Materials
For this paper you must have:

- Ruler
- Pencil and Rubber
- Scientific calculator, which you are expected to use when appropriate

Instructions

- Answer all questions
- Answer questions in the space provided
- All working must be shown

Information

- The marks for the questions are shown in brackets
(a) The diagram shows the structure of a traditional transformer.

Use words from the box to label the diagram.

<table>
<thead>
<tr>
<th>aluminium</th>
<th>brass</th>
<th>iron</th>
<th>large</th>
<th>primary</th>
<th>secondary</th>
</tr>
</thead>
</table>

(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?
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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 consideration.
- a political consideration.
- a social consideration.

(Total 5 marks)
The diagram shows a ‘G-machine’. The G-machine is used in astronaut training.

The G-machine moves the astronaut in a horizontal circle.

Force A is known as the **centripetal** force acting on the astronaut

(a) The centripetal force on the astronaut is measured.

**Graph X** shows how the centripetal force is affected by the speed of rotation. The radius of rotation is kept the same.

(i) Use **Graph X** to determine the centripetal force on the astronaut when rotating at a speed of 30 metres per second.

Centerpetal force = .............................. newtons

(1)
(ii) Complete the following sentence to give the conclusion that can be made from Graph X.

Increasing the speed of rotation of a G-machine will ................................................
the centripetal force on the astronaut.

(iii) Graph Y shows how the centripetal force is affected by the radius of rotation, when
the speed of rotation is kept the same.

Complete the following sentence to give the conclusion that can be made from
Graph Y.

The greater the radius of rotation, the ......................................... the centripetal force
on the astronaut.

(1)
(b) The G-machine is rotated by an electric motor. The diagram shows a simple electric motor.

The following statements explain how the motor creates a turning force. The statements are in the wrong order.

M – The magnetic field interacts with the magnetic field of the permanent magnets.

N – A magnetic field is created around the coil.

O – The power supply applies a potential difference across the coil.

P – This creates a force that makes the coil spin.

Q – A current flows through the coil.

Arrange the statements in the correct order. Two of them have been done for you.

O → [ ] → [ ] → [ ] → P

(c) The electric motor produces a turning force.

Give two ways of increasing the turning force.

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2 .....................................................................................................................

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(2)
(d) Draw a ring around the correct answer to complete the sentence.

It costs a lot of money to send astronauts into space.

This is an economic issue.

(1) (Total 8 marks)
The G-machine moves the astronaut in a horizontal circle.

(a) The force causing the astronaut to move in a circle is measured.

The graph shows how the speed of the astronaut affects the force causing the astronaut to move in a circle for two different G-machines.

The radius of rotation of the astronaut is different for each G-machine.

(i) State three conclusions that can be made from the graph.

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3 ............................................................................................................
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(3)
(ii) The speed of rotation of G-machine 1 is increased from 20 m/s to 40 m/s.
Determine the change in force on the astronaut.

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Change in force = ............................................................ N

(1)

(b) Each G-machine is rotated by an electric motor. The diagram shows a simple electric motor.

(i) A current flows through the coil of the motor.
Explain why side \( A \) of the coil experiences a force.

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(2)

(ii) Draw arrows on the diagram to show the direction of the forces acting on side \( A \) of the coil and side \( C \) of the coil.

(1)

(iii) When horizontal, side \( B \) experiences no force.
Give the reason why.

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(1)
(c) While a G-machine is rotating, the operators want to increase its speed.

What can the operators do to make the G-machine rotate faster?

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(1)

(d) The exploration of space has cost a lot of money.

Do you think spending lots of money on space exploration has been a good thing?

Draw a ring around your answer.

Yes       No

Give a reason for your answer.

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(1)

(Total 10 marks)
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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(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)
A student has made a simple electric motor. The diagram shows the electric motor.

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

Once the coil is spinning, one side of the coil is pushed by the cell and the other side is pulled, so the coil continues to spin.

(b) Suggest two changes to the electric motor, each one of which would make the coil spin faster.

1 ....................................................................................................................
2 ....................................................................................................................

(c) Suggest two changes to the electric motor, each one of which would make the coil spin in the opposite direction.

1 ....................................................................................................................
2 ....................................................................................................................

(Total 5 marks)
(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.

\[\text{p.d. across secondary coil} = \frac{25 \times 12,800}{800} \text{ volts} \]

(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?

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(1)

(ii) Why is the core made of iron?

