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OCR GCSE PHYSICS A (J249): QUESTIONS BY TOPIC

Topic P4: Magnetism and magnetic fields (F)

GCSE Physics A Foundation Tier (J249) · Topic P4

17 questions · 81 marks · Mark schemes included

OCR GCSE (9–1) Physics A (Gateway Science) J249, June 2018 – June 2025

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HOW TO USE THIS BOOKLET

Questions are grouped by specification sub-topic; within each sub-topic they run from the lowest mark tariff to the highest.

Click any heading or question row below to jump straight to it.

On every question page, click ANSWER in the top-right corner to jump to its mark scheme.

Diagrams, graphs, tables and data are printed exactly as they appeared in the original papers.

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2. Q6	J249/01 Paper 1 June 2022	1	5
3. Q14	J249/01 Paper 1 June 2022	1	6
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QUESTIONS

17 questions · 81 marks · grouped by sub-topic, lowest tariff first



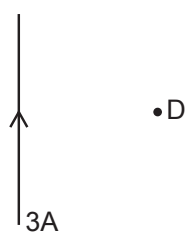
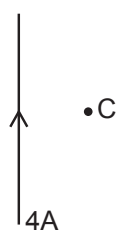
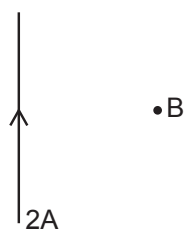
SUB-TOPIC P4.1

MAGNETS AND MAGNETIC FIELDS

11 questions in this sub-topic · 59 marks · lowest tariff first



- 7 The different currents in four wires are shown below. The magnetic field is measured at positions **A**, **B**, **C** and **D**.



Which position will experience the strongest magnetic field?

Your answer

[1]

- 6 A student places a magnet next to a copper rod and then an iron rod.

	Copper rod	Iron rod
A	attracts	attracts
B	attracts	repels
C	nothing happens	attracts
D	nothing happens	repels

Which row in the table describes what happens?

Your answer

[1]



14 What is an induced magnet?

- A** A permanent magnet which is always magnetic.
- B** A permanent magnet with two identical poles.
- C** A temporary magnet which is only magnetic when it is within a magnetic field.
- D** A temporary magnet with two identical poles.

Your answer

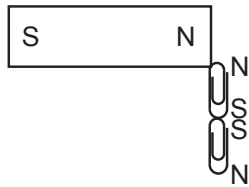
[1]



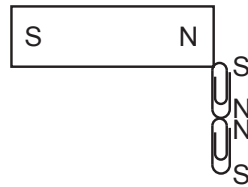
- 8 A magnet attracts two paperclips. S represents a South pole and N represents a North pole.

Which diagram shows the correct magnetic poles of each paperclip?

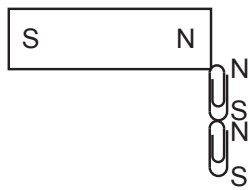
A



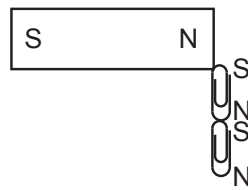
B



C



D



Your answer

[1]

- 20 (a) Draw the magnetic field pattern between the North and South poles of the magnets.

Include arrows on your field lines.



[3]

- (b) Describe **one difference** between a permanent magnet and an induced magnet.

.....
..... [1]

- (c) A student investigates solenoids and writes the following:

Solenoids

Solenoids are coils of wire.

When a voltage flows through them a magnetic field is created.

The magnetic field can be increased by decreasing the number of turns or by increasing the current.

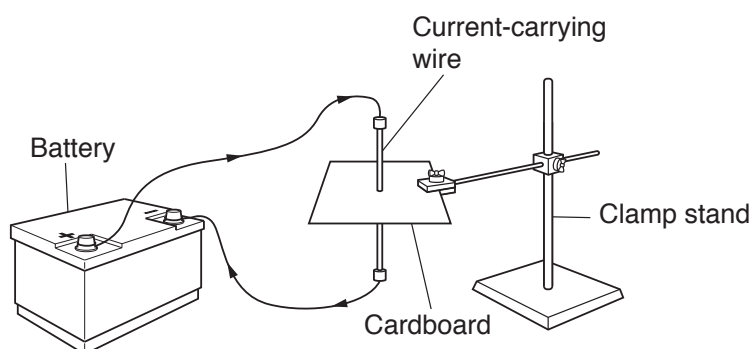
The student makes **two** mistakes.

Put a (ring) around the **two** mistakes in the above box.

[2]



23 A student sets up an experiment to investigate the magnetic field around a current-carrying wire.



- (a) (i) Describe how the student could use this experiment and a compass to investigate the magnetic field produced by the wire.

.....

.....

.....

.....

.....

..... [3]

- (ii) Draw the shape of the field which would be found around **this** wire.

[2]

- (b) The behaviour of a magnetic compass is evidence that the core of the Earth is magnetic. Explain why.

