DO NOT WRITE ABOVE THIS LINE

1. Galileo and Copernicus were two famous scientists who worked hard to convince the world about the movements of the Earth and the Sun.

a. Valentina is standing on point A on the Earth while Martin is standing on point B.
   i. State if it is day or night where Martin is standing (point B).

Day

(1 mark)

   ii. Who would be during the night 36 hours later, Valentina or Martin?

Martin

(1 mark)

   iii. Is it summer or winter in Martin's point? Explain.

Winter since he is in the Southern hemisphere which is tilted away from the sun + is furthest away from Sun.

(3 marks)

b. How long would it take the Earth to spin once round the sun?

365¼ days

(1 mark)

c. All the following form part of the Universe.

Milky Way **Solar System** **Earth** **Sun**

   i. Place the above terms in a list according to their size, smallest first.

Earth, Sun, Solar System, Milky Way

(2 marks)

   ii. The diameter of a galaxy is measured in light years. What is a light year?

The distance travelled by light in a year.

(1 mark)

d. Identify one economic benefit of space exploration.

It increases a country's economy + tourism.

(1 mark)

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2. Male mosquitoes beat their wings approximately 36000 times in 1 minute and fly at a speed of 6.5 m/s. The speed of sound of wing beats is 330 m/s.

a. Calculate the frequency of the sound waves produced by the mosquitoes.

36000 times → 1 min (60 sec)
? → 1 sec

$\frac{1 \times 36000}{60} = 600$ Hz

(2 marks)

b. Calculate the wavelength of the sound wave produced by the mosquito.

$v = f\lambda$ $\quad 330 = 600\lambda$ $\quad \lambda = \frac{330}{600} = 0.55$ m

(1 mark)

c. Calculate the time taken for a mosquito to travel 1500 m.

speed $= s/t$ $\quad 6.5 = \frac{1500}{t}$ $\quad t = \frac{1500}{6.5} = 231$ s

(1 mark)

d. Every year a number of hedgehogs are run over by vehicles. It has been suggested that a whistle emitting a sound wave of 45000 Hz is attached to the front of a car. The movement of the car forces air into the whistle and creates the sound. When the hedgehog hears the whistle it will remain at the side of the road.

i. State and explain how the sound travels from the whistle to the hedgehog.

Air particles in the whistle are made to vibrate parallel to the direction of travel of the wave, as rarefactions & compressions

(2 marks)

ii. People might complain that in this way roads are going to be noisier. Do you agree? Explain.

No, since 45000 Hz is ultrasound, ∴ outside of the audible range of frequencies for the human ear.

(2 marks)

iii. What do you think will happen to the sound produced if the car moves faster? Explain

When car moves faster, the particles will have more energy ∴ a bigger amplitude.

(2 marks)

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3. Nuclear power plants use Uranium-238 to produce energy.

a. The atom of Uranium-238 is represented as:

$$^{238}_{92}U$$

i. Which particles does the number 238 represent?

protons + neutrons

(1 mark)

ii. What is this number usually called?

mass number or nucleon number

(1 mark)

iii. What is the charge of the particles mentioned in part (i)?

positive

(2 marks)

iv. Why is the net charge of an atom of Uranium-238 neutral?

because if there are 92 protons,

(2 marks)

b. The table below shows the daily count rate of another radioactive element X:

Day	0	1	2	3	4	5	6	7
Count Rate	6000	4601	3604	3005	2300	1800	1500	1154

i. From the table above estimate the half-life of the radioactive element X. Explain your reasoning.

$\frac{6000}{2} = 3000$ (which is close to 3005)

∴ half life is 3 days

(2 marks)

ii. Hence, deduce the values for the count rate for day 6 and day 7.

3000 ÷ 2 = 1500 for day 6.

for day 7 ∴ 6000 ÷ 4601 = 1.3, 3005 ÷ 2300 = 1.3

∴ 1500 ÷ 1.3 =

(2 marks)

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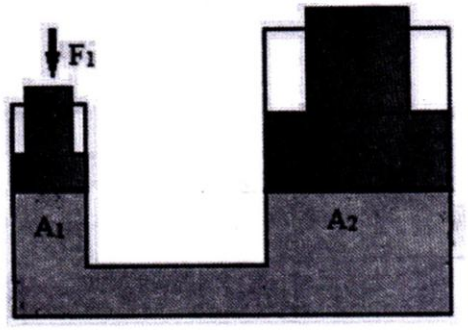
4. a. Define the term *pressure*. State its units.

