Week 18

IGCSE Physics

Homework bundle for this week

本周作业合集

exercises.lol

Contents 目录

IGCSE Physics Name: ____________ Score: ______

1. Two north poles are brought close together. They:
   - ☐ repel (push apart)
   - ☐ attract (pull together)
   - ☐ do nothing
   - ☐ swap to become south poles
2. Two negative charges attract each other.
   ☐ True ☐ False
3. A charge of 30 C flows past a point in 10 s. What is the current, in A?
   ____________ A
4. A component has 12 V across it and a current of 3.0 A through it. What is its resistance, in Ω?
   ____________ Ω
5. What happens to the resistance of a thermistor as it gets hotter?
   - ☐ it falls
   - ☐ it rises
   - ☐ it stays the same
   - ☐ it becomes infinite
6. Select **all** of these that are electrical hazards.
   - ☐ damaged insulation (bare wires)
   - ☐ overloading a socket
   - ☐ damp conditions
   - ☐ switching a lamp off

   Tick every correct option.
7. The magnetic field of a solenoid (a long coil carrying current) looks like the field of:
   - ☐ a bar magnet
   - ☐ a single point charge
   - ☐ no field at all
   - ☐ a flat sheet

8. How can you induce a current in a coil with a magnet?
   - ☐ move the magnet in or out of the coil
   - ☐ hold the magnet still inside the coil
   - ☐ warm the magnet up
   - ☐ paint the coil
9. A transformer works with a steady direct current (d.c.).

   ☐ True ☐ False
10. Which of these is a magnetic material (attracted by a magnet)?
   - ☐ iron
   - ☐ copper
   - ☐ plastic
   - ☐ wood

4. Electricity and magnetism

Answers · 答案

IGCSE Physics

1. **repel (push apart)**

   Like poles repel. Only different poles (N and S) attract.
2. **False**

   Like charges repel; only different charges (+ and −) attract.
3. **3 A**

   $I = \frac{Q}{t} = \frac{30}{10} = 3.0$ A.
4. **4 Ω**

   $R = \frac{V}{I} = \frac{12}{3.0} = 4.0\ \Omega$.
5. **it falls**

   A thermistor's resistance falls as temperature rises — useful in temperature-sensing circuits.
6. **damaged insulation (bare wires); overloading a socket; damp conditions**

   Bare wires, overloading and damp all raise the risk of shock or fire. Switching a lamp off is normal, safe use.
7. **a bar magnet**

   A solenoid produces a bar-magnet-like field, with a north pole at one end and a south at the other.
8. **move the magnet in or out of the coil**

   A current is induced only when the field through the coil is changing — for example by moving the magnet.
9. **False**

   A transformer needs a changing magnetic field, so it works on a.c. only. A steady d.c. makes no change and induces nothing.
10. **iron**

   Iron (also steel, cobalt, nickel) is magnetic. Copper, plastic and wood are not.

IGCSE PHYSICS • EXERCISE SHEET

4.1 Simple phenomena of magnetism

Name: ____________ Class: ________ Date: __________ **Total: 9 marks**

KEY WORDS magnet 磁体 • magnetic field 磁场 • magnetic material 磁性材料 • permanent magnet 永磁体 • magnetism 磁学

Objective

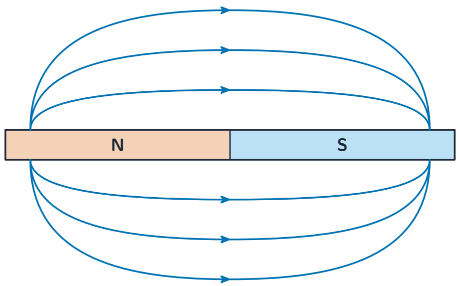
Build the skills to answer exam questions on **magnetism 磁学** — poles and forces, **induced magnetism 感应磁性**, soft iron vs steel, and **magnetic fields 磁场**.

You must be able to:

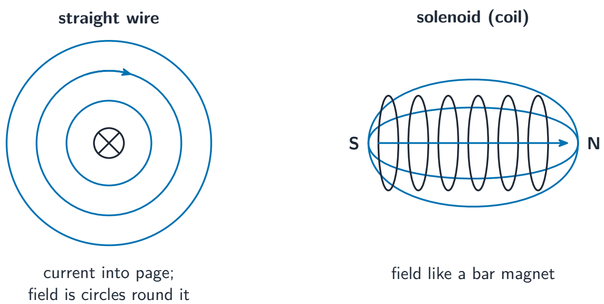
- use the rule of poles (like repel, unlike attract)
- compare soft iron (temporary) and steel (permanent) magnets
- draw and describe magnetic field lines

1 Worked examples

Fields and materials



Field lines come out of the N pole and into the S pole; closer lines = stronger field



Soft iron magnetises easily but loses it (temporary); steel keeps its magnetism (permanent)

- **like poles repel; unlike poles attract.**
- magnetic materials: iron, steel, cobalt, nickel.

2 Practice

2.1 State what happens when the N pole of one magnet is brought near the N pole of another. [1]

2.2 State which is better for a permanent magnet: soft iron or steel. [1]

3 Exam-style questions

3.1 Magnetic field lines around a bar magnet point: [1]

- **A** from S to N outside the magnet
- **B** from N to S outside the magnet
- **C** into both poles
- **D** out of both poles

3.2 A piece of soft iron is placed next to a magnet.

(a) Explain why the iron becomes magnetised. [2]

(b) State why soft iron, not steel, is used for the core of an electromagnet. [2]

3.3 Describe how you could show the magnetic field pattern of a bar magnet using iron filings. [2]

Solutions

2.1 they repel (push apart).

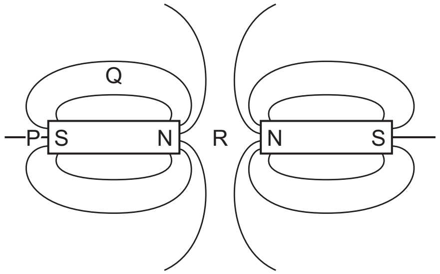
2.2 steel.

3.1 **B**. Field lines run from N to S outside the magnet.

3.2 (a) the magnet's field induces magnetism in the iron; the near end gains the opposite pole, so the two attract.
(b) soft iron magnetises and demagnetises easily; so the electromagnet can be switched on and off (loses its magnetism when the current stops).

3.3 place paper over the magnet and sprinkle iron filings on top; tap gently — the filings line up along the field lines, showing the pattern.

24 The diagram shows part of the magnetic field around two magnets.



Which list gives the order of magnetic field strengths at the positions P, Q and R, from weakest to strongest?