.....

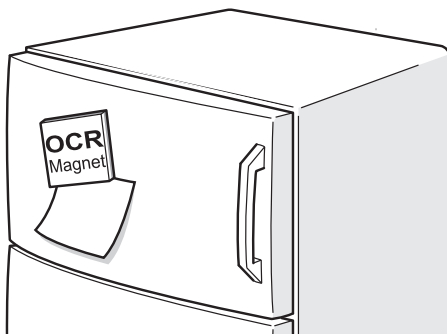
.....

.....

..... [2]



18 A fridge magnet is used to hold pieces of paper onto a metal fridge.



A student tests the strength of **three** square fridge magnets using this method:

- Place pieces of paper between each magnet and the fridge
- Increase the amount of pieces of paper until the magnets no longer stick to the fridge.

(a) Suggest **two** variables that the student should keep the same for this experiment.

1

2 [2]

(b) The student tests three different magnets **A**, **B** and **C** and puts their results into a table.

Magnet	Maximum number of pieces of paper held by the magnet
A	24
B	20
C	26

Which magnet is the strongest? Give a reason for your answer.

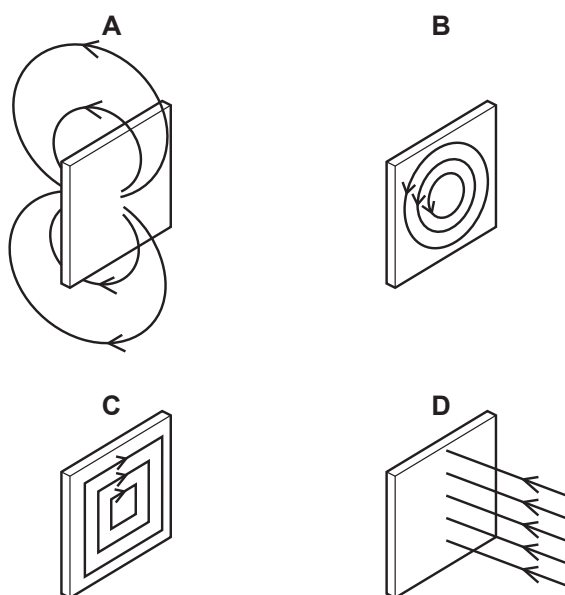
Magnet:

Reason:

..... [1]

- (c) The front and back faces of the fridge magnets are the poles.

The student draws four magnetic field line diagrams for a fridge magnet.



- (i) Which diagram, **A**, **B**, **C** or **D**, shows the correct magnetic field around a fridge magnet?
 [1]
- (ii) How does this diagram show the direction of the magnetic field?
 [1]
- (d) The student writes a method to plot the magnetic field around a bar magnet using a plotting compass.
- 1 Join the dots together on the paper to show the field line.
 - 2 Move the compass so that the opposite end of its arrow points to the dot you have just drawn.
 - 3 Place the magnet on a piece of paper and draw around the magnet.
 - 4 Place the compass near to one end of the bar magnet and mark where the compass arrow points to with a dot.
 - 5 Draw another dot on the paper for the new compass position and repeat.

The student has written their method steps in the wrong order.

Write down the correct order for their method.



[2]

- 18** A student investigates how the number of turns of wire on an electromagnet affects the strength of the magnetic field produced.

The student passes a current through a wire wrapped around an iron nail and uses this to pick up paperclips.

- (a) (i)** Name **two** variables the student controls in the experiment.

1

2 [2]

- (ii)** The table shows the student's results.

Number of turns	Number of paperclips picked up
4	5
8	10
12	15
16	20
20	25

Describe the pattern shown by the student's results.

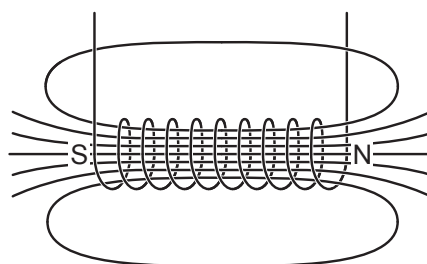
.....

..... [2]

- (iii)** Predict how many paperclips the electromagnet will pick up if it has 28 turns.

..... [1]

- (b)** The diagram shows a sketch of the magnetic field around the electromagnet.



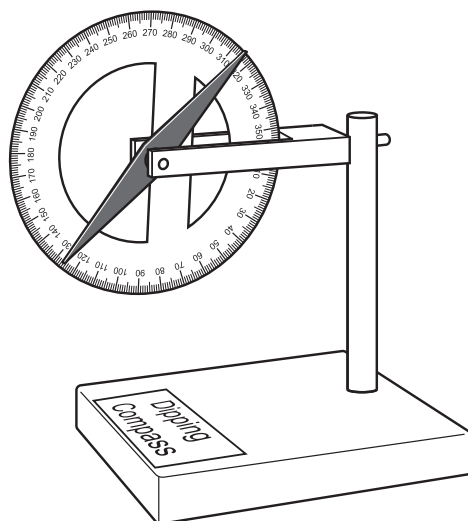
- (i)** Add arrows to the magnetic field lines to show the direction of the magnetic field. [1]
- (ii)** Write the letter **X** to show a position where the magnetic field is stronger. [1]
- (iii)** Write the letter **W** to show a position where the magnetic field is weaker. [1]

23

(a) Fig. 23.1 shows a (dipping) compass used in schools.