Pressure is the force per unit area, Pascals. (Pa)

(2 marks)

b. The diagram shows a hydraulic press used for crushing waste paper.



i. Explain in terms of pressure, how the hydraulic press works.

The force F_1 will cause a pressure in the liquid by A_1, which is then transferred equally throughout all the liquid, until it reaches Piston A_2 and causes a Force on the waste paper.

(2 marks)

ii. The area of piston A_1 is 0.4 m^2. A force of 50 N is used to push the handle in. Calculate the pressure exerted by the piston A_1.

$P = F/A = 50/0.4 = 125$ Pa

(2 marks)

iii. The area of piston A_2 is 2.0 m^2 calculate the force piston A_2 exerts on the waste paper.

$P = F/A \quad 125 = F/2 \quad \therefore F = 125 \times 2 = 250$ N.

(2 marks)

iv. Which fluid would you recommend between air and oil in the hydraulic system? Explain.

Oil since it is nearly incompressible

(2 marks)

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5. The table shows the braking distance for a car at different speeds and kinetic energy.

braking distance (m)	5	9	18	28	40
speed of Car (m/s)	10	15	20	25	30
Kinetic Energy of Car (kJ)	20	45	80	125	180

a. Use one set of values from the above table to calculate the mass of the car.

$KE = \frac{1}{2} mv^2$ $m = 0.4kg$.

$125 = \frac{1}{2} m (25^2)$

$\frac{125 \times 2}{25^2} = m$

(2 marks)

b. Jeremy suggests that the braking distance is directly proportional to the kinetic energy.

i. Draw a graph of braking distance (m) on the x-axis and kinetic energy (kJ) on the y-axis.

(5 marks)

ii. Does the graph show that Jeremy's suggestion is correct or not? Give **one** reason for your answer.

Yes, KE is directly proportional to the Braking distance since the graph resulted to be a straight line through origin.

(2 marks)

c. Explain how energy is conserved during braking.

During braking, the K.E of car is transformed to heat & sound energy.

(1 mark)

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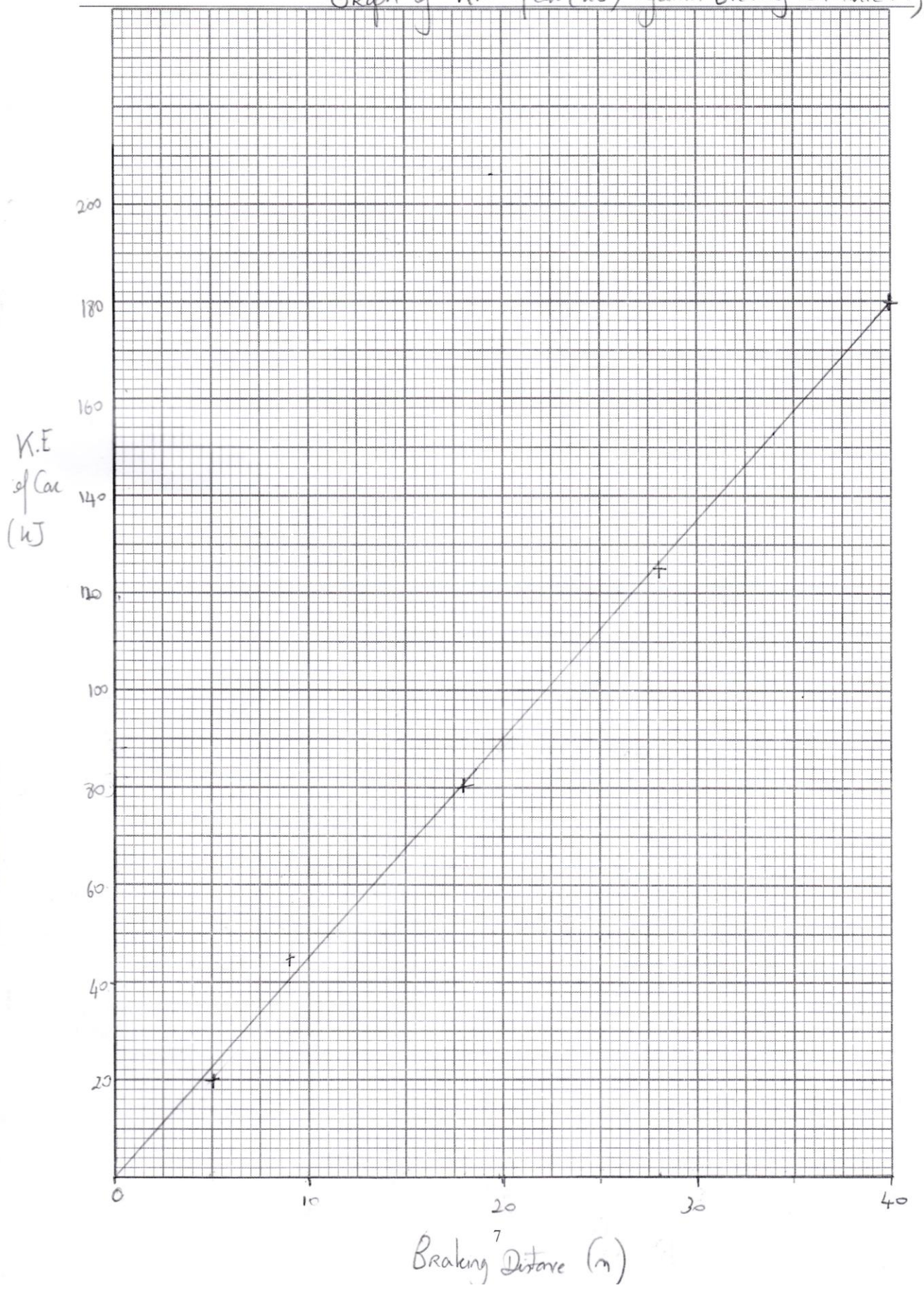
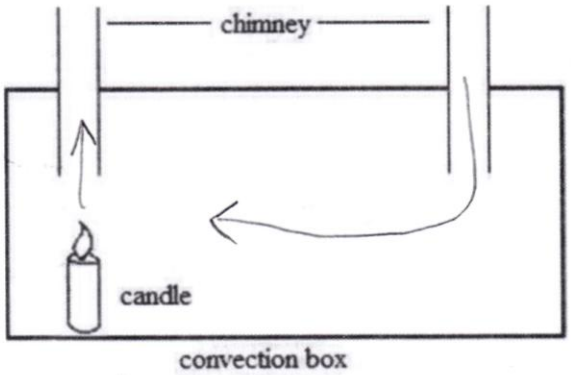
Graph of K.E. of car (kJ) against Braking Distance (m).