A P → Q → R

B P → R → Q

C Q → P → R

D R → Q → P

24 Which statements about magnets are correct?

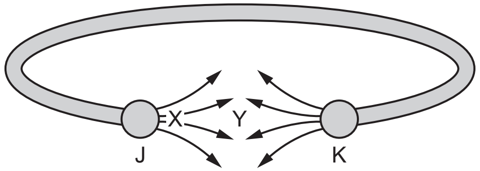
1 Permanent magnets are made of steel.

2 Electromagnets are temporary magnets.

3 A magnet can be used to induce magnetism in an iron bar.

A 1, 2 and 3 **B** 1 and 2 only **C** 1 and 3 only **D** 2 and 3 only

24 The diagram shows a bracelet containing two magnets. The arrows represent the pattern and the direction of the magnetic field due to the magnets.



Which row identifies the magnetic pole at J, the magnetic pole at K and where the magnetic field is the strongest?

	magnetic pole at J	magnetic pole at K	where the magnetic field is the strongest
A	N	N	X
B	N	N	Y
C	S	S	X
D	S	S	Y

6 Fig. 6.1 shows a person using a magnetic window cleaner. The part on the outside of the window is attracted to the inside part through the glass window.

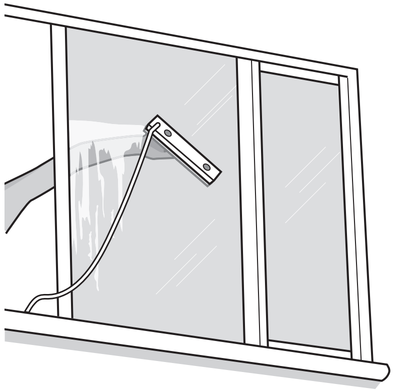


Fig. 6.1

Each part of the window cleaner contains two magnets. Fig. 6.2 shows the magnetic field between the parts of the window cleaner.

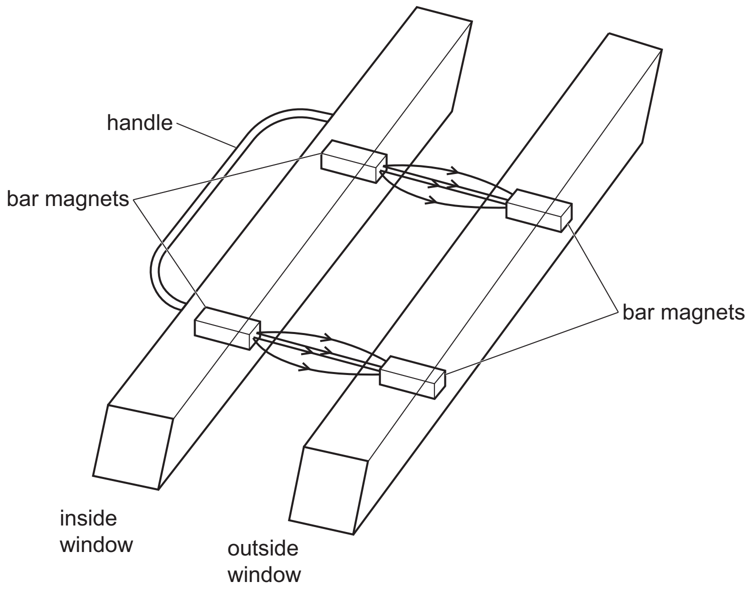


Fig. 6.2

(a) Glass is **not** a magnetic material.

State the difference between magnetic and non-magnetic materials.

....

.... [1]

(b) Suggest a suitable material for the magnets in the window cleaner. Explain your answer.

....

.... [1]

(c) Label the poles of the magnets in Fig. 6.2. [1]

(d) State how the field lines in Fig. 6.2 show different strengths of the magnetic field between the magnets.

....

.... [1]

[Total: 4]

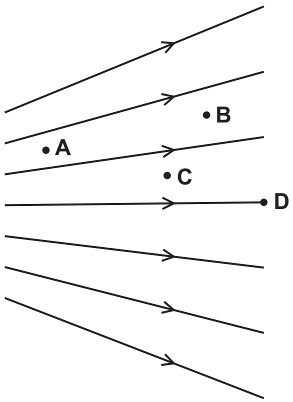
IGCSE Physics: **s24 21**

24 Which row describes suitable materials for use in a temporary magnet and in a permanent magnet?

	temporary magnet	permanent magnet
A	soft iron	soft iron
B	soft iron	steel
C	steel	soft iron
D	steel	steel

25 A magnetic field is represented in the diagram by magnetic field lines.

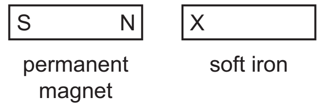
At which point is the magnetic field strongest?



24 Which metal could be used for a permanent magnet and which metal could be used for the core of an electromagnet?

	permanent magnet	core of electromagnet
A	iron	copper
B	iron	steel
C	steel	copper
D	steel	iron

23 An unmagnetised piece of soft iron is placed close to a strong permanent magnet, as shown.



What is the induced polarity of end X of the soft iron and in which direction does the magnetic force act on the soft iron?

	polarity of end X	direction of force on the soft iron
A	N	to the left
B	N	to the right
C	S	to the left
D	S	to the right

IGCSE PHYSICS • EXERCISE SHEET

4.2 Electrical quantities

Name: ______________ Class: _________ Date: ___________ **Total: 45 marks**

KEY WORDS resistance 电阻 • current 电流 • potential difference 电势差 • conductor 导体 • kilowatt-hour 千瓦时 • current 电流 • resistance 电阻 • volt 伏特 • electrical power 电功率 • electrical quantities 电学量

Objective

Build the skills to answer exam questions on **electrical quantities 电学量**: charge, current, e.m.f. and p.d., resistance, and electrical power and energy.

You must be able to:

- describe **charging by friction 摩擦起电** and test whether an object is charged
- tell conductors from insulators, and explain the difference using electrons
- use $I = \dfrac{Q}{t}$, and choose the right range on an ammeter or a voltmeter
- define e.m.f. and p.d. and use $E = \dfrac{W}{Q}$ and $V = \dfrac{W}{Q}$
- measure resistance, use $R = \dfrac{V}{I}$, and say how length and thickness change it
- read current–voltage graphs for a resistor, a filament lamp and a diode
- use $P = IV$ and $E = IVt$, and work out a cost in kilowatt-hours

1 Worked examples

Charges, conductors and current

Rub a plastic rod with a cloth: **electrons 电子** move from the cloth onto the rod. The rod is now negative and the cloth is positive. Only electrons move; the positive charge stays where it is. Like charges **repel 排斥** and unlike charges **attract 吸引**. To test whether a rod is charged, hang it on a thread and bring another charged rod near it: **repulsion 排斥力** is the only sure sign, because attraction also happens with an uncharged object.