It is currently showing the reading for the UK.

Fig. 23.1



(i) Describe how the position of the needle changes if the compass is moved from the equator to the poles of the Earth.

.....

.....

.....

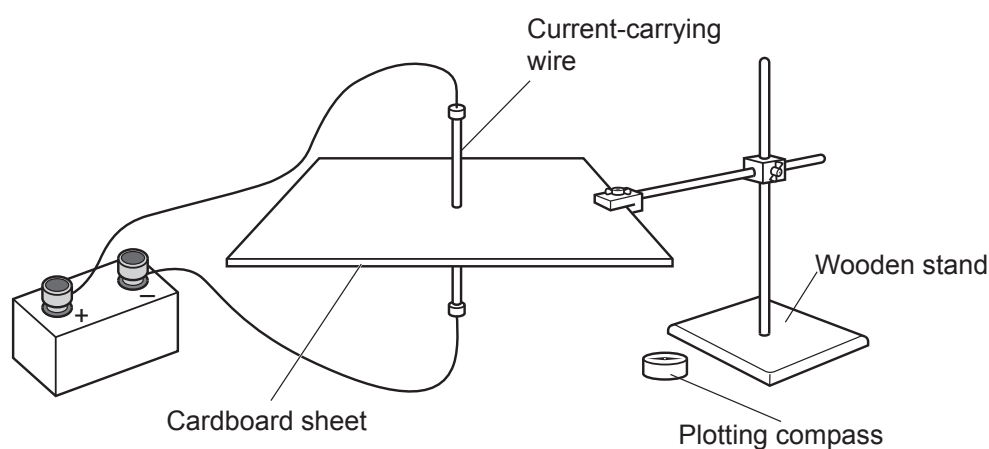
..... [2]

(ii) What does your answer to (a)(i) suggest about the Earth's core?

..... [1]

- (b) Fig. 23.2 shows the equipment a teacher sets up to demonstrate using a plotting compass to investigate the magnetic field around a current-carrying wire.

Fig. 23.2



- (i) Describe how the teacher uses this equipment to show the shape of the magnetic field around the current-carrying wire.

.....

.....

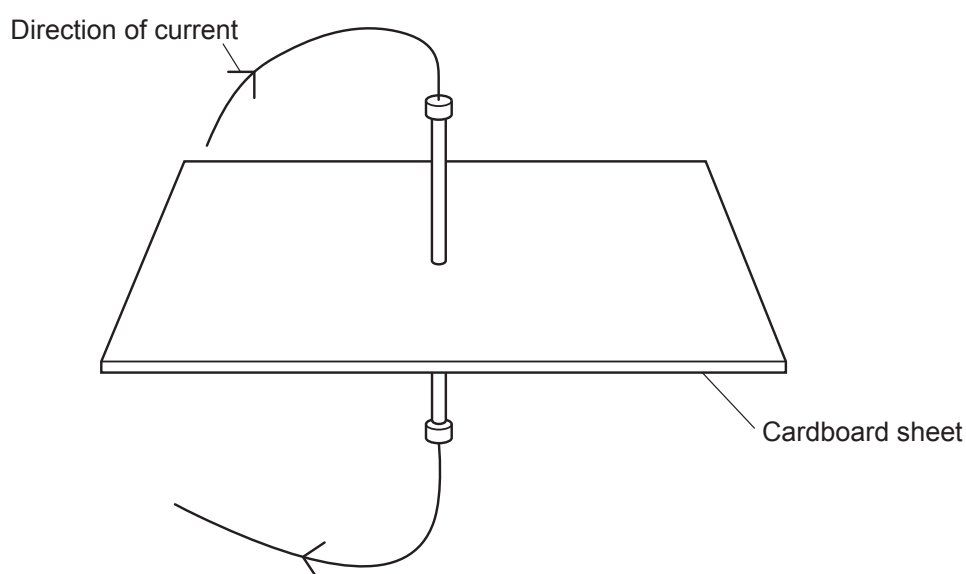
.....

.....

..... [3]

- (ii) On Fig. 23.3 sketch the magnetic field around the current carrying wire.