6. a Sean and Carol demonstrate convection currents in air in their school laboratory by means of the convection box shown in the diagram. They light a candle under one of the chimneys.



convection box

i. On the diagram, draw arrows to show the direction of air flow in and out of the box. (1 mark)

ii. Use the kinetic theory to explain the movement of air particles in this experiment.

Heating → increase in K.E → decrease in density, ∴ heated air rises due to a smaller density compared to cool air

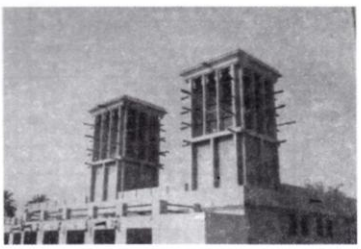
(2 marks)

* iii. Explain why convection cannot take place in a solid.

In a solid, one cannot change the density by heating. ∴ convection currents cannot occur.

(2 marks)

b. In very warm countries some traditional houses have two wind towers. Wind towers are built high above the ground where wind velocity is greater.



* i. Explain how the air currents keep the residential houses cool.

Since warm/hot air rises by convection,

(2 marks)

ii. The breeze increases evaporation from the skin of the people inside the building. Explain how this evaporation helps to reduce the body temperature.

Evaporation cools the body, reducing the temperature due to a decrease in energy.

(2 marks)

iii. Shading, vegetation close to the building, and use of reflective outside paint coatings are other features of buildings. State how a building is kept cool using **one** of these features.

reflective outside paint is a good reflector of heat, ∴ heat transfer by radiation is reduced (1 mark)

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7. Joanne went with her class for a visit to the Power Station.

a. They were told that the Power Station generates a.c. for the whole country and is supplied through the mains to our households.

i. What does a.c. stand for?

alternating current

(1 mark)

ii. Give one characteristic of a.c.

the + and - teeminals of battery are continuously swapping places.