A **conductor 导体** (a metal) has free electrons that can move, so charge flows through it. An **insulator 绝缘体** (plastic, rubber, glass) has no free electrons. To test a material, put it in a circuit with a cell and a lamp: the lamp lights only for a conductor.

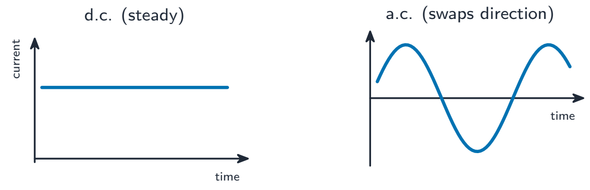
Current 电流 is the charge passing a point each second, measured in amperes (A):

$$I = \frac{Q}{t}$$

Worked example 1. A current of 3.0 A flows in a lamp for 20 s. Find the charge that passes.

1. Write down what you know: $I = 3.0$ A and $t = 20$ s.
2. Rearrange $I = Q/t$ to give $Q = It$.
3. Substitute: $Q = 3.0 \times 20 = 60$ C.

Conventional current 常规电流 flows from + to − round the circuit; the electrons drift the other way. A **direct current 直流电** (d.c.) always flows one way; an **alternating current 交流电** (a.c.) keeps reversing.



d.c. flows one way; a.c. keeps reversing

Meters and their ranges

An **ammeter 电流表** goes in series; a **voltmeter 电压表** goes in parallel, across the component. Both may be **analogue 模拟** (a needle on a scale) or **digital 数字** (a number on a screen). Choose the **range 量程** just above the biggest reading you expect: for a current of about 0.4 A use the 0–1 A range, not the 0–10 A range, because the needle moves further and the reading is more accurate.

E.m.f. and p.d.

The **e.m.f. 电动势** of a cell is the work it does driving one coulomb of charge round the whole circuit. The **p.d. 电势差** across a component is the work done by one coulomb passing through that component. Both are measured in volts (V):

$$E = \frac{W}{Q} \qquad V = \frac{W}{Q}$$

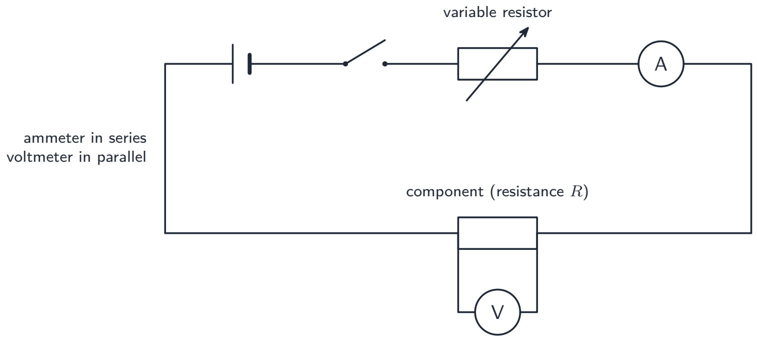
Worked example 2. A battery does 180 J of work moving 30 C of charge round a circuit. Find its e.m.f.

$E = \dfrac{W}{Q} = \dfrac{180}{30} = 6.0$ V.

■ **Measuring resistance**

Resistance 电阻 measures how hard it is for current to flow:

$$R = \frac{V}{I}$$

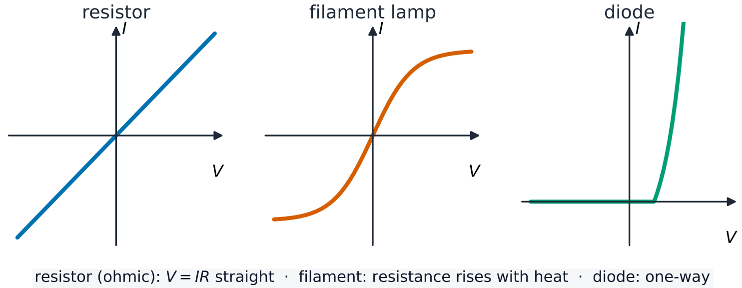


The circuit for measuring resistance: the ammeter is in series, the voltmeter is across the component, and the variable resistor changes the current

Worked example 3. In this circuit the voltmeter reads 4.8 V and the ammeter reads 0.20 A. Find the resistance of the component.

$R = \dfrac{V}{I} = \dfrac{4.8}{0.20} = 24\ \Omega$. In the experiment, change the variable resistor to get four or five pairs of readings. Then either find R for each pair and take the average, or plot V against I: the gradient of the straight line is R.

For a wire at constant temperature, a longer wire has more resistance ($R \propto l$) and a thicker wire has less ($R \propto 1/A$). Doubling the length doubles R; doubling the cross-sectional area halves it.



A resistor gives a straight line through the origin (constant R); a filament lamp curves as it heats up and its resistance rises; a diode conducts one way only

■ **Power, energy and the kilowatt-hour**

$$P = IV \qquad E = IVt$$

Worked example 4. A 230 V kettle takes a current of 8.0 A for 3.0 minutes. Find its power and the energy it transfers.

1. Power: $P = IV = 8.0 \times 230 = 1840$ W.
2. Time in seconds: $t = 3.0 \times 60 = 180$ s.
3. Energy: $E = Pt = 1840 \times 180 = 331\,000\ \text{J} \approx 3.3 \times 10^5$ J.

Electricity bills use the **kilowatt-hour** 千瓦时 (kWh), the energy a 1 kW appliance uses in 1 hour:

$$E\ (\text{kWh}) = P\ (\text{kW}) \times t\ (\text{h}) \qquad \text{cost} = E\ (\text{kWh}) \times \text{price per kWh}$$

Worked example 5. A 2.0 kW heater runs for 2.5 hours. Electricity costs 0.60 yuan per kWh. Find the cost.

$E = 2.0 \times 2.5 = 5.0$ kWh, so the cost is $5.0 \times 0.60 = 3.0$ yuan.