Fig. 23.3



[2]

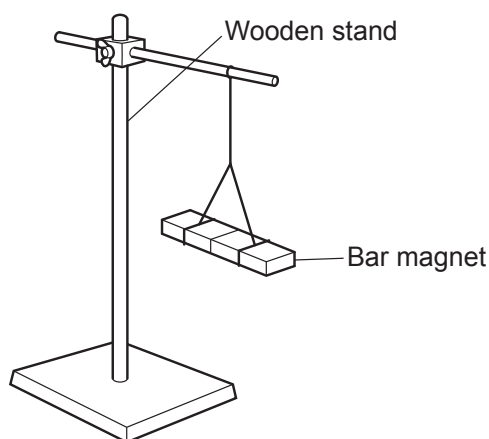
17 A student investigates magnetic fields using a bar magnet.

(a) Draw the magnetic field around the bar magnet.



[3]

(b) The student freely suspends the bar magnet from a wooden stand.



(i) Why did the student choose a wooden stand instead of an iron stand?

..... [1]

(ii) The bar magnet is able to move freely.

In which direction does the bar magnet face when it **stops** moving?

Tick (✓) **one** box.

East-west

☐

North-south

☐

Up-down

☐

[1]

(iii) Why does the bar magnet face in this direction?

Tick (✓) **one** box.

It lines up with the wooden stand.

☐

It lines up with the Earth's gravitational field.

☐

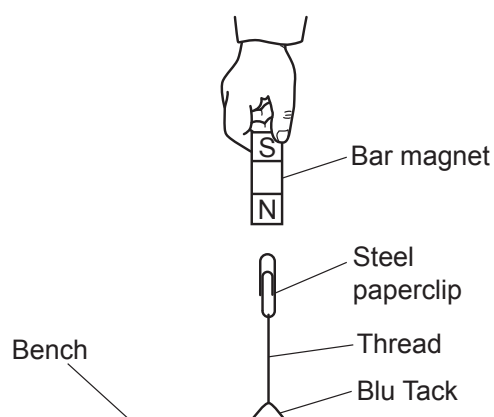
It lines up with the Earth's magnetic field.

☐

[1]

(c) An unmagnetised steel paperclip is attached to Blu Tack using thread. The Blu Tack is stuck to a bench.

The student uses the bar magnet to lift the paperclip until the paperclip is suspended in the air.



(i) Which type of magnet is the steel paperclip?

Tick (✓) **one** box.

Induced

☐

Permanent

☐

Solenoid

☐

[1]

(ii) Explain your answer to (c)(i).

.....

..... [1]

16 A group of students investigate magnetic fields.

(a) **Fig. 16.1** shows the magnetic field around a bar magnet.

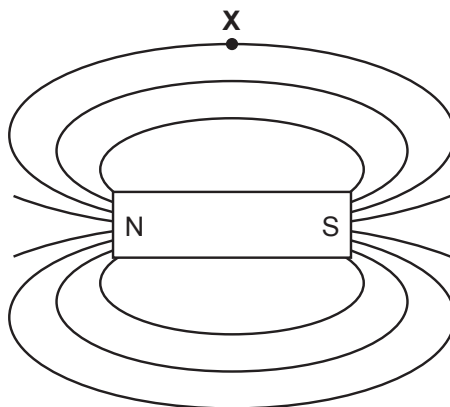


Fig. 16.1

Draw an arrow on the field line at position **X** on **Fig. 16.1** to show the direction of the magnetic field. [1]

(b) A current in a wire creates a magnetic field. A straight wire carrying an electric current passes through a flat card as shown in **Fig. 16.2**.

(i) Draw on **Fig. 16.2** the shape and direction of the magnetic field observed on the card. [2]

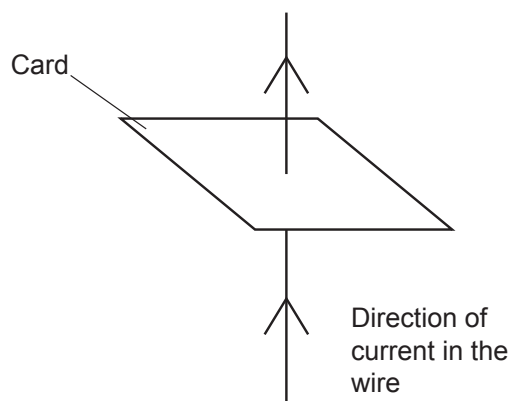


Fig. 16.2

(ii) Suggest **one** way the students could increase the strength of the magnetic field around the wire.