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(1)
(iii) Explain how the transformer works.

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(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.

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2 .....................................................................................................................
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(2)
(Total 9 marks)
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.
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(1)

(Total 4 marks)
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?

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

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

Why?
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(1)

What is the minimum number of turns needed on the secondary coil for the transformer to act as a step-up transformer?
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Give a reason for your answer.
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(2)

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?
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(1)

(Total 6 marks)
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.

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(1)

(ii) Why is the core made of iron?

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(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.

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Number of turns on the secondary coil = ............................................

(2)

(Total 4 marks)

The diagram shows a device called a current balance.

The switch is closed, the part of the wire labelled \textbf{XY} moves upwards.

Explain why.

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(2)
(ii) What is the name of the effect that causes the wire XY to move?
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(1)

(iii) An alternating current (a.c.) is a current which reverses direction. How many times the current reverses direction in one second depends on the frequency of the alternating supply.

Describe the effect on the wire XY if the battery is replaced by an a.c. supply having a frequency of 5 hertz.
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(2)
(b) The diagram shows how a small weight can be used to make the wire $XY$ balance horizontally.

![Diagram showing a small weight and a wire $XY$ balanced by a force $F$.]

Use the data in the diagram and the equation in the box to calculate the force, $F$, acting on the wire $XY$.

**Equation:**

\[
\text{moment} = \text{force} \times \text{perpendicular distance from the line of action of the force to the axis of rotation}
\]

Show clearly how you work out your answer.

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Force = ............................................................ N

(3)

(Total 8 marks)
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.

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

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(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.
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?

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(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.

(Total 5 marks)

(a) Complete the description of the device shown below by drawing a ring around the correct line in each box.

(i) The device is being used as an electric motor.

a generator.

a transformer.
(ii) The coil needs a flick to get started. Then one side of the coil is pushed by the

\[
\begin{array}{|c|c|c|}
\hline
\text{cell} & \text{coil} & \text{force} \\
\hline
\end{array}
\]

and the other side is pulled, so that the coil spins.

(1)

(b) Suggest two changes to the device, each one of which would make the coil spin faster.

1 ......................................................................................................................
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2 ......................................................................................................................
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(2)

(c) Suggest two changes to the device, each one of which would make the coil spin in the opposite direction.

1 ......................................................................................................................
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2 ......................................................................................................................
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(2)

(Total 6 marks)
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.

\[
\frac{230V}{p.d.\ across\ secondary} = \frac{4600}{200} \\
p.d.\ across\ secondary = \frac{230V \times 200}{4600} = 10V
\]

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

Why is the wire insulated?

(c) (i) What material is the core of a transformer made from?
(ii) A science technician sets up the apparatus shown below to demonstrate the motor effect. He uses a powerful permanent magnet.

The copper roller is placed across the metal rails. When the switch is closed, the copper roller moves to the right.

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

This happens because copper is

- an electrical conductor.
- an electrical insulator.
- a magnetic material.

(ii) Suggest one change that the technician can make which will cause the copper roller to move faster.

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(1) (Total 5 marks)
(iii) Suggest **two** changes which the technician can make, each of which will separately cause the copper roller to move to the left.

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2 ................................................................................................................................................

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(2)

(b) Many electrical appliances, such as vacuum cleaners, drills and CD players, contain electric motors. As more electrical appliances are developed, more electricity needs to be generated. Generating electricity often produces pollutant gases.

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

Generating more electricity to power the increasing number of electrical appliances used

an ethical

raises an environmental issue.

a political


(1)

(ii) The number of electrical appliances used in the world’s richest countries is increasing yet many people in the world’s poorest countries have no access to electricity.

What type of issue does this inequality between people in different countries raise?

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(1)

(Total 6 marks)
(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.

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\[\text{p.d. across secondary coil} = \text{..........................................................}\]

(3)

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

Why is this insulation necessary?

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(1)

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

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(3)

(Total 7 marks)
A student investigates the electromagnetic force acting on a wire which carries an electric current. The wire is in a magnetic field.

The diagram shows the circuit which the student uses.

(a) Draw an X on the diagram, with the centre of the X in the most strongest part of the magnetic field.

(b) Give one change that she can make to the magnets to decrease the electromagnetic force on the wire.

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(c) The student wants to change the electromagnetic force on the wire without changing the magnets or moving their position.

(i) Give one way in which she can increase the electromagnetic force.

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