2 Practice

2.1 A current of 2.0 A flows for 15 s. Find the charge that passes. [2]

2.2 A charge of 240 C passes through a motor in 4.0 minutes. Find the current. (Hint: change the time into seconds first.) [3]

2.3 A student wants to measure a current of about 0.25 A. Her ammeter has ranges of 0–100 mA, 0–1 A and 0–10 A. State which range she should use and explain why. [2]

2.4 A cell does 27 J of work moving 18 C of charge round a circuit. Find its e.m.f. [2]

2.5 A p.d. of 12 V across a heater drives a current of 0.50 A through it. Find its resistance. [2]

2.6 Wire P has a resistance of 6.0 Ω. Wire Q is made of the same metal and is the same thickness as P, but twice as long. Wire S is the same length as P but has twice the cross-sectional area. State the resistance of Q and of S. [2]

2.7 A 12 V motor draws a current of 2.5 A. Find its power, and the energy it transfers in 40 s. [3]

2.8 An electric oven is rated 3.0 kW. It is used for 1.5 hours each day for 10 days. Electricity costs 0.55 yuan per kWh. Find the cost. [3]

3 Exam-style questions

3.1 Two wires, X and Y, are made of the same metal at the same temperature. Y is twice as long as X and has half the cross-sectional area of X. The resistance of X is R. What is the resistance of Y? [1]

- **A** $R/4$
- **B** R
- **C** $2R$
- **D** $4R$

3.2 A charged rod is brought near a small ball hanging on a thread. The ball moves towards the rod. Which statement is correct? [1]

- **A** The ball must have the opposite charge to the rod.
- **B** The ball must be a conductor.
- **C** The ball may be uncharged.
- **D** The ball must have the same charge as the rod.

3.3 A phone charger is connected to the 230 V mains. It supplies a current of 2.0 A at a p.d. of 5.0 V to the phone for 30 minutes.

(a) Define the potential difference across the phone. [1]

(b) Calculate the charge that flows into the phone in the 30 minutes. [3]

(c) Calculate the energy transferred to the phone in this time. [2]

(d) The case of the charger is made of plastic. Explain, in terms of electrons, why the plastic case does not conduct. [2]

3.4 A student is given a length of resistance wire, a cell, a switch, an ammeter, a voltmeter and a variable resistor.

(a) Draw a labelled circuit diagram she could use to find the resistance of the wire. [3]

(b) Describe how she uses the circuit to obtain a reliable value for the resistance. [3]

(c) Her readings are $V = 3.0$ V and $I = 0.60$ A. Calculate the resistance of the wire. [2]

(d) She replaces the wire with a filament lamp and increases the current. State and explain how the resistance of the lamp changes. [2]

3.5 A 1.5 kW electric kettle and a 100 W lamp are each switched on for 20 minutes.

(a) Calculate the energy, in kWh, used by the kettle. [2]

(b) Calculate how many times longer the lamp would have to be on to use the same energy as the kettle. [2]

(c) The kettle is connected to the 230 V mains. Calculate the current in the kettle. [2]

Solutions

2.1 $Q = It = 2.0 \times 15 = 30$ C.

2.2 $t = 4.0 \times 60 = 240$ s; $I = \dfrac{Q}{t} = \dfrac{240}{240} = 1.0$ A.

2.3 The 0–1 A range. It is the smallest range above 0.25 A, so the needle moves well up the scale and the reading is more accurate; the 0–100 mA range would be overloaded and the 0–10 A range would read only coarsely.

2.4 $E = \dfrac{W}{Q} = \dfrac{27}{18} = 1.5$ V.

2.5 $R = \dfrac{V}{I} = \dfrac{12}{0.50} = 24\ \Omega$.

2.6 Q: twice the length, so 12 Ω. S: twice the area, so 3.0 Ω.

2.7 $P = IV = 2.5 \times 12 = 30$ W; $E = Pt = 30 \times 40 = 1200$ J.

2.8 $E = 3.0 \times 1.5 \times 10 = 45$ kWh; cost $= 45 \times 0.55 = 24.75 \approx 25$ yuan.

3.1 D. Twice the length doubles the resistance and half the area doubles it again, so $R_Y = 4R$. A takes both changes the wrong way, B assumes they cancel, and C counts only the length.

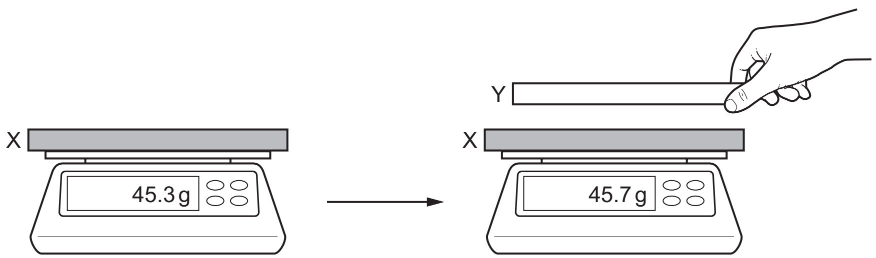
3.2 C. A charged rod attracts an uncharged object as well as an oppositely charged one, so attraction proves nothing; only repulsion is a sure test.

3.3 (a) The work done by a unit charge (one coulomb) passing through the phone.
(b) $t = 30 \times 60 = 1800$ s; $Q = It = 2.0 \times 1800 = 3600$ C.
(c) $E = IVt = 2.0 \times 5.0 \times 1800 = 18\,000$ J.
(d) Plastic has no free electrons; its electrons are held in their atoms, so charge cannot flow through it.

3.4 (a) Cell, switch, variable resistor and ammeter in series with the wire; voltmeter in parallel across the wire; correct symbols in a complete loop.
(b) Close the switch and read the ammeter and the voltmeter; adjust the variable resistor to obtain several pairs of readings; calculate $R = V/I$ for each pair and take the average, or plot V against I and use the gradient.
(c) $R = \dfrac{V}{I} = \dfrac{3.0}{0.60} = 5.0\ \Omega$.
(d) The resistance increases, because the filament gets hotter as the current rises.

3.5 (a) $E = 1.5 \times \dfrac{20}{60} = 0.50$ kWh.
(b) The lamp uses 0.10 kW, so it needs $\dfrac{0.50}{0.10} = 5.0$ h; 5.0 h ÷ 20 min = 15 times longer.
(c) $I = \dfrac{P}{V} = \dfrac{1500}{230} = 6.5$ A.

23 A charged rod X is placed on a balance and another rod Y is brought close to it, as shown.



Which combination of charges would cause the change in the balance reading shown?

	X	Y
A	negative charge	negative charge
B	negative charge	positive charge
C	negative charge	no charge
D	positive charge	no charge

24 What is the unit of potential difference (p.d.)?

A ampere

B coulomb

C coulomb / second

D volt

7 **(a)** Draw the circuit symbol for a potential divider.

[1]

(b) Fig. 7.1 shows a circuit.

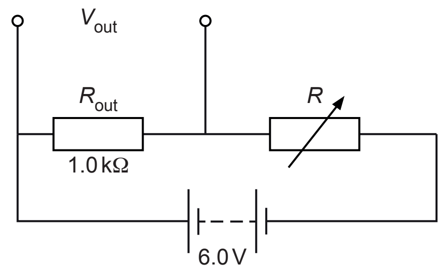


Fig. 7.1

(i) Calculate the value of V_{out} when the value of R is 3.0 kΩ.