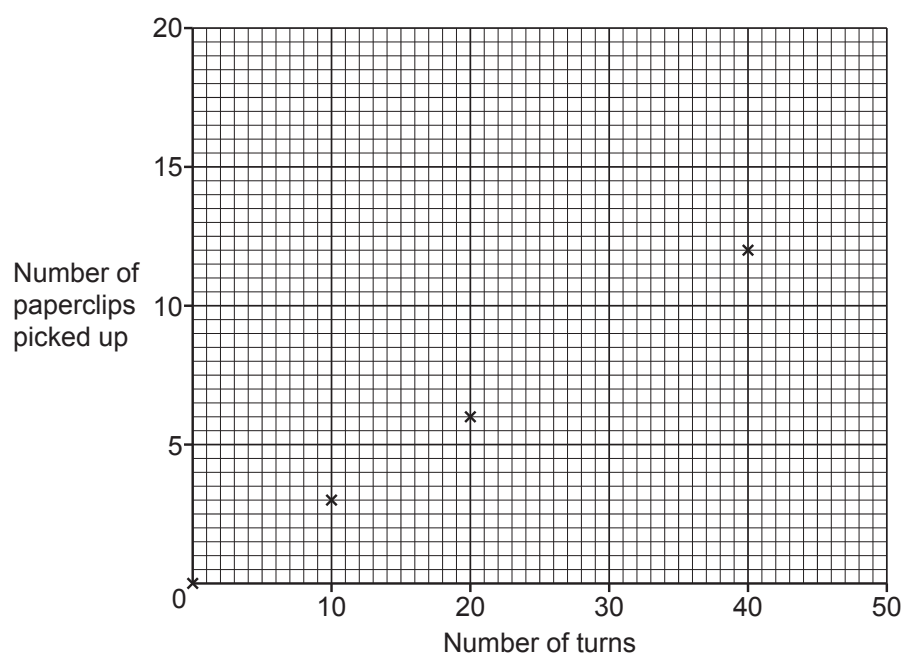
- (c) The students investigate the strength of an electromagnet. They change the number of turns on the electromagnet and count how many paperclips it can pick up.

The students record their data in a table.

Number of turns	Number of paperclips picked up
0	0
10	3
20	6
30	10
40	12
50	14

- (i) Plot the **two** missing results onto the graph.

Draw a line of best-fit.



[3]

- (ii) Describe the relationship between the number of turns and the number of paperclips picked up. You may use data from the graph in your answer.

.....

 [2]

- (iii) Suggest **two** variables the students need to control in their experiment.

1
 2 [2]

Turn over



SUB-TOPIC P4.2

USES OF MAGNETISM

6 questions in this sub-topic · 22 marks · lowest tariff first



4 Which action **increases** the strength of an electromagnet?

- A Decreasing the current
- B Decreasing the number of turns of wire
- C Increasing the number of turns of wire
- D Using a copper core

Your answer

[1]



14 Which row in the table is correct for a **step-down** transformer?

	Current	Potential difference
A	Decreases	Decreases
B	Decreases	Increases
C	Increases	Decreases
D	Increases	Increases

Your answer

[1]



12 This question is about electricity at power stations and at homes.

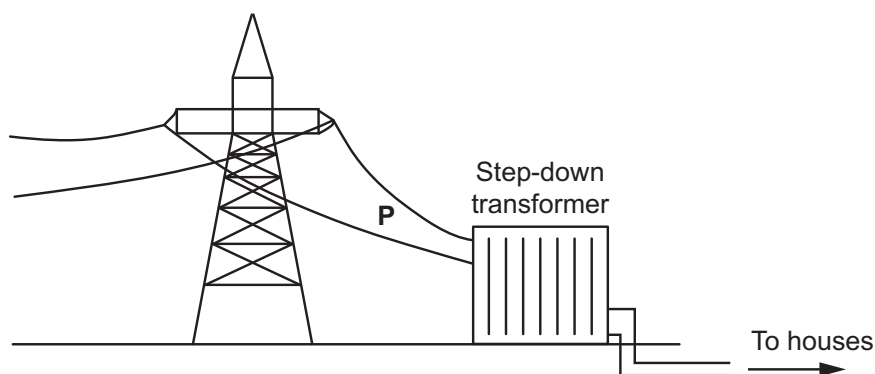
Which row in the table is correct?

	Voltage at the power station (V)	Voltage in the home (V)
A	230	50
B	230	230
C	25 000	50
D	25 000	230

Your answer

[1]

- 12 The diagram shows how a step-down transformer is used before electricity is transferred to houses.



Which row gives the correct potential difference and frequency of the electricity in the wires at **P**?

	Potential difference (V)	Frequency (Hz)
A	230	50
B	230	230
C	400 000	50
D	400 000	230

Your answer

[1]

22 This question is about how electricity is transferred from a power station to homes.

- (a)** Draw:
- **one** line to connect **each** type of transformer with the **one** box that describes what it does
 - **one** line to connect what each type of transformer does with the **one** box that gives the reason for its use.

Type of transformer	What it does	Reason for its use
Step-down transformer	Decreases current	For safety
Step-up transformer	Decreases potential difference	Increases heat losses
	Generates current	Reduces heat losses

[2]

- (b)** The table shows information for a transformer.

Potential difference across primary coil	132 000 V
Current in secondary coil	1800 A
Potential difference across secondary coil	33 000 V

Calculate the current in the primary coil of the transformer.

