

(1)

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(ii) The magnetic field acting on the cross-section of wire is produced by the current in the other side of the loop of wire.

Explain why there is no effect on the direction of the force on the cross-section of wire when the direction of the current in the loop is reversed.

(2)

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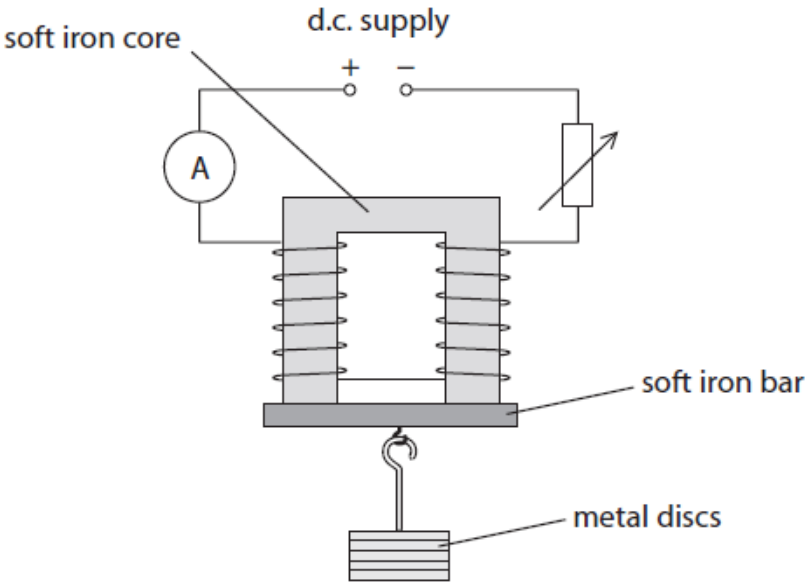
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(Total for question = 10 marks)

Q2.

A student investigates how the minimum current required to support a load using an electromagnet varies as the load is increased.

He uses metal discs to increase the load and changes the current using a variable resistor.



(a) (i) State the independent variable in this investigation.

(1)

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(ii) Give a reason for using a core and a bar made from soft iron.

(1)

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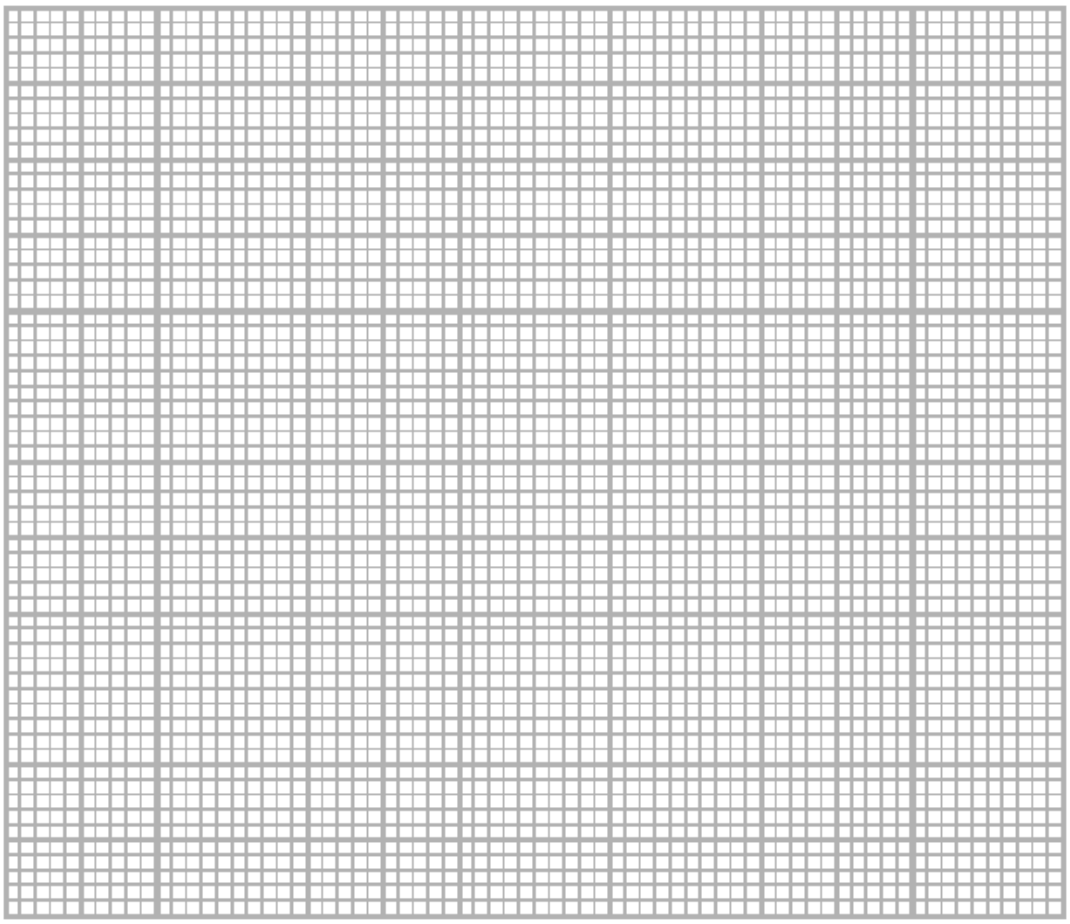
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(b) The student's results are given in the table.

Number of metal discs	Minimum current / mA
0	30
2	48
5	75
6	78
7	93
10	120

(i) On the grid, draw a bar chart of current against number of metal discs.

(4)



(ii) State why a current is needed when there are no metal discs added to the load.

(1)

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(iii) Explain how the student can improve his results.

(3)

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(Total for question = 10 marks)

Q3.

A racing car uses an engine and an electric motor to power its wheels.



(Source: Jens Mommens/Shutterstock)

(a) The electric motor can only operate at maximum power for part of each lap of the race.

The electric motor has a maximum power output of 1.2×10^5 W.