V_{out} = ... [2]

(ii) The value of R is adjusted until the current in the circuit is 1.7 mA.

Calculate the charge that flows through the circuit in 300 s.

charge = ... [2]

[Total: 5]

3 **(a)** State the principle of conservation of energy.

....

....

.... [2]

(b) A wind turbine has a maximum output power of 1.8 MW. The turbine operates at maximum power for 4.0 h.

(i) Define the unit kW h.

....

....

.... [1]

(ii) Calculate the energy produced by the wind turbine operating at maximum power for 4.0 h. Give your answer in kW h.

energy = ... kW h [2]

(c) Radiation from the Sun is the main source of energy for most of our energy resources.

State **two** energy resources that are **not** due to radiation from the Sun.

....

.... [2]

[Total: 7]

7 Fig. 7.1 shows a circuit including a 12 V battery and two identical lamps.

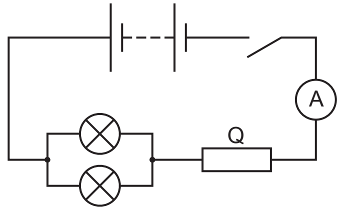


Fig. 7.1

(a) The 12 V battery consists of cells connected in series. Each cell in the battery has an electromotive force (e.m.f.) of 1.5 V.

Determine how many cells are in the battery.

number of cells = ... [1]

(b) **(i)** When the switch is closed, the ammeter reading is 2.4 A.

Calculate the total resistance of the circuit.

resistance = ... [2]

(ii) Each lamp has a resistance of 3.0 Ω.

Calculate the resistance of Q.

resistance of Q = ... [2]

(c) **(i)** On Fig. 7.1, draw the symbol for a voltmeter that measures the potential difference (p.d.) across the two lamps. [1]

(ii) Calculate the power supplied to **one** lamp.

power = ... [3]

IGCSE PHYSICS • EXERCISE SHEET

4.3 Electric circuits

Name: ____________ Class: ________ Date: __________ **Total: 12 marks**

KEY WORDS series and parallel 串联与并联 • electric circuits 电路 • potential divider 分压器 • parallel 并联 • series 串联

Objective

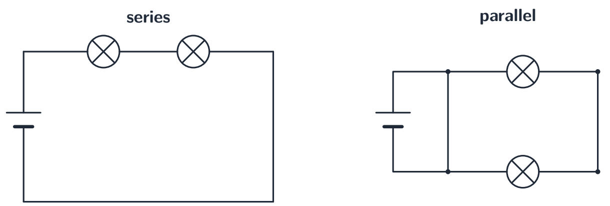
Build the skills to answer exam questions on **electric circuits 电路** — **series and parallel 串联与并联** rules, combining resistors, and **potential dividers 分压器**.

You must be able to:

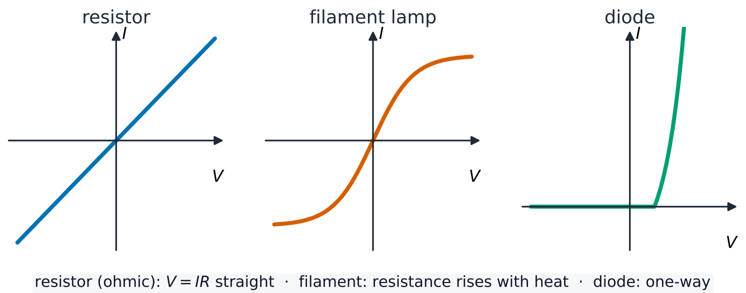
- use the current/p.d. rules for series and parallel circuits
- add series resistors and combine two parallel resistors
- use the potential-divider idea ($\frac{R_1}{R_2} = \frac{V_1}{V_2}$)

1 Worked examples

■ Combining resistors



Series: same current, shared p.d., $R_{total} = R_1 + R_2$. Parallel: same p.d., split current, smaller total R



A resistor gives a straight I–V line; a filament lamp curves as it heats

6 Ω **and** 3 Ω **in parallel:** $\frac{1}{R} = \frac{1}{6} + \frac{1}{3} = \frac{1}{2} \Rightarrow R = 2\ \Omega$.

2 Practice

2.1 Two resistors of 4 Ω and 6 Ω are in series. Find the total resistance. [1]

2.2 State how the current behaves at every point in a series circuit. [1]

3 Exam-style questions

3.1 Compared with the smallest single resistor, two resistors in parallel give a total resistance that is: [1]

- **A** larger
- **B** smaller
- **C** the same
- **D** zero

3.2 A 12 V supply is connected to a 4 Ω and an 8 Ω resistor in series.

(a) Find the total resistance and the current. [3]

(b) Find the p.d. across the 8 Ω resistor. [2]

3.3 A 6 Ω and a 12 Ω resistor are connected in parallel across a 6 V supply. Find the total resistance and the total current from the supply. [4]

Solutions

2.1 $R = 4 + 6 = 10\ \Omega$.

2.2 the current is the same at every point.

3.1 **B**. Two resistors in parallel give a total smaller than the smaller one.

3.2 (a) $R = 4 + 8 = 12\ \Omega$; $I = \dfrac{V}{R} = \dfrac{12}{12} = 1.0$ A.
(b) $V = IR = 1.0 \times 8 = 8.0$ V.

3.3 $\dfrac{1}{R} = \dfrac{1}{6} + \dfrac{1}{12} = \dfrac{3}{12} = \dfrac{1}{4} \Rightarrow R = 4\ \Omega$; $I = \dfrac{V}{R} = \dfrac{6}{4} = 1.5$ A.

28 A student has two resistors.

One resistor has a resistance of 2.0 Ω and the other has a resistance of 40 kΩ.

Which statement is correct?

A When connected in parallel, the combined resistance is 1.9 Ω.

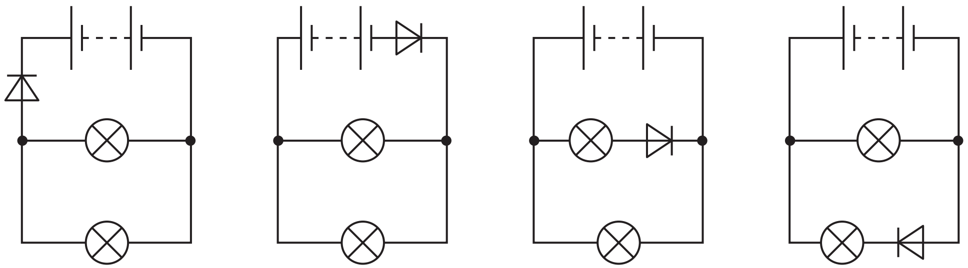
B When connected in parallel, the combined resistance is 2.0 Ω.

