

4.2 Electrical quantities

01.0625_m23_qp_42 Q: 6

- (a) Sound waves have compressions and rarefactions.

Explain what is meant by compression and rarefaction.

compression

.....

rarefaction

.....

[2]

- (b) We can see light from the Sun but we cannot hear any sound from it.

State the reason for this.

.....

..... [1]

- (c) During a thunderstorm, an observer sees the lightning almost immediately but hears the sound of the thunder several seconds later. The thunder and lightning are produced at the same time.

The sound of the thunder is heard 9.0 s after the lightning is seen. The speed of sound in air is 340 m/s.

Calculate the distance from the thunderstorm to the observer.

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distance = [2]

4.2. ELECTRICAL QUANTITIES

(d) In a lightning strike, there is a current of $3.0 \times 10^4 \text{ A}$ for 48ms.

Calculate the charge that flows.

charge = [3]



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02. 0625_s23_qp_43 Q: 6

An electric heater uses a resistance wire of resistance 26Ω . The power dissipated in the resistance wire is 2500 W .

(a) Calculate the current in the resistance wire.

current = [3]

(b) The resistance wire of the heater has a length of 1.2 m and a cross-sectional area of $7.9 \times 10^{-7} \text{ m}^2$.

A new heater is designed using wire of the same material with length 1.8 m and cross-sectional area $5.8 \times 10^{-7} \text{ m}^2$.

Calculate the resistance of this wire.

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(c) The 2500 W heater is used in a country where electricity costs 0.30 dollars per kilowatt-hour.

Calculate the cost of using the heater continuously for two days.

cost = dollars [2]

4.2. ELECTRICAL QUANTITIES

03. 0625_w23_qp_41 Q: 7

(a) A plastic rod is uncharged.

When the rod is rubbed with a woollen cloth, the rod becomes negatively charged.

Explain, in terms of particles, why the rod becomes negatively charged.

.....
.....
..... [2]

(b) Fig. 7.1 shows a negatively charged metal sphere S.

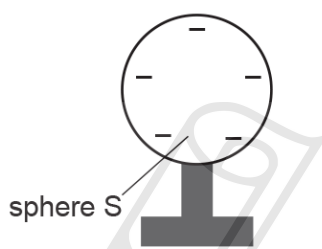


Fig. 7.1

There is an electric field surrounding S.

(i) State what is meant by an electric field.

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

(ii) On Fig. 7.1, draw the pattern of the electric field surrounding sphere S and indicate its direction. [2]

(c) Fig. 7.2 shows a small negative charge Z placed near to sphere S.

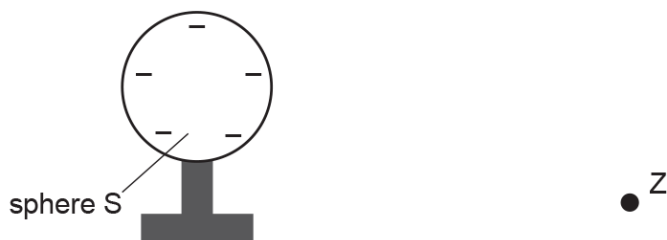


Fig. 7.2

Charge Z experiences a force due to the electric field surrounding S.

On Fig. 7.2, draw an arrow to show the direction of this force on Z. [1]

04. 0625_w23_qp_43 Q: 7

(a) Fig. 7.1 shows the electric field pattern around point X.

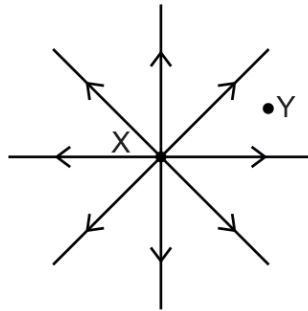


Fig. 7.1

(i) On Fig. 7.1, draw an arrow to indicate the direction of the force on a negative point charge placed at point Y. [2]

(ii) State what is at point X to produce the field pattern shown in Fig. 7.1.