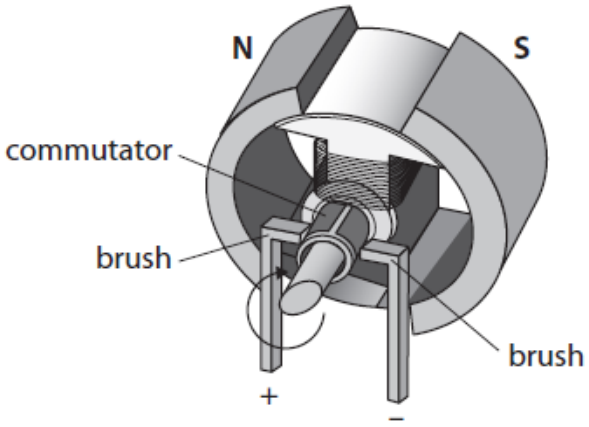
The electric motor transfers 4.0×10^6 J of energy when it operates at maximum power.

Calculate the amount of time the electric motor can operate at maximum power.

(3)

time = ... s

(b) The diagram shows a simplified view of a direct current (d.c.) electric motor.



(i) State what is meant by the term **direct current**.

(1)

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(ii) Explain the purpose of the brushes and the commutator in the d.c. motor.

(3)

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(c) The electric motor in the racing car can also be used as a generator to charge a battery pack. It is known as a motor generator unit (MGU).

The rotating wheels of the car cause the magnets in the MGU to spin near a coil of wire.

This induces a current in the coil when the coil is connected to the battery pack.

(i) Name the energy store of the battery pack that increases when the battery pack is being charged.

(1)

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(ii) Explain why the kinetic energy store of the car must decrease when the MGU charges the battery pack.

(3)

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(Total for question = 11 marks)

Q4.

This question is about electromagnetism.

(a) Diagram 1 shows the construction of an electromagnet.

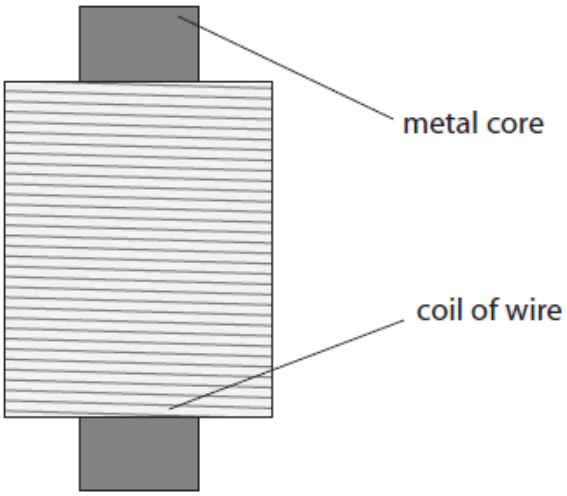


Diagram 1

(i) Name a suitable metal for the core.

(1)

.....

(ii) State what must be done to the coil of wire to produce a magnetic field.

(1)

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(b) Electromagnets are used in transformers to change the size of a voltage.

Diagram 2 shows the construction of a simple transformer.

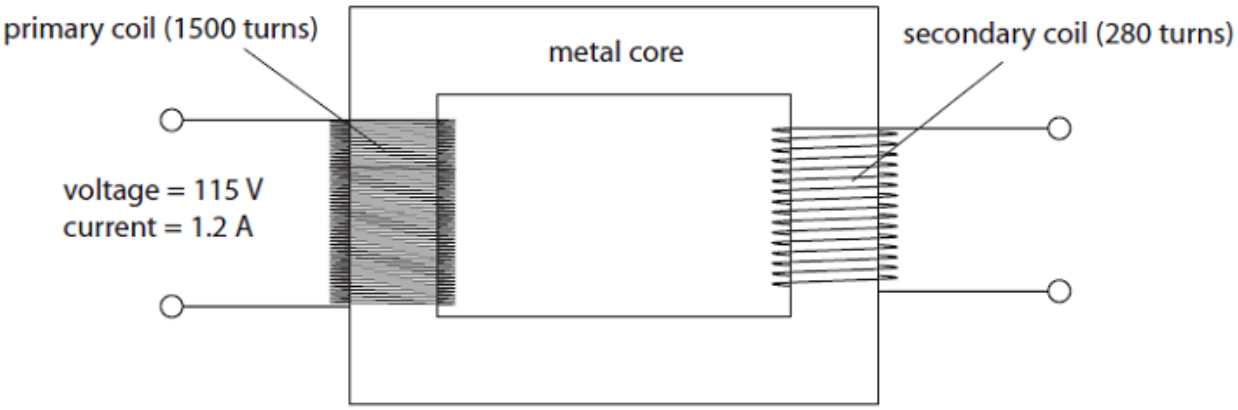


Diagram 2

(i) State the formula linking the input (primary) voltage, output (secondary) voltage and the turns ratio for a transformer.

(1)

(ii) The input voltage to the transformer is 115 V.

Show that the output voltage is approximately 20 V.

(3)

(iii) The input current to the transformer is 1.2 A.

Calculate the output current.

Assume that the transformer is 100% efficient.

(3)

output current = ... A

(iv) State two factors that would increase the output current of the transformer.

(2)

1 .....

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2 .....

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(Total for question = 11 marks)

Q5.

A student investigates a transformer.

This is the student's method.

- use a primary coil with 10 turns
- connect the primary coil to a constant maximum input voltage
- measure the output voltage across the secondary coil
- repeat using an increasing number of turns on the primary coil

The table shows the student's results.