C When connected in series, the combined resistance is 1.9 Ω.

D When connected in series, the combined resistance is 42 Ω.

29 In which circuit do both lamps light?

A **B** **C** **D**



7 **(a)** Draw the circuit symbol for a potential divider.

[1]

(b) Fig. 7.1 shows a circuit.

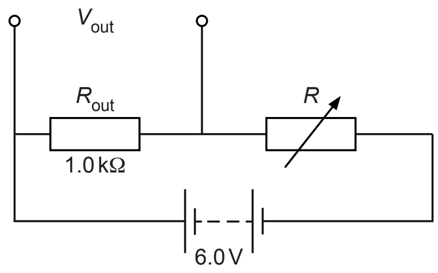


Fig. 7.1

(i) Calculate the value of V_{out} when the value of R is 3.0 kΩ.

V_{out} = ... [2]

(ii) The value of R is adjusted until the current in the circuit is 1.7 mA.

Calculate the charge that flows through the circuit in 300 s.

charge = ... [2]

[Total: 5]

7 **(a)** Define potential difference (p.d.).

....

.... [2]

(b) **(i)** State the equation which defines electromotive force (e.m.f.) *E*.

[1]

(ii) The e.m.f. of a battery is 9.0 V. The battery is in a circuit.

Calculate the work done by the battery when it moves a charge of 30 C around a complete circuit.

work done = ... [2]

(c) A circuit consists of a d.c. power supply, a lamp and a thermistor.

(i) Draw a circuit diagram of these components connected in series.

[2]

(ii) Explain what happens in the circuit you have drawn in **(c)(i)** when the temperature of the thermistor is increased.

....

....

.... [2]

[Total: 9]

7 Fig. 7.1 shows a circuit including a 12 V battery and two identical lamps.

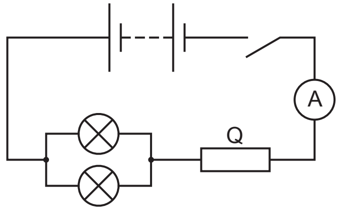


Fig. 7.1

(a) The 12 V battery consists of cells connected in series. Each cell in the battery has an electromotive force (e.m.f.) of 1.5 V.

Determine how many cells are in the battery.

number of cells = ... [1]

(b) **(i)** When the switch is closed, the ammeter reading is 2.4 A.

Calculate the total resistance of the circuit.

resistance = ... [2]

(ii) Each lamp has a resistance of 3.0 Ω.

Calculate the resistance of Q.

resistance of Q = ... [2]

(c) **(i)** On Fig. 7.1, draw the symbol for a voltmeter that measures the potential difference (p.d.) across the two lamps. [1]

(ii) Calculate the power supplied to **one** lamp.

power = ... [3]

IGCSE PHYSICS • EXERCISE SHEET

4.4 Electrical safety

Name: ____________ Class: ________ Date: __________ **Total: 11 marks**

KEY WORDS earthing 接地 • live wire 火线 • earth wire 地线 • fuses 保险丝 • neutral wire 零线

Objective

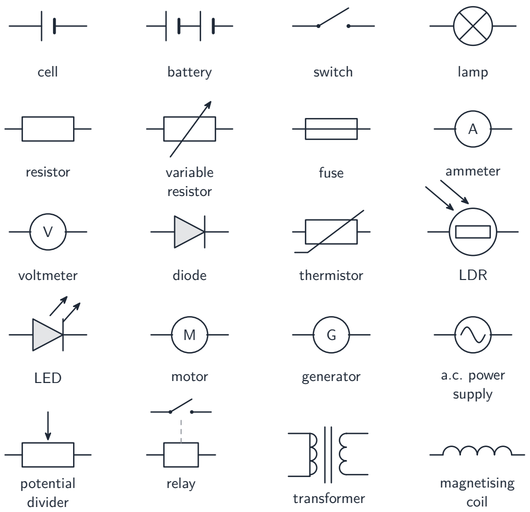
Build the skills to answer exam questions on **electrical safety** 电气安全 — mains **hazards** 危险, the live/neutral/earth wires, and **fuses** 保险丝 and **earthing** 接地.

You must be able to:

- state mains hazards (damaged insulation, overheating, damp, overloading)
- name the three mains wires and the role of each
- explain how a fuse and earthing protect the user

1 Worked examples

■ **Fuses and earthing**



A fuse is a thin wire that melts and breaks the circuit if the current is too large

- **wires:** live (high voltage), neutral (≈0 V), earth (safety wire to ground).
- the switch and fuse go in the **live** wire.
- **earthing:** if a live wire touches a metal case, a large current flows to earth and blows the fuse.
- choose a fuse rating just **above** the normal working current.

2 Practice

2.1 Name the three wires in a mains cable. [2]

2.2 State one hazard of using mains electricity in damp conditions. [1]

3 Exam-style questions

3.1 A fuse should be fitted in the: [1]

- **A** earth wire
- **B** neutral wire
- **C** live wire
- **D** casing

3.2 An appliance normally draws a current of 8 A. Fuses are available rated 3 A, 5 A, 10 A and 13 A.

(a) State which fuse should be used, and why. [2]

(b) Explain how the fuse protects the cable. [2]

3.3 Explain how earthing a metal-cased appliance keeps the user safe if a fault makes the case live. [3]

Solutions

2.1 live, neutral and earth.

2.2 water lets current pass into a person, increasing the risk of an electric shock.

3.1 **C**. The fuse (and switch) must be in the live wire.

3.2 (a) the 10 A fuse; it is just above the normal working current of 8 A, so it carries normal current but blows on a fault.
(b) if the current gets too large, the thin fuse wire melts and breaks the circuit before the cable overheats.

3.3 if a live wire touches the metal case, the earth wire provides a low-resistance path to the ground; a large current flows to earth; this blows the fuse, cutting off the supply so the case cannot give a shock.