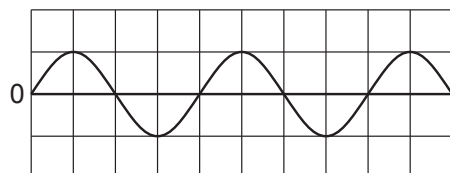
Use the Equation Sheet.

Current in primary coil = ... A [2]

(c) A teacher connects the primary coil of a transformer to the domestic mains supply.

The teacher uses an oscilloscope to view the potential difference across the secondary coil of the transformer.

The graph shows the oscilloscope trace.



Use the graph to explain which type of current is supplied by the mains supply.

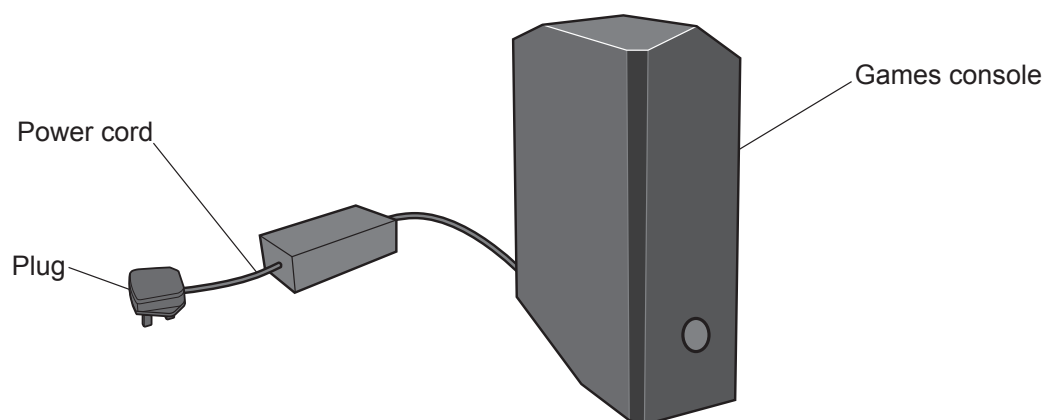
Type of current

Explanation

[2]

20 The diagram shows a games console.

A games console is an electrical device used to play computer games.



(a) The games console is connected to the mains supply and switched on.

Describe how energy is **transferred** through the power cord to the games console.

..... [1]

(b)

(i) The games console uses $4.2 \times 10^5 \text{ J}$ of energy per hour when a student is playing on it.

The actual energy input to the games console in one hour is $5.2 \times 10^5 \text{ J}$.

Calculate the energy **wasted** by the games console in one hour of playing.

Energy wasted = ... J [2]

(ii) Explain why some energy is wasted when the student is playing on the games console.

.....

 [2]

(iii) Calculate the efficiency of the game console.

Use the equation: $\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{input energy transfer}}$

Give your answer to **2** significant figures.

Efficiency = ... [3]

(c) The games console has a transformer built into the power cord.

The transformer needs to decrease the potential difference of the mains supply from 230 V to 12.1 V.

(i) State the type of transformer used in the games console.

..... [1]

(ii) The current in the primary coil of the transformer is 0.51 A.

Calculate the current in the secondary coil of the transformer.

Assume the transformer is 100% efficient.

Use the Equation Sheet.

Current in secondary coil = ... A [3]



MARK SCHEMES

official Pearson Edexcel mark schemes



Question				Answer	Marks	AO element	Guidance
7			C		1	2.2	



Question	Answer	Marks	AO element	Guidance
6	C ✓	1	1.2	



Question	Answer	Marks	AO element	Guidance
14	C ✓	1	1.1	



Question	Answer	Marks	AO element	Guidance
8	D	1	1.2	



20	(a)	One straight line between the middle of the two poles ✓ At least 2 correctly curved lines between the edges of the poles, one above and one below ✓ Arrows on field lines going N to S ✓	3	1.2 1.2 1.2	Ignore any field lines not between the labelled poles Allow dotted lines. Straight line by eye (rulers not used) Concave smooth curves Any wrong arrow loses this mark
	(b)	Any one from: Induced magnets lose their magnetism (when away from a magnetic field)/AW OR ✓ Permanent magnets retain their magnetism (when away from a magnetic field)/AW ✓	1	1.1	
	(c)	Mistakes: When a <u>voltage</u> flows through them a magnetic field is created. ✓ The magnetic field can be increased by <u>decreasing</u> the number of turns..... ✓	2	3.1b 3.1b	Must circle 'voltage, or 'flows through', or whole sentence Should circle 'decreasing (the number of turns)' but NOT the increasing current bit. If a candidate circles 'magnetic field can be increased' and then circles all or part of the increasing current bit, award 1 mark only for this sentence.