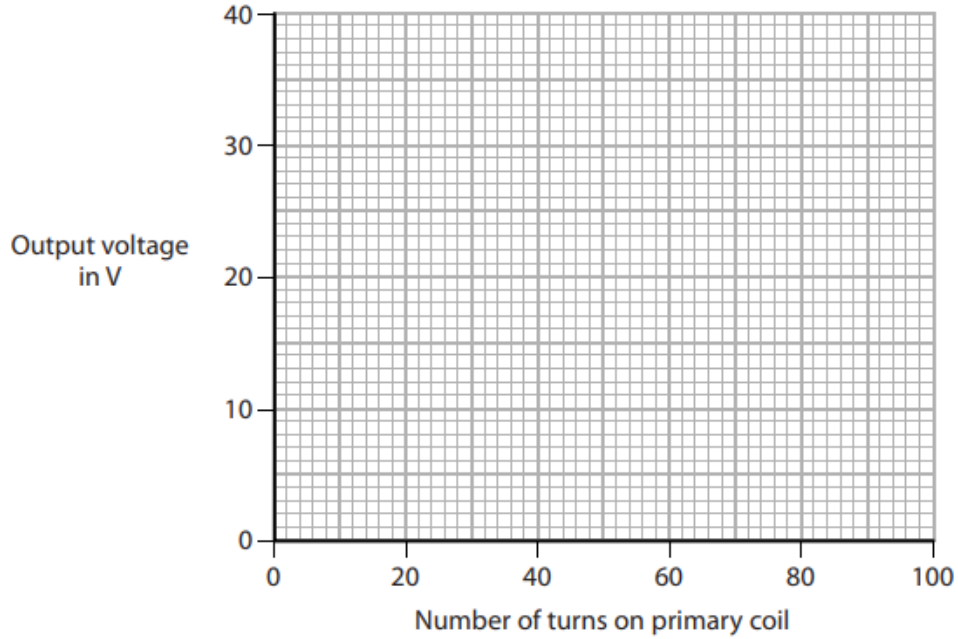
Number of turns on primary coil	Output voltage in V
10	39.6
20	19.7
40	9.9
60	6.6
80	5.0
100	4.0

(a) (i) Plot a graph of the student's results on the grid.

(1)

(ii) Draw a curve of best fit.

(1)



(iii) Describe the relationship between the output voltage and the number of turns on the

primary coil.

(2)

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(b) (i) State the formula linking input and output voltages and the turns ratio for the transformer.

(1)

(ii) The input voltage of the transformer is 6.8 V.

Calculate the number of turns on the secondary coil.

(2)

number of turns = ...

(Total for question = 7 marks)

Q6.

(a) A student investigates a sound wave with a frequency of 25 000 Hz.

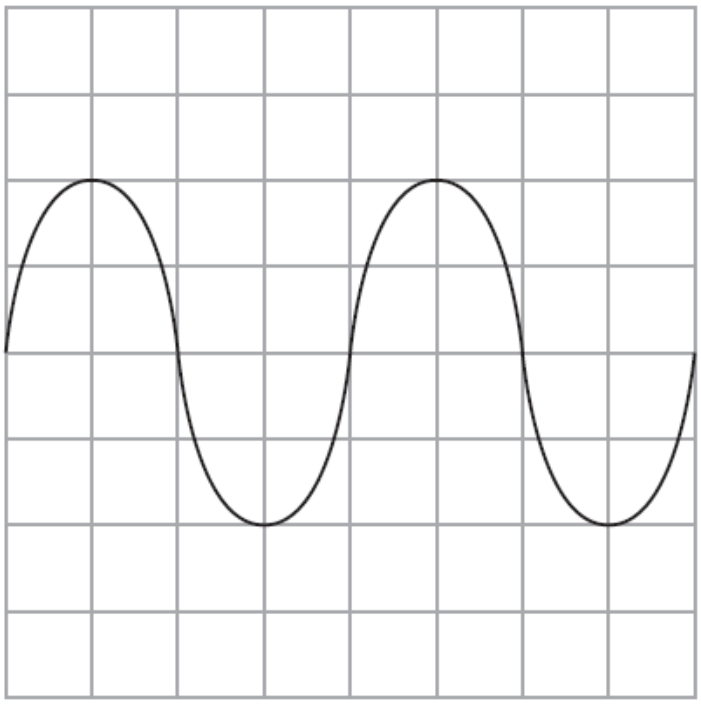
(i) Calculate the wavelength of this sound wave.

[speed of sound = 330 m/s]

(3)

wavelength = ... m

(ii) The oscilloscope trace represents the sound wave.



Oscilloscope settings

y direction: 1 square = 5 V

x direction: 1 square = 0.01 ms

Determine the amplitude of the oscilloscope trace.

(2)

amplitude = ... V

(b) (i) Diagram 1 shows a coil of wire wrapped around a cardboard tube.

The coil is fixed to the cardboard tube.

On diagram 1, draw field lines to represent the magnetic field produced when the current is in the direction shown.

(3)

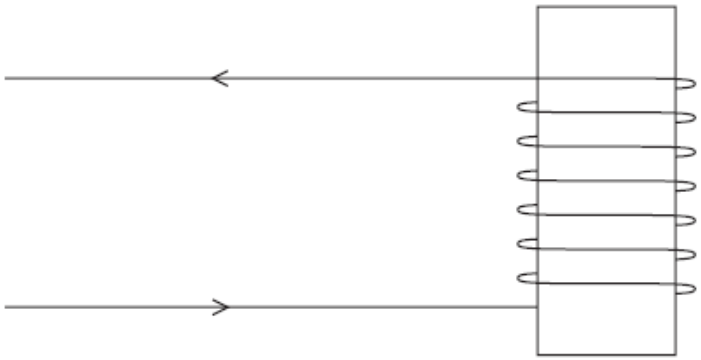


Diagram 1

(ii) Diagram 2 shows a model of a loudspeaker that uses the coil and the cardboard tube.

The cardboard tube is fixed to a thin piece of card, which is clamped at both ends.