(1 mark)

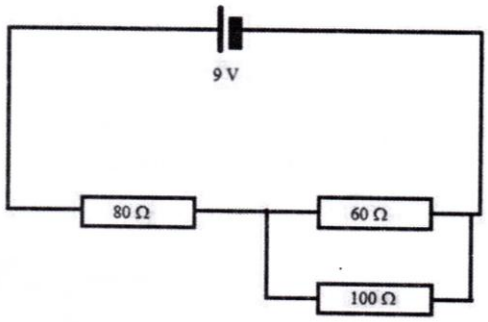
iii. The a.c. supplied to our houses flows through two wires – one BLUE and one BROWN. What are these wires called?

BLUE: neutral

BROWN: live

(2 marks)

b. The circuit diagram shows three resistors connected to a 9 V battery.



i. State the type of connection between the 60 Ω and the 100 Ω resistor.

in parallel

(1 mark)

ii. Calculate the total resistance in the circuit.

$\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{60} + \frac{1}{100} = \frac{2}{75}$ $\therefore R_t = 75/2 = 37.5\,\Omega$

$R_t = R_1 + R_2 = 80 + 37.5 = 117.5\,\Omega$

(3 marks)

iii. Hence find the current coming out of the battery.

$V = IR$

$9 = I(117.5)$

$I = 9/117.5 = 0.08\ A$

(2 marks)

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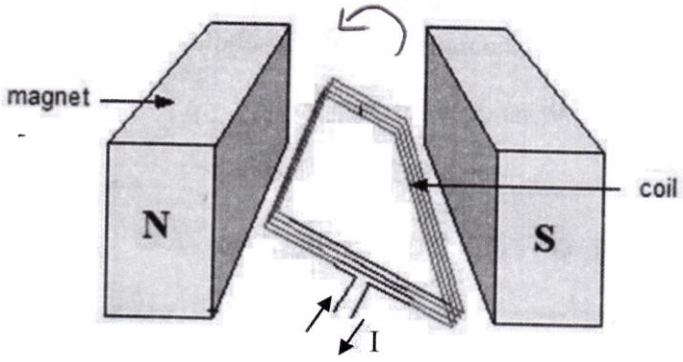
8.a Joe and Caroline searched for a picture of an electric motor on the internet and found the one below.



i. Draw an arrow on the diagram to show the direction in which the coil turns (use Fleming's left hand rule).

anticlockwise (1 mark)

ii. Explain why the coil turns.

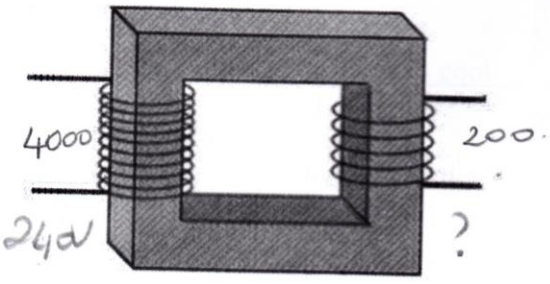
Since there is a magnetic field cutting an electric field, the wire experiences a force. Since current in each side is in the opposite direction then the force is in the opposite direction, causing rotation. (3 marks)

iii. Name **two** changes that can be done to the electric motor to increase its speed.

- increase the no. of turns of the coil.
- increase the current.

(2 marks)

b. The diagram below shows an iron core transformer. The primary and secondary coils of the transformer have 4000 and 200 turns, respectively. The primary circuit is connected to a 240 V a.c. supply.



i. Calculate the voltage across the secondary.

$\frac{N_p}{N_s} = \frac{V_p}{V_s}$ $\quad \frac{4000}{200} = \frac{240}{V_s}$ $\quad V_s = \frac{240 \times 200}{4000}$ $\quad V_s = 12\ V.$

(2 marks)

ii. Explain why the primary current must be alternating.

Current in primary is a.c, so that there will be continuous cutting of magnetic lines of flux, ∴ a continuous a.c. is induced in the secondary coil. (2 marks)

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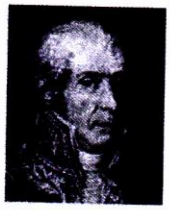
9. The greatest achievement of the Italian physicist, Alessandro Volta, was the invention of the electric battery in 1794.



a. In the space below, draw the appropriate circuit symbol of a battery and indicate the positive terminal with a "+".

(2 marks)

b. A battery is used to push charge round a circuit.

i. Charge is measured in Coulombs (C). (1 mark)

ii. **State** the energy conversion in a battery.

chemical energy to electrical energy.