IGCSE PHYSICS • EXERCISE SHEET

4.5 Electromagnetic effects

Name: ____________ Class: ________ Date: __________ **Total: 35 marks**

KEY WORDS transformer 变压器 • step-down 降压 • primary coil 原线圈 • secondary coil 副线圈 • a.c. generator 交流发电机 • step-up 升压 • a.c. generator 交流发电机 • electromagnetic induction 电磁感应 • step-down 降压 • electromagnetic effects 电磁效应

Objective

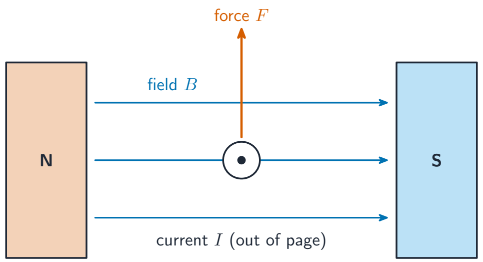
Build the skills to answer exam questions on **electromagnetic effects** 电磁效应 — the **motor effect** 电动机效应, **electromagnetic induction** 电磁感应, the a.c. generator, and **transformers** 变压器.

You must be able to:

- describe the force on a current-carrying wire (and how to reverse it)
- describe electromagnetic induction and the a.c. generator
- use $\dfrac{V_p}{V_s} = \dfrac{N_p}{N_s}$ for a transformer

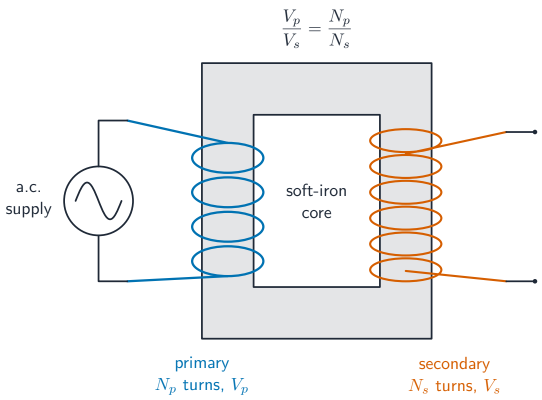
1 Worked examples

■ **Motor effect & transformer**



F, B and I are all at 90° (Fleming's left-hand rule)

A current-carrying wire in a magnetic field feels a force; reverse the current or field to reverse the force



$$\frac{V_p}{V_s} = \frac{N_p}{N_s} \text{ — \textit{the voltage ratio equals the turns ratio}}$$

$N_p = 1200$, $N_s = 100$, $V_p = 240$ **V:** $V_s = 240 \times \frac{100}{1200} = 20$ V (step-down).

Induction, the generator and the transformer

An e.m.f. is **induced** 感应 whenever a conductor cuts across a magnetic field or the field through a coil changes. The induced e.m.f. is larger with a **stronger magnet**, a **faster movement**, or **more turns** on the coil, and it always opposes the change causing it. Find the direction of the induced current with **Fleming's right-hand rule** 弗莱明右手定则 (thumb = motion, first finger = field, second finger = current); for the force on a current-carrying wire use the left-hand rule instead.

In an **a.c. generator** 交流发电机 a coil spins in a magnetic field, and **slip rings** 滑环 with brushes carry the current out. The e.m.f. is largest when the coil is flat, because its sides then cut the field fastest, and zero when the coil is upright, because its sides move along the field. So the e.m.f.-time graph is a sine curve: peak, zero, opposite peak, zero for each turn.

A **transformer** 变压器 has a **primary coil** 原线圈 and a **secondary coil** 副线圈 wound on a laminated **soft-iron core** 软铁芯. The a.c. in the primary makes a changing field in the core; the core carries that field to the secondary, where it induces an alternating e.m.f. It works only on a.c., because a steady current makes no change of field.

$$\frac{V_p}{V_s} = \frac{N_p}{N_s} \qquad I_p V_p = I_s V_s \text{ (at 100\% efficiency)}$$

Worked example (transmission). A power station sends 2.0 MW along cables of total resistance 5.0 Ω. Compare the loss at 10 kV and at 400 kV.

1. At 10 kV: $I = \frac{P}{V} = \frac{2.0 \times 10^6}{10\,000} = 200$ A, so the loss is $I^2R = 200^2 \times 5.0 = 200\,000$ W, a tenth of the power sent.
2. At 400 kV: $I = \frac{2.0 \times 10^6}{400\,000} = 5.0$ A, so the loss is $5.0^2 \times 5.0 = 125$ W.

That is why a step-up transformer raises the voltage for transmission and a step-down transformer lowers it again for homes: the same power at a higher voltage needs a smaller current, and the heating loss I^2R falls with the square of the current.

2 Practice

2.1 State two ways to increase the force on a current-carrying wire in a magnetic field. [2]

2.2 State what a step-up transformer does to the voltage. [1]

2.3 State three ways to increase the e.m.f. induced in a coil by a moving magnet. [3]

2.4 State the two parts that carry the current out of a spinning generator coil, and state where in the turn the e.m.f. is zero. [2]

2.5 Describe the construction of a simple transformer. [3]

3 Exam-style questions

3.1 Reversing the current in a wire in a magnetic field: [1]

- **A** removes the force
- **B** reverses the force
- **C** doubles the force
- **D** has no effect

3.2 A transformer has 200 turns on the primary and 1000 turns on the secondary. The primary voltage is 12 V.

(a) Find the secondary voltage. [3]

(b) State whether this is a step-up or step-down transformer. [1]

3.3 Describe how an e.m.f. is induced when a magnet is moved into a coil, and state two ways to make the induced e.m.f. larger. [3]

3.4 A power station generates 2.0 MW of electrical power, transmitted through cables of total resistance 5.0 Ω.

(a) A step-up transformer raises the voltage to 400 kV. Calculate the current in the cables. [2]

(b) Calculate the power wasted as heat in the cables. [2]

(c) Explain why much more power would be wasted if the voltage were only 10 kV. [2]

(d) The step-up transformer has 500 turns on its primary and the generator supplies 20 kV. Calculate the number of turns on the secondary. [3]

(e) Explain why a transformer cannot be used with a direct current. [1]

3.5 A student spins a coil between the poles of a magnet and connects it to an oscilloscope.

(a) Sketch the e.m.f. against time for two complete turns of the coil. [2]

(b) Explain, by referring to the position of the coil, why the e.m.f. is zero twice in each turn. [2]

(c) The student spins the coil faster. State two changes to the trace. [2]

Solutions

2.1 increase the current; use a stronger magnetic field.

2.2 it increases (steps up) the voltage.

2.3 Any three of: use a stronger magnet; move the magnet or coil faster; use more turns on the coil; use a coil of larger area.

2.4 Slip rings and carbon brushes. The e.m.f. is zero when the coil is upright, so its sides move along the field instead of cutting across it.

2.5 Two coils, a primary and a secondary, wound on a soft-iron core that links the coils magnetically but is not electrically connected to them.

3.1 **B**. Reversing the current reverses the direction of the force.