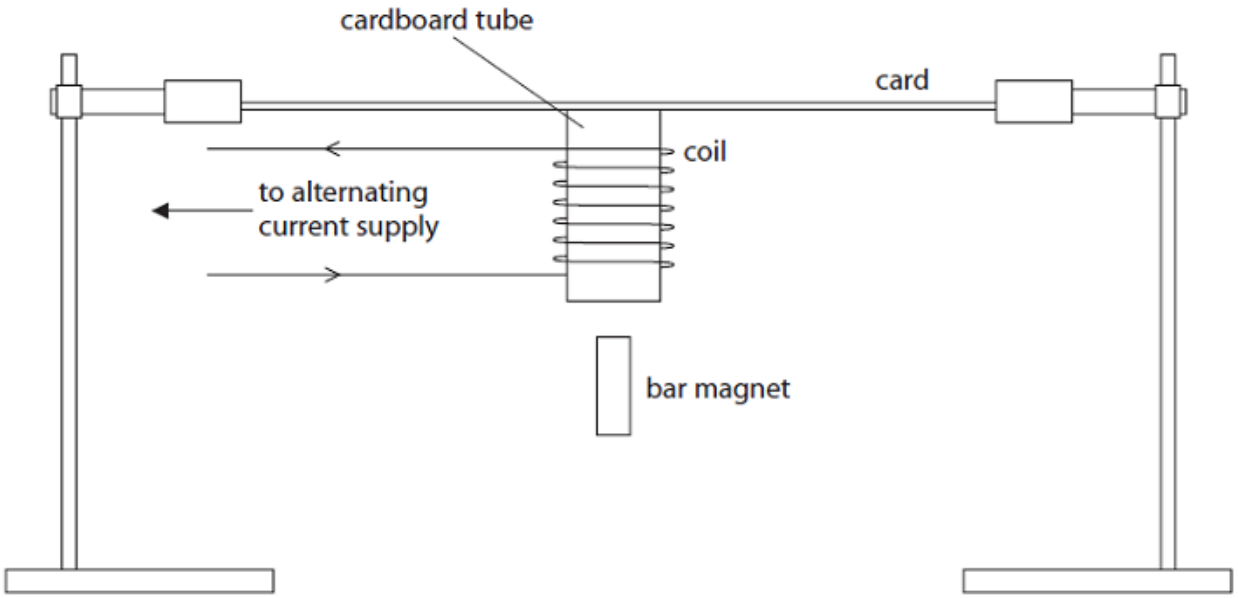


Diagram 2

The student holds a bar magnet near the bottom of the cardboard tube.

Explain why this causes the loudspeaker to produce a sound.

(3)

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(iii) When the frequency of the alternating current is 10 kHz, the student hears a sound.

The student increases the frequency of the alternating current to 25 kHz.

Explain why the student cannot hear a sound now, even though the card is still vibrating.

(2)

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(iv) Suggest a change to the apparatus that would increase the loudness of the sound when the frequency of the
alternating current is 10 kHz.

(1)

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(Total for question = 14 marks)

Q7.

A machine called the synchrocyclotron (SC) was designed to cause protons to move in a circular path using strong magnetic fields.

(a) The SC used electromagnets to produce the strong magnetic fields.

Describe the construction of a simple electromagnet.

You may draw a diagram to support your answer.

(3)

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(b) The diagram shows a proton moving at velocity v in the magnetic field produced by the SC.



The direction of the magnetic field is into the page.

Using the left hand rule, determine the direction of the force acting on the proton due to the magnetic field.

(1)

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(c) The SC is surrounded by very thick concrete walls.

The radiation produced by the SC created atoms of radioactive barium-133 in the concrete walls.

Barium-133 has a half-life of 10.5 years.

(i) State what is meant by the term **half-life**.

(2)

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(ii) In 1990, the SC stopped being used at CERN, a research centre.

In 1990, the largest number of barium-133 atoms were found 40 cm deep in the concrete walls.

Since 2014, members of the public have been allowed to visit the SC at CERN.

Explain why the radioactive barium-133 in the concrete walls is not a risk to people visiting the SC.

(2)

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(Total for question = 8 marks)

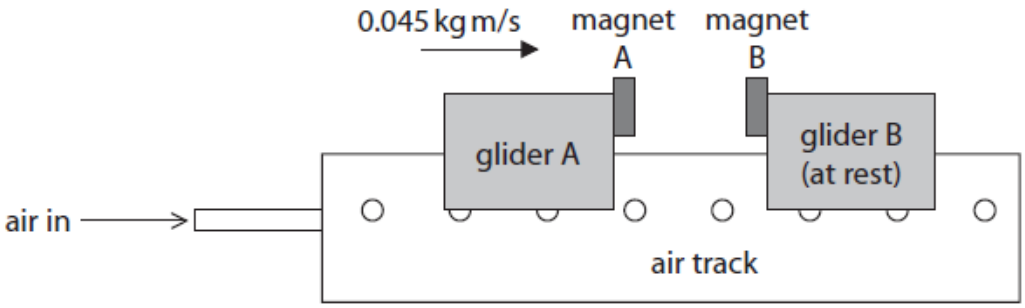
Q8.

The diagram shows an air track that can be used to investigate motion without friction.

Air comes out through a series of small holes in the air track, which lifts the gliders slightly above the track.

There are two gliders on the track.

Each glider has a magnet.



The poles of the magnets nearest each other are alike.

(a) Explain the direction of the force acting on magnet A from magnet B.

(2)

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(b) The gliders collide and the magnets cause them to rebound.

Before the collision, the momentum of glider A is 0.045 kg m/s to the right and glider B is at rest.

(i) State the total momentum of glider A and glider B after the collision.

(1)

total momentum = ... kg m/s

(ii) After the collision, the momentum of glider A is 0.021 kg m/s to the left.

Calculate the momentum of glider B after the collision.

(2)

momentum of glider B = ... kg m/s

(iii) The time taken for glider B to change its momentum is 0.19 seconds.

Calculate the average force on glider B that causes this change in momentum.

(2)

average force = ... N

(iv) Give the direction of the force on glider B from glider A.

(1)

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(Total for question = 8 marks)

Q9.

Magnetic Resonance Imaging (MRI) machines can take scans of the inside of a patient.

(a) There is an electromagnet inside the MRI machine.

Describe the construction of an electromagnet.

You may draw a diagram to help your answer.