.....
 [2]

(b) A piece of plastic is charged positively by friction.

State what charge transfers occur during this process.

.....

 [2]

(c) Explain how the structure of an electrical conductor differs from the structure of an electrical insulator.

.....
 [2]

4.2. ELECTRICAL QUANTITIES

05.0625_s22_qp_43 Q: 1

A battery provides energy to an electric car.

- (a) The electric car has an acceleration of 2.9 m/s^2 when it moves from rest. The combined mass of the car and its driver is 1600 kg.

- (i) Calculate the time taken to reach a speed of 28 m/s.

time = [2]

- (ii) Calculate the force required to produce this acceleration.

force = [2]

- (iii) Calculate the kinetic energy of the car when its speed is 28 m/s.

kinetic energy = [2]

- (b) The time taken for the car battery to be recharged from zero charge to full charge is 8.3 h. The charge is delivered to the battery by a charger with a current of 32 A.

Calculate the charge supplied by the charger.

charge = [3]

- (c) Under ideal conditions, the car can travel a maximum distance of 390 km when the battery is fully charged.

Suggest why, in normal use, the car needs to be recharged after travelling less than 390 km.

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

06. 0625_w22_qp_42 Q: 8

Fig. 8.1 shows an electrical circuit.

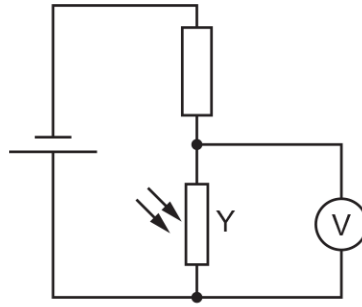


Fig. 8.1

- (a) The light intensity at the circuit increases from dark to bright.

State any effect on the resistance of component Y.

.....

State and explain any effect on the reading of the voltmeter.

.....

.....

[3]

- (b) The circuit shown in Fig. 8.2 is switched on for 2.0 min.

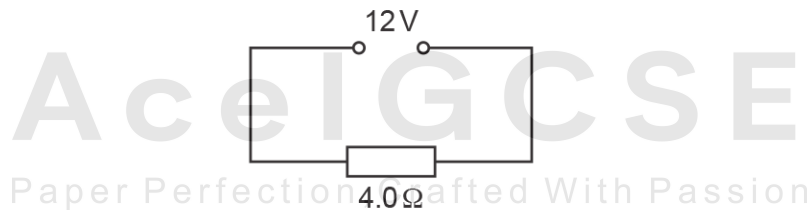


Fig. 8.2

The current in the 4.0Ω resistor is 3.0A and the magnitude of the charge on an electron is $1.6 \times 10^{-19}\text{C}$.

- (i) Calculate the number of electrons that pass through the resistor each second.

number = [3]

- (ii) Calculate the power dissipated by the resistor.

power = [2]

08.0625_s21_qp_42 Q: 9

(a) Fig. 9.1 shows a circuit.

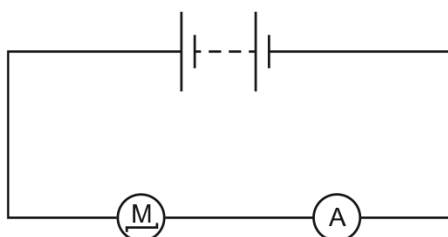


Fig. 9.1

On Fig. 9.1, draw **two** clearly labelled arrows to show the direction of the electron flow and the direction of the conventional current in the circuit. [2]

(b) The current in the motor is 13A. The charge on an electron is $1.6 \times 10^{-19}\text{C}$.

Calculate the number of electrons that pass through the motor every second.

number of electrons = [3]

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4.2. ELECTRICAL QUANTITIES

09. 0625_w21_qp_41 Q: 7

A plastic rod becomes negatively charged when it is rubbed with a woollen cloth.