23	(a)	(i)	Any three from: place the compass onto the card or near to the wire (and turn on the current) ✓ plot / observe the direction of the compass / needle ✓ repeat idea of tip-to-tail / plotting onto the card ✓ repeat at different distances from the centre ✓	3	3 x 1.2	
		(ii)	one or more circles around wire ✓ clockwise arrow(s) ✓	2	2 x 2.2	DO NOT ALLOW a spiral BUT ALLOW if clockwise direction shown by an arrow on the spiral then ✓
	(b)		always points to North / South ✓✓ OR Points to (magnetic) North / South ✓ line up with the magnetic field lines of the Earth ✓ OR Compass needle shows (an angle of) dip ✓ Dip (angle) changes (from equator) ✓	2	2 x 1.1	ALLOW Points North/South wherever you are ✓✓

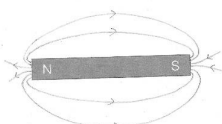


18	(a)	Any two from: (Same) size/area of paper (sheets) ✓ (Same) thickness/type/mass of paper (sheets) ✓ (Same) amount of paper under the magnet (see Fig.) ✓ (Same) size/area of (fridge) magnets ✓ (Same) fridge ✓	2	2 x 3.3a	
	(b)	(Magnet C no mark) (It is the one which) held the most (paper) sheets / AW ✓	1	3.2b	
	(c) (i)	A ✓	1	3.2a	
	(ii)	(direction of the) arrow ✓	1	1.1	
	(d)	3 – 4 – 2 – 5 – 1 ✓✓	2	2 x 1.2	ALLOW 1 mark for any three consecutive numbers in correct order (e.g. 3 – 4 – 2, 4 – 2 – 5, 2 – 5 – 1)

18	(a)	(i)	Any two from: Same (size/mass/weight/type of) paperclips ✓ Current (passing through wire) / voltage/potential difference (across turns) ✓ (Same) nail (throughout) ✓ Turns same distance apart ✓	2	2 x 3.3a	ALLOW type/material/diameter/length/resistance of wire ALLOW diameter of turns Size of turns is insufficient
		(ii)	As the number of turns increases the number of paperclips picked up increases ✓ BUT (they are) directly proportional ✓	2	3.1a 3.1b	Every 4 turns picks up 5 more paperclips gains 2 marks Double the number of turns picks up double the number of paperclips gains 2 marks IGNORE (positive) correlation
		(iii)	35 ✓	1	3.2a	
	(b)	(i)	Arrows drawn N to S on at least 1 field line and no contradicting arrows ✓	1	1.2	
		(ii)	X labelled inside the solenoid or close to the either end of the electromagnet (where field lines are closer together) ✓	1	2.2	Centre of the X anywhere within the space between the field lines and between the ends of the central 5 field lines on the diagram
		(iii)	W labelled at either side of the electromagnet (where the field lines are further apart) ✓	1	2.2	The W anywhere outside the space between the 5 central field lines on the diagram



23	(a)	(i)	(The needle) is horizontal / 0° / 180° at/near the equator ✓ (The needle) is vertical / 90° / 270° at/near the poles ✓	2	1.2 x2	ALLOW 2 marks for needle changes from horizontal to vertical ALLOW 1 mark for needle changes from vertical to horizontal ALLOW parallel to the earth (at the equator) ALLOW perpendicular / at right angles (at the pole(s)) IGNORE changes position unqualified.
		(ii)	(The Earth's core) is magnetic ✓	1	1.1	ALLOW (bar) magnet / (core is) electromagnetic
	(b)	(i)	Any three from: Place the plotting compass onto the cardboard sheet ✓ Mark the direction of the compass needle (with a dot) ✓ Move the plotting compass to another of these marks / dots / arrows and repeat ✓ Connect the marks / dots / arrows together to show the field ✓	3	3.3a x3	ALLOW 1 mark for using the plotting compass to show the magnetic field if no other marking points scored
		(ii)	One (or more) circles drawn around the current-carrying wire ✓ Correct direction of the field shown (clockwise) ✓	2	2.2 x2	DO NOT ALLOW crossing lines. accept <u>small</u> gaps in circles. ALLOW 2 marks for a minimum of 3 circles drawn with increasing distance between the field lines (with no arrows)

17	(a)	A minimum of 2 lines drawn correctly between N and S of the magnet ✓ A minimum of 4 lines drawn correctly between N and S of the magnet ✓ Correct direction drawn on (some of) the N to S field lines ✓	3	3 × 1.2	Lines must be on both sides of the magnet e.g.  IGNORE lines that originate from between the letter N and the letter S. DO NOT ALLOW crossing N-S lines DO NOT ALLOW any arrows drawn in the wrong direction IGNORE any lines drawn inside the magnet.
	(b) (i)	Any one from: It is not magnetic ORA ✓ It would not interfere with the experiment ORA ✓ It would not attract the magnet ORA ✓	1	3.3a	ALLOW not pulled towards stand / not aligned with stand. IGNORE not stuck to the stand
	(ii)	North-south ✓	1	1.2	
	(iii)	It lines up with the Earth's magnetic field ✓	1	1.1	
	(c) (i)	Induced ✓	1	2.2	
	(ii)	(Paperclip has been placed) in the magnetic field (of the bar magnet) ✓ OR When paperclip is removed from the magnetic field of the bar magnet, its magnetism (appears to be) lost ✓	1	2.2	ALLOW in contact with magnet for in magnetic field ALLOW paperclip is magnetised by the magnet ALLOW ECF for permanent box ticked in (c)(i) e.g. steel does not lose its magnetism when removed from a magnetic field. DO NOT ALLOW ECF for solenoid box ticked in (c)(i)