(4)

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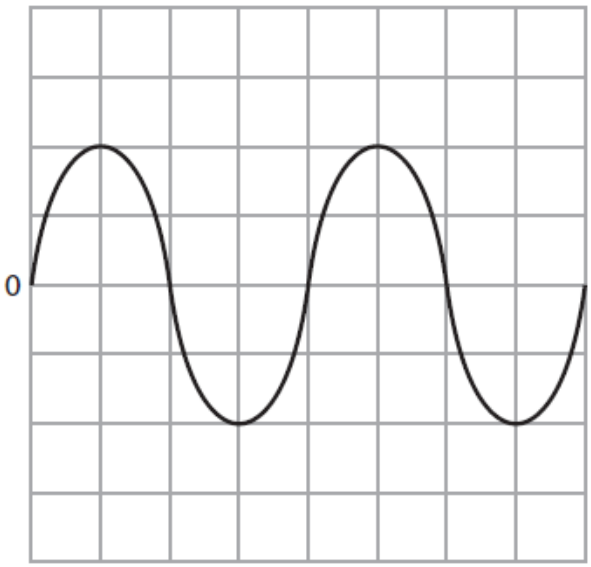
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(b) During the scan, music can be played through a loudspeaker to the patient.

The oscilloscope trace in the diagram represents a sound played to the patient.



Oscilloscope settings:

y direction: 1 square = 0.5 V

x direction: 1 square = 0.5 ms

(i) Determine the period of the sound wave.

(3)

period = ... s

(ii) Calculate the frequency of the sound wave.

(2)

frequency = ... Hz

(iii) Deduce whether humans can hear the sound wave.

(2)

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(iv) The current in the loudspeaker is alternating current (a.c.).

Give the evidence from the oscilloscope trace to support this statement.

(2)

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(v) Draw the circuit symbol for an a.c. power supply.

(1)

(Total for question = 14 marks)

Q10.

This question is about nuclear fusion.

(a) The incomplete nuclear equation shows the fusion of two isotopes of hydrogen.

$$^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + X$$

(i) Identify particle X in the nuclear equation.

(1)

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(ii) Each fusion reaction releases approximately 3×10^{-12} J of energy.

Estimate how many reactions are needed to produce 1 J of energy.

Give your answer to 1 significant figure.

(2)

number of reactions = ...

(iii) Explain why this fusion reaction will only happen at high temperature and high pressure.

(3)

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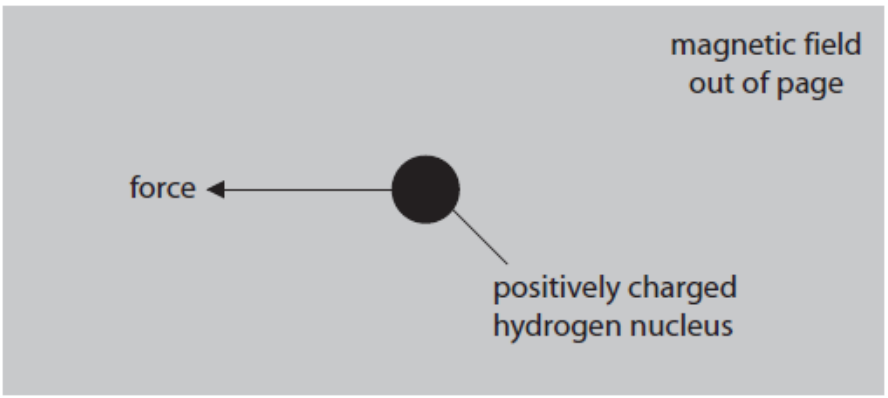
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(b) A tokamak is an experimental nuclear fusion reactor.

Strong magnetic fields are used to contain the reactants inside the tokamak.

(i) The diagram shows a positively charged hydrogen nucleus in a uniform magnetic field directed out of the page.



The nucleus experiences a force acting to the left because of the magnetic field.

Deduce how the nucleus must behave to experience this force.

(2)

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(ii) Suggest how engineers working on the tokamak could increase the force on the nucleus.

(1)

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(Total for question = 9 marks)

Q11.

This is a question about a nuclear fusion power station.

(a) Explain what happens during nuclear fusion.

(3)

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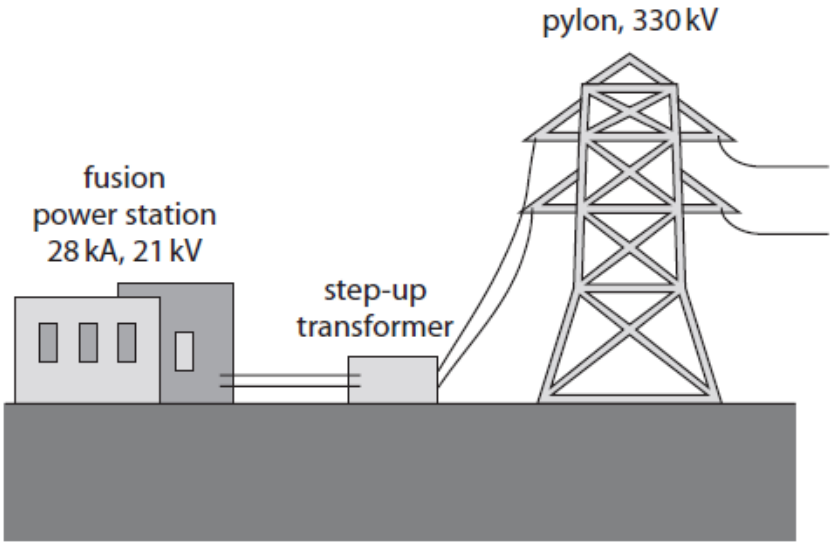
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(b) The diagram shows how a fusion power station could supply the National Grid in the future.



(i) State the main method of energy transfer from the fusion power station generator to the primary coil of the
step-up transformer.

(1)

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(ii) The fusion power station could supply the input coil of the step-up transformer with a current of 28 kA at a
voltage of 21 kV.

The output coil of the transformer has a voltage of 330 kV.

Assume the transformer is 100% efficient.

Calculate the current in the output coil of the transformer.