- (a) Describe, in terms of particles, how the rod becomes negatively charged when rubbed with the cloth.

.....
.....
..... [2]

- (b) A light, conducting ball is at rest on a metal table. When the rod is brought close to the ball, as shown in Fig. 7.1, the ball jumps up towards the rod.

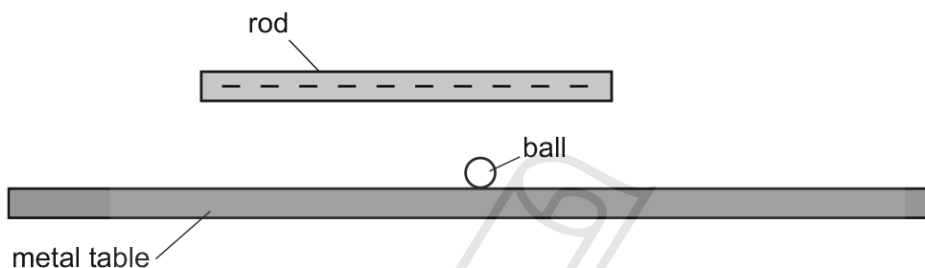


Fig. 7.1

- (i) Explain why the ball jumps up.

.....
.....
..... [3]

- (ii) The ball touches the rod and falls back down to the table.

Explain why this happens.

.....
.....
..... [2]

10. 0625_w21_qp_42 Q: 8

- (a) Fig. 8.1 shows a conducting object A, initially uncharged, held on an insulating stand. The positively charged rod B is brought close to object A.

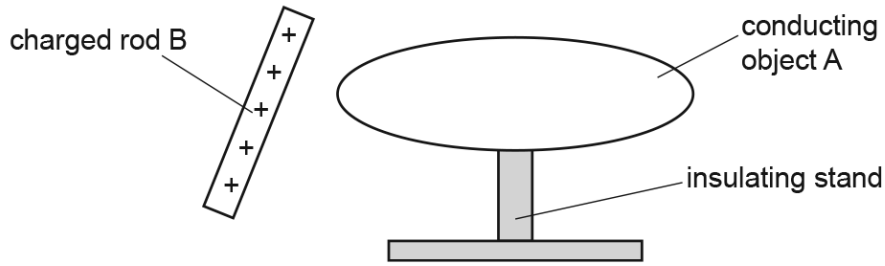


Fig. 8.1

- (i) On Fig. 8.1, draw the distribution of charges on object A. [2]

- (ii) A wire is connected from object A to earth.

State and explain any movement of charge.

statement

explanation

.....

..... [2]

- (b) There is a current in a wire of 0.65 mA for 2.2 minutes.

Calculate the charge that flows.

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charge = [3]

4.2. ELECTRICAL QUANTITIES

11. 0625_s20_qp_43 Q: 5

(a) Fig. 5.1 shows a plastic cup. The cup contains sand, an electric heater and a thermometer.

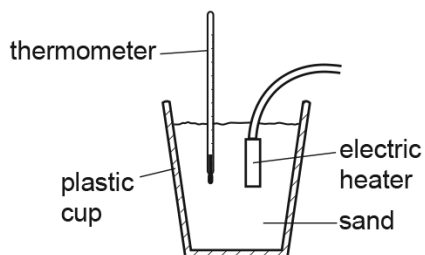


Fig. 5.1

The power of the heater is 50W. The mass of the sand in the cup is 550g. The initial temperature of the sand is 20 °C. The heater is switched on for 2.0 minutes. The temperature is recorded until the temperature stops increasing. The highest temperature recorded by the thermometer is 33 °C.

(i) Calculate the energy supplied by the heater.

energy = [2]

(ii) Calculate a value for the specific heat capacity of the sand, using your answer to (a)(i) and the data in the question.

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specific heat capacity = [3]

(iii) Explain why the specific heat capacity of sand may be different from the value calculated in (a)(ii).