(1 mark)

c. A 2.4 V battery is capable of delivering 1.5 A for 2 days.

i. How much charge will the battery **push** round the circuit, if 1.5A flow for 2 days?

$Q = It = 1.5 (2 \times 24 \times 3600)$

$Q = 259,200\ C$

(2 marks)

ii. How much energy is supplied by the battery? Give your answer in kJ.

$E = QV = 259200 \times 2.4 = 622080\ J$

$\therefore 622.08\ kJ.$

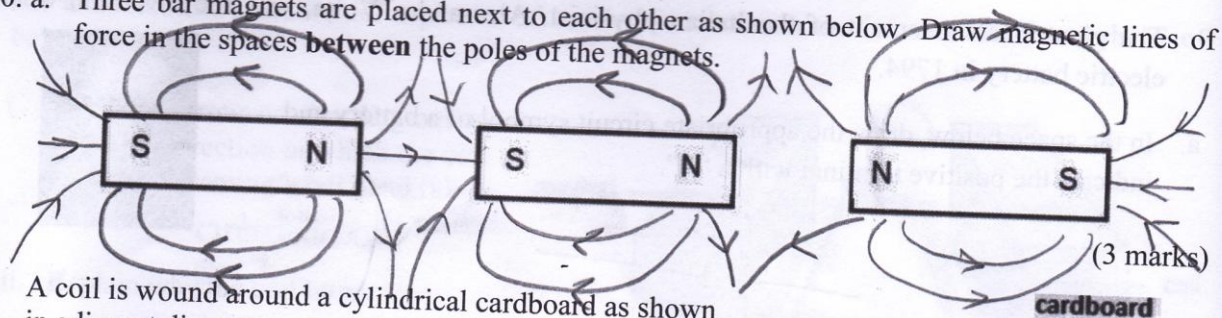
(3 marks)

d. Some calculators can be operated using batteries or a renewable source of energy. Mention a suitable source of renewable energy.

Solar energy

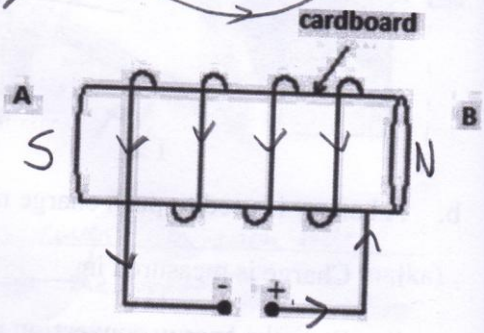
(1 mark)

10. a. Three bar magnets are placed next to each other as shown below. Draw magnetic lines of force in the spaces **between** the poles of the magnets.



(3 marks)

b. A coil is wound around a cylindrical cardboard as shown in adjacent diagram.

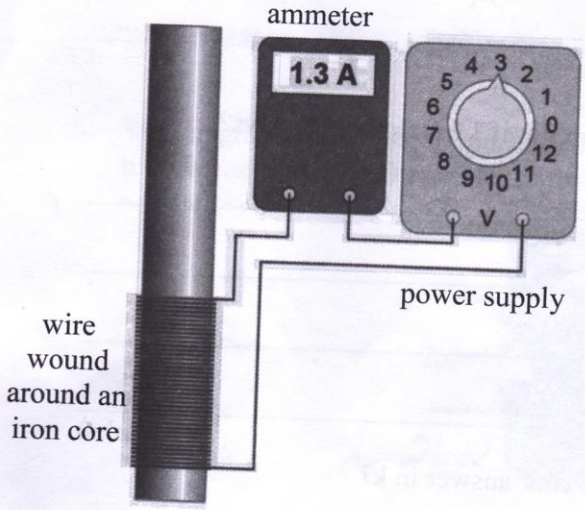


Mark on the diagram,

i. the direction of the current;
ii. the magnetic polarity of the ends A and B.

(2 marks)

c. James and Rachel set up an experiment in the school laboratory as shown below.



iron nails

i. What did they observe when the circuit is switched on?

the iron nails are attracted to the iron core

(1 mark)

ii. Describe what happens when they increase the number of turns of wire around the iron core and switch on the circuit. Explain.

more nails are attracted since the higher the no. of turns the stronger is the magnet produced

(2 marks)

iii. Assuming resistance is constant and without changing anything to the setup in part (ii) James and Rachel reduce the voltage in the circuit. Explain what is observed.

V ↓, ∴ I ↓, ∴ less nails are attracted since the smaller the current, the weaker is the magnet produced

(2 marks)