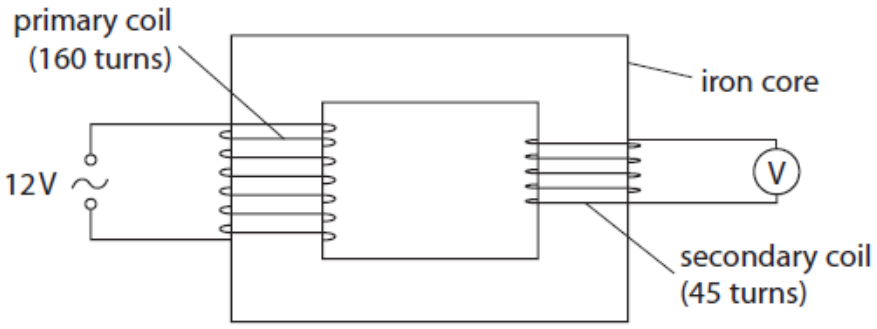
(3)

current = ... kA

(Total for question = 7 marks)

Q12.

The diagram shows a step-down transformer.



(a) Explain the operation of a step-down transformer.

(4)

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(b) (i) State the formula linking input voltage, output voltage and the turns ratio of a transformer.

(1)

(ii) Calculate the output voltage for the transformer.

(3)

voltage = ... V

(Total for question = 8 marks)

Q13.

The SPS is a particle accelerator in Geneva.

The SPS can accelerate sulfur particles to speeds almost as fast as the speed of light.

(a) Neutral sulfur particles can become positively charged sulfur particles.

Describe the difference between a neutral sulfur particle and a positively charged sulfur particle.

(2)

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(b) Diagram 1 shows a section of the SPS.

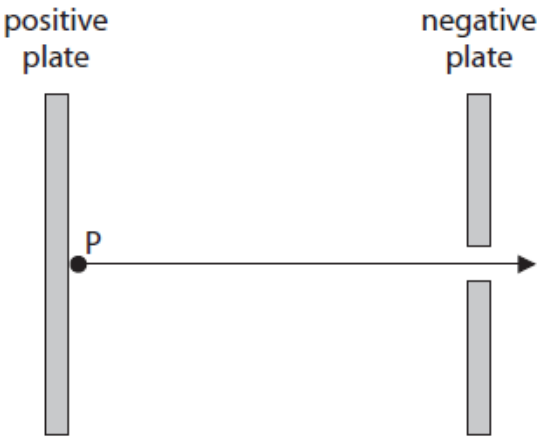


Diagram 1

Positively charged sulfur particles are introduced at point P and accelerate to the right.

Explain why the positively charged sulfur particles accelerate.

(2)

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(c) The sulfur particles enter a large tube and complete a circular orbit.

Diagram 2 shows a sulfur particle, travelling with velocity v, in the tube.

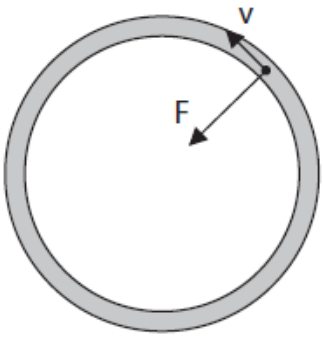


Diagram 2

(i) A magnetic force acts on the positively charged sulfur particle.

This force makes the particle travel in a circle.

The force is labelled F.

Use the left-hand rule to determine the direction of the applied magnetic field.

(1)

- ☒ **A** ↘ opposite to the direction of the velocity
- ☒ **B** ↙ along direction of force
- ☒ **C** ⊙ out of the page
- ☒ **D** ⊗ into the page

(ii) The tube has a radius of 1.1 km and the sulfur particle has an orbital speed of 2.9×10^8 m/s.

Calculate the orbital period of the sulfur particle.

(3)

orbital period = ... s

(Total for question = 8 marks)

Q14.

This question is about magnetic fields.

(a) Diagram 1 shows a positively charged proton moving downwards in a uniform magnetic field.

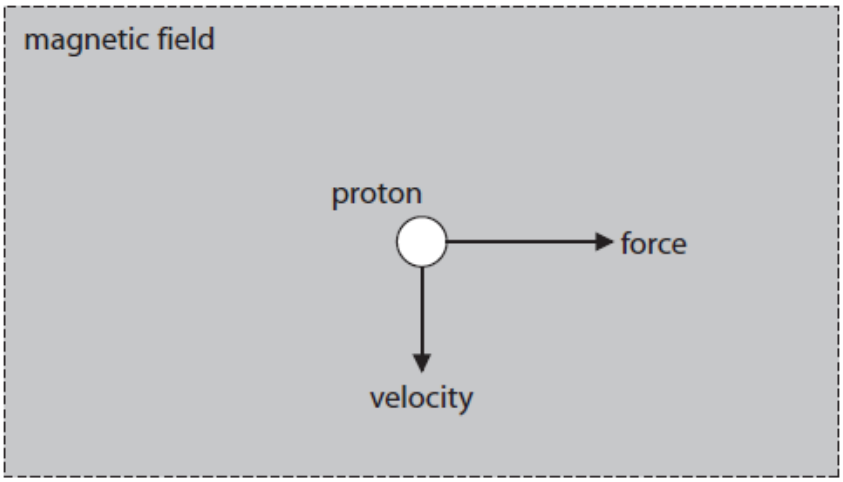


Diagram 1

The proton experiences a force to the right.

What is the direction of the magnetic field?

(1)

☒ **A** into the page

☒ **B** left

☒ **C** out of the page

☒ **D** upward

(b) When a current passes through a flat circular coil, a magnetic field is produced.

Complete diagram 2 by drawing the magnetic field of the flat circular coil.

(3)



Diagram 2

(c) A wireless charging base uses a magnetic field to charge the battery of a mobile phone.



© BeeBright/Shutterstock

There is an alternating current in a coil of wire in the charging base.

There is another coil of wire connected to the battery in the mobile phone.

(i) Explain how the wireless charging base charges the battery of the mobile phone.

(3)

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(ii) Discuss the advantages and disadvantages of using a high current in the wireless charging base.