.....
..... [2]

- (b) On a sunny day, the temperature of the sand on a beach is much higher than the temperature of the sea.

Explain why.

.....
.....
..... [2]

- (c) Draw a labelled diagram to show the structure of a thermocouple thermometer.

[3]

[Total: 12]



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4.2. ELECTRICAL QUANTITIES

12. 0625_s20_qp_43 Q: 8

(a) (i) Describe what is meant by an *electric field*.

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

(ii) State what is meant by the *direction* of an electric field.

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

(b) Fig. 8.1 shows a polystyrene ball covered with aluminium paint. The polystyrene ball is suspended between two charged metal plates by an insulated thread.

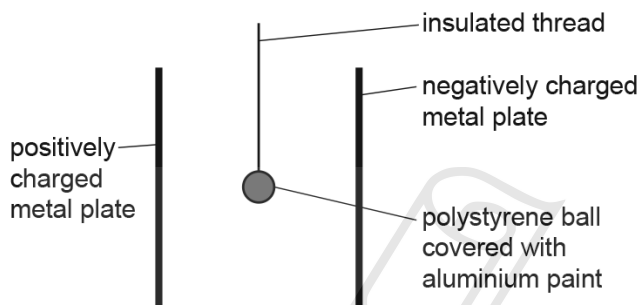


Fig. 8.1

The ball oscillates between the two charged plates.

Explain why the ball oscillates.

.....
.....
.....
.....
.....
..... [4]

(c) There is a current of 0.29A in an electrical circuit.

Calculate the time taken for a charge of 15C to flow through the electrical circuit.

time = [3]

[Total: 9]

13. 0625_w19_qp_41 Q: 5

Fig. 5.1 shows a sphere that is negatively charged. The sphere is attached to a plastic stand.

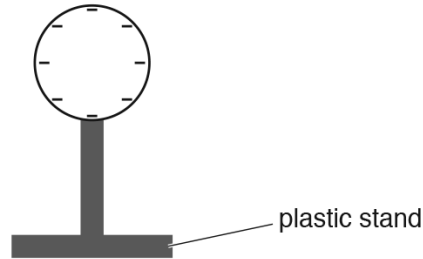


Fig. 5.1

- (a) On Fig. 5.1, draw arrows to indicate the pattern and direction of the electric field in the region surrounding the sphere. [2]
- (b) A smaller, uncharged metal sphere S is suspended by a plastic thread and brought close to the negatively charged sphere. Fig. 5.2 shows the two spheres.

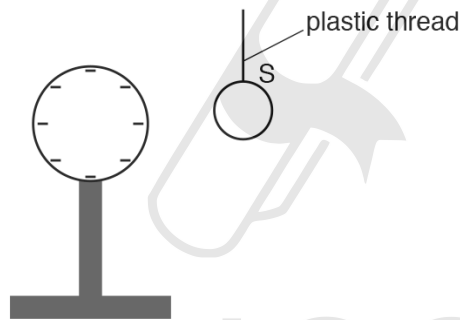


Fig. 5.2

- (i) By drawing on Fig. 5.2, indicate the distribution of charge on S. [2]
- (ii) State what happens to S. [1]

.....
 [1]

- (iii) An earth wire is then touched against S.

Describe what happens in the wire and state how this affects the charge on S.

.....

 [2]

4.2. ELECTRICAL QUANTITIES

(c) The metal sphere S is an electrical conductor. The plastic thread is an electrical insulator.

Explain this difference by referring to the structures of the two materials.

.....
.....
..... [2]

[Total: 9]



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14. 0625_w19_qp_41 Q: 7

The resistance of a 1.0 m length of resistance wire is $7.6\ \Omega$. A length of this wire is taped to a metre rule. A crocodile clip is connected to one end of the resistance wire exactly at the 0 m mark of the rule. Fig. 7.1 shows the crocodile clip connected to terminal P.