16	(a)	Arrow near X to the right	1	1.2	ALLOW an arrow near to X / top 3 field lines that points in the correct direction IGNORE any correct arrows on additional field lines DO NOT ALLOW any incorrect arrows on additional field lines
	(b)	(i) At least 2 circles drawn ✓ Anticlockwise arrow on at least one circle ✓	2	1.2 2.2	
		(ii) Increase current ✓	1	1.2	ALLOW Increase power/voltage/potential difference/pd
	(c)	(i) Both points correctly plotted ✓✓ OR Any one point correctly plotted ✓ Best-fit line is a straight line passing through the origin ✓	3	3 x 2.2	+/- ½ square tolerance DO NOT ALLOW 'blobs' plotted with more than ½ square diameter
		(ii) As the number of turns increases the number of paperclips picked up increases ✓ The number of paperclips picked up is (directly) proportional to the number of turns ✓	2	2 x 3.1a	ALLOW If the number of turns is doubled the number of paperclips picked up doubles
		(iii) Any two from: Keep the core (of the electromagnet) the same ✓ Keep the current the same ✓ Keep the area of the coils the same ✓ Use identical paperclips ✓ Keep the distance between the electromagnet and the paperclips the same / AW ✓	2	2 x 3.3a	ALLOW Power/voltage/potential difference/pd

Question				Answer	Marks	AO element	Guidance
4				C	1	1.1	



Question			Answer	Marks	AO element	Guidance
14			C ✓	1	1.1	



Question			Answer	Marks	AO element	Guidance
12			D ✓	1	1.1	



Question			Answer	Marks	AO element	Guidance
12			C ✓	1	1.1	



22	(a)	✓✓	2	2 × 1.1	Mark independently Correct matching of both transformers to what they do Correct matching of what they do to reason If no other marks scored: ALLOW 1 mark for step-down transformer → decreases pd → for safety OR step-up transformer → decreases current → reduces heat losses
	(b)	First check the answer on the answer line If answer = 450 (A) award 2 marks $132\,000 \times I_p = 1800 \times 33\,000$ ✓ OR $(I_p =) 1800 \times 33\,000 \div 132\,000$ ✓ $(I_p =) 450$ (A) ✓	2	2 × 2.1	ALLOW substitution into any correct rearrangement of the equation ALLOW equation in letters/words rearranged $(I_p =) V_s I_s \div V_p$
	(c)	Alternating (current) / a.c. ✓ p.d./voltage/current/it changes direction / becomes + and – / changes polarity ✓	2	1 × 1.1 1x3.2b	ALLOW p.d./voltage/current/it/oscilloscope trace/charge <u>flow</u> goes in both directions or both ways or two ways or different ways ALLOW oscillates/fluctuates across the centre/zero IGNORE just changes or switches / goes up and down / alternates IGNORE charge changes from positive to negative

20	(a)		(transferred by) electric current ✓	1	2.1	ALLOW transferred by electrical working / electrically IGNORE electricity / voltage
	(b)	(i)	First check the answer on the answer line If answer = 1.0×10^5 award 2 marks $5.2 \times 10^5 - 4.2 \times 10^5$ ✓ (energy wasted) = 1.0×10^5 (J) ✓	2	2×2.1	ALLOW 1×10^5 or 100 000 ALLOW $5.2 - 4.2$ (expression needed)
		(ii)	(it is transferred to) thermal / heat (store) ✓ BUT (it is transferred to) thermal / heat (store) (of) power cord / air / console / transformer ✓✓	2	1.1 2.1	IGNORE not 100% efficient ALLOW surroundings
		(iii)	First check the answer on the answer line If answer = 0.81 award 3 marks substitution: (efficiency =) $4.2(\times 10^5) \div 5.2(\times 10^5)$ ✓ (efficiency =) 0.8(0769)... ✓ (efficiency to 2sf =) 0.81 ✓	3	 2.1 2.1 1.2	ALLOW 81% for three marks ALLOW 80(.769)% for two marks ALLOW any answer given to 2sf for this mark if processing attempted
	(c)	(i)	step-down ✓	1	1.1	
		(ii)	First check the answer on the answer line If answer = 9.7 award 3 marks Select and substitute: $230 \times 0.51 = 12.1 \times \text{current}$ ✓ Rearrangement: current = $(230 \times 0.51) \div 12.1$ ✓ evaluation: 9.7 (A) ✓	3	3×2.1	ALLOW substitution and rearrangement in any order ALLOW 9.69421.....