(2)

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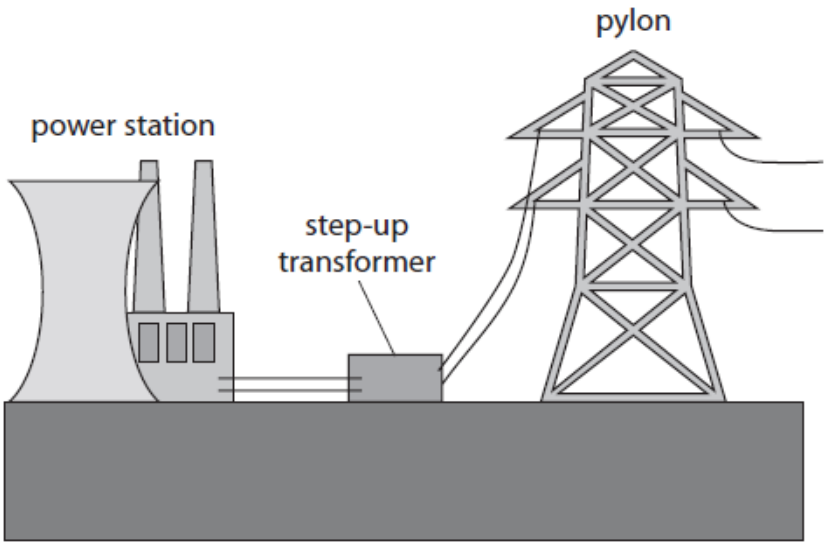
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(Total for question = 9 marks)

Q15.

The diagram shows part of the National Grid.



(a) There is a step-up transformer at the power station end of a transmission line and a step-down transformer at a distant town.

Explain why step-up transformers and step-down transformers are used in this way.

(4)

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

(1)

(ii) The primary coil on a step-up transformer has 3300 turns.

Calculate the number of turns required on the transformer's secondary coil to step up the voltage from 15 kV to 340 kV.

(3)

number of turns = ...

(c) Transformers in the National Grid have efficiencies less than 100%.

(i) Suggest which energy store of the transformer increases as a result of the efficiency being less than 100%.

(1)

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(ii) The iron core of a transformer is an electrical conductor.

When the transformer is in use, the primary coil causes a changing magnetic field in the iron core. This causes a small current to be induced in the core.

Explain how a current is induced in the core of the transformer.

(3)

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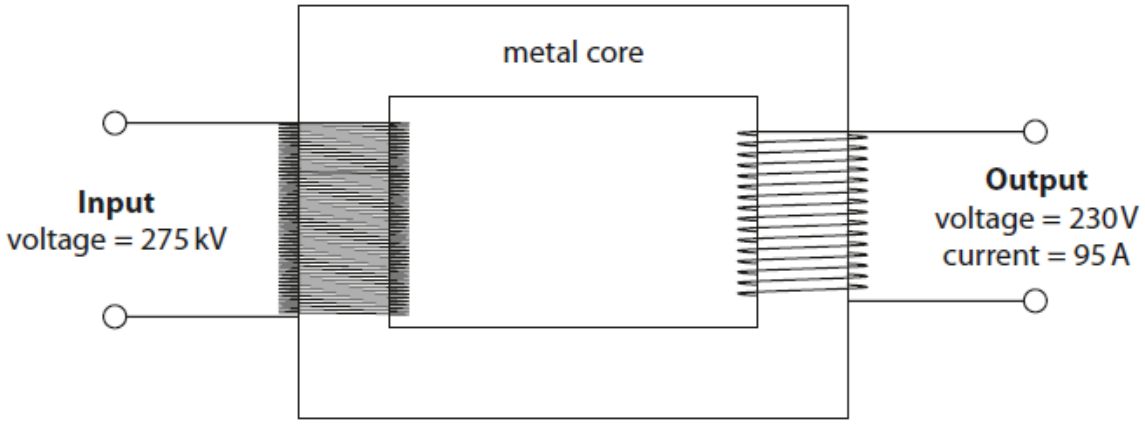
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(Total for question = 12 marks)

Q16.

Transformers are useful in the transmission of electricity.

(a) The diagram shows a step-down transformer.



(i) Give the name of a suitable metal that could be used in the core of the transformer.

(1)

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(ii) State the formula linking input power and output power for a transformer.

(1)

(iii) The step-down transformer has an input voltage of 275 kV and an output voltage of 230 V.

The transformer has an output current of 95 A.

Calculate the input current to the transformer.

Assume the transformer is 100% efficient.

(3)

input current = ... A

(b) Explain how transformers are useful in the large-scale transmission of electricity.

You may draw a diagram to support your answer.

(5)

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(Total for question = 10 marks)

Q17.

Mobile phone charger X contains a transformer and is used to charge the phone's battery.

Diagram 1 shows the information on charger X.

Input voltage = 230 V
Output voltage = 5.0 V
Output current = 1.2 A

Diagram 1

(a) (i) The power of the charger can be calculated using the formula

power = current × voltage

Calculate the output power of charger X.

(2)

output power = ... W

(ii) Calculate the input current to charger X.

Assume that charger X is 100% efficient.

(3)

input current = ... A

(b) Charger X transfers a charge of 10 500 C to the mobile phone battery.

(i) State the formula linking charge, current and time.

(1)

(ii) Calculate the time in minutes to transfer a charge of 10 500 C to the battery.

(3)

time = ... minutes

(iii) Charger Y can also be used to charge the mobile phone battery.

Diagram 2 shows the information label for charger Y.

Input voltage = 230V
Output voltage = 5.0V
Output current = 2.1 A

Diagram 2

Explain how the time taken to transfer the same amount of charge to the mobile phone battery will be affected when charger Y is used instead of charger X.

(2)

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(c) Both chargers contain step-down transformers.

Explain how a step-down transformer works.

You may include a diagram to support your answer.