3.2 (a) $\dfrac{V_p}{V_s} = \dfrac{N_p}{N_s}$; $\dfrac{12}{V_s} = \dfrac{200}{1000}$; $V_s = 12 \times 5; = 60$ V.
(b) step-up (more turns on the secondary).

3.3 moving the magnet changes the magnetic field through the coil, which induces an e.m.f.; make it larger by moving the magnet faster; use a stronger magnet or more turns on the coil.

3.4 (a) $I = \dfrac{P}{V} = \dfrac{2.0 \times 10^6}{400\,000} = 5.0$ A.
(b) $P = I^2R = 5.0^2 \times 5.0 = 125$ W.
(c) At 10 kV the current would be 200 A, forty times larger; the loss is I^2R, so it would be about 1600 times larger, roughly 200 kW.
(d) $\dfrac{V_p}{V_s} = \dfrac{N_p}{N_s}$; $\dfrac{20\,000}{400\,000} = \dfrac{500}{N_s}$; $N_s = 10\,000$ turns.
(e) A direct current gives a steady magnetic field in the core, and a field that does not change induces no e.m.f. in the secondary.

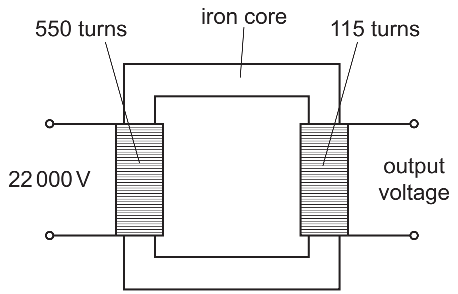
3.5 (a) A sine-shaped curve crossing zero twice per turn, with two complete cycles shown.
(b) The e.m.f. is zero when the coil is upright, because its sides are then moving parallel to the field lines and cut none of them.
(c) The peaks are higher and the cycles are closer together, so the frequency is higher.

32 A 24 V power supply and a 100% efficient transformer are used to light a 6.0 V, 12 W lamp.

What is the current in the power supply?

A 0.50 A **B** 2.0 A **C** 3.0 A **D** 8.0 A

25 The diagram shows a transformer.



What is the output voltage?

A 0.35 V **B** 2.9 V **C** 4600 V **D** 105 000 V

8 **(a)** Fig. 8.1 shows a wire carrying a large current.

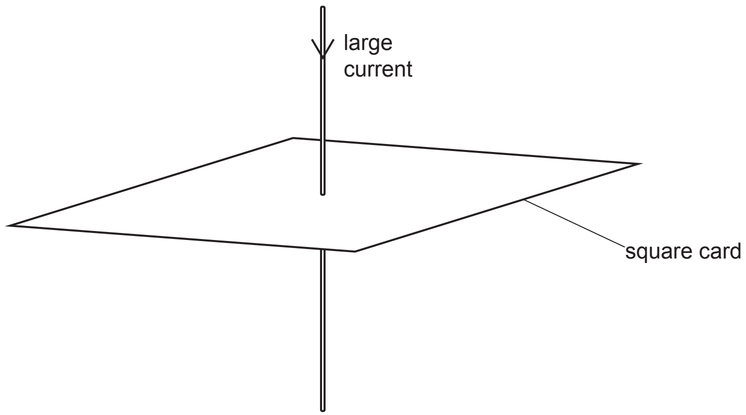


Fig. 8.1

(i) Fig. 8.2 shows the square card viewed from above.

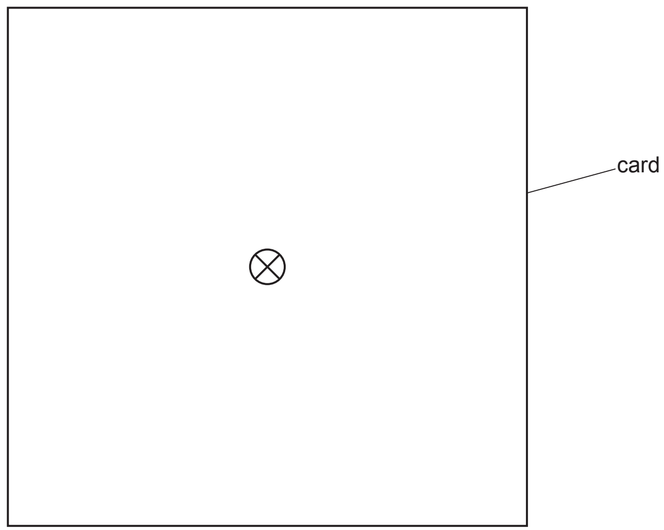


Fig. 8.2

On Fig. 8.2, draw **three** magnetic field lines that indicate the direction of the magnetic field and how its strength varies with distance from the wire. [3]

(ii) The current in the wire increases and the direction of the current is reversed.

State how these changes affect the magnetic field.

....

[2]

(b) Electricity is transmitted at high voltage.

Explain why a high voltage increases the efficiency of transmission even with thinner wires.

....

....

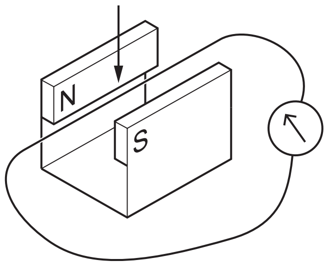
....

.... [3]

[Total: 8]

IGCSE Physics: **m23 22**

30 A wire is moved down in a direction perpendicular to the magnetic field.



Three changes are suggested.

1. The speed of the movement of the wire is increased.
2. The magnetic field strength is decreased.
3. The direction of the magnetic field is reversed.

Which changes increase the electromotive force (e.m.f.) induced in the wire?

A 1 and 3 **B** 1 only **C** 2 and 3 **D** 3 only

8 Fig. 8.1 shows a horizontal, flat coil in a magnetic field

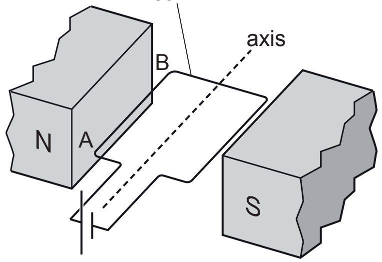


Fig. 8.1

The coil is connected to a cell. The coil rotates.

(a) Determine the direction of movement of the side AB relative to the plane of the coil.

direction of movement = ... [1]

(b) Explain how you determined the direction in **(a)**.

....

....

.... [2]

(c) State and explain what happens to the coil as it reaches the vertical position.

....

....

....

.... [2]

(d) To operate as a motor, a split-ring commutator and brushes are added to the parts shown in Fig. 8.1.

Explain the effects of the split-ring commutator and the brushes on the action of the motor.

....

....

.... [3]

[Total: 8]