(4)

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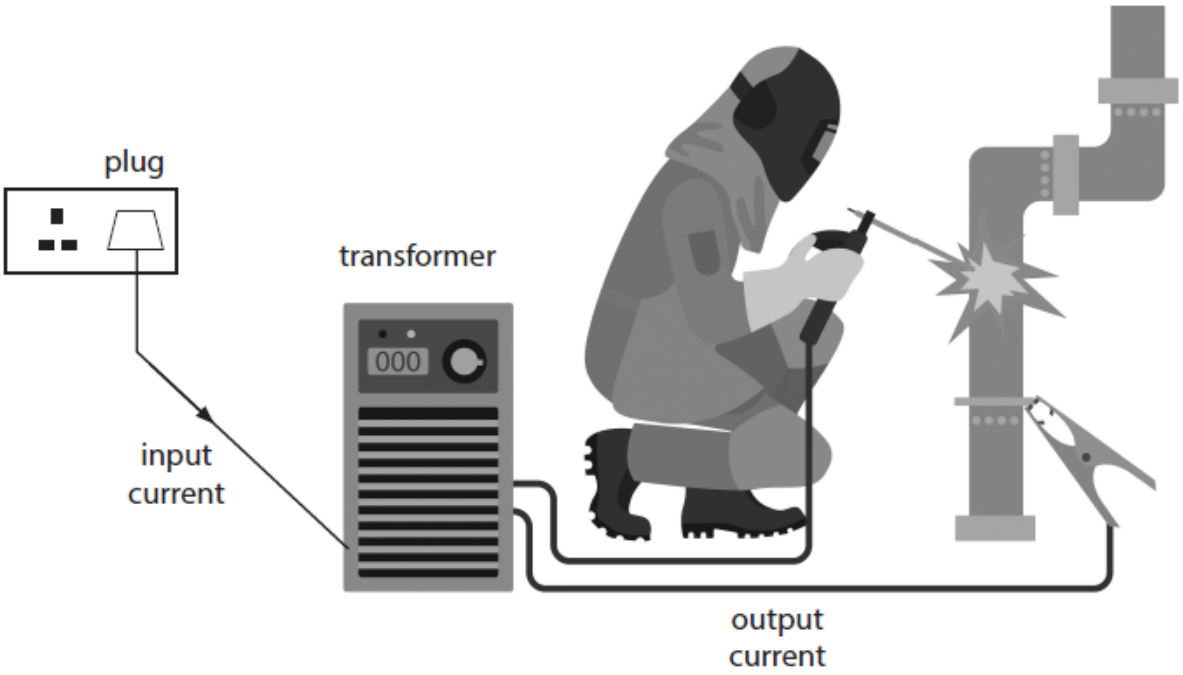
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(Total for question = 15 marks)

Q18.

Welding is a process where pieces of metal are melted and then joined together.

The diagram shows apparatus used for welding.



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The welding apparatus uses the transformer to decrease the voltage from 230 V.

(a) State the name of this type of transformer.

(1)

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

(1)

(c) The table gives some information about the transformer.

input voltage in V	230
number of turns on input coil	16
number of turns on output coil	4
input current in A	11

(i) Use information from the table to calculate the output current of the transformer.

Assume that the transformer is 100% efficient.

(5)

current = ... A

(ii) A fuse is installed in the plug which supplies the input current.

Which fuse should be used in this plug?

(1)

☒ **A** 3 A

☒ **B** 5 A

☒ **C** 10 A

☒ **D** 13 A

(Total for question = 8 marks)

Q19.

Wind is a renewable resource used to generate electricity.

(a) (i) State **one** advantage and **one** disadvantage of producing electricity using wind turbines.

(2)

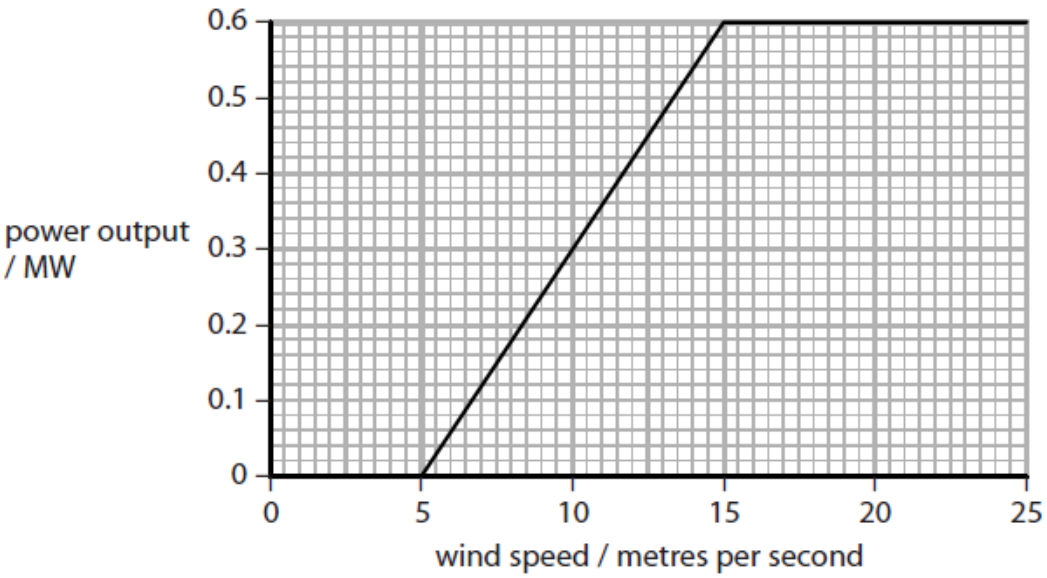
Advantage .....

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Disadvantage .....

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(ii) The graph shows how the power output of a wind turbine varies with wind speed.



Describe how the power output of a wind turbine varies with wind speed.

You should use data points from the graph in your answer.

(3)

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(b) A wind turbine produces an alternating voltage of 600 V.

The voltage needs to be increased to 132 kV before transmission to a nearby town.

The size of the voltage is changed using a transformer.

Describe the structure and operation of a suitable transformer.

You may use a diagram in your answer.

(5)

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(Total for question = 10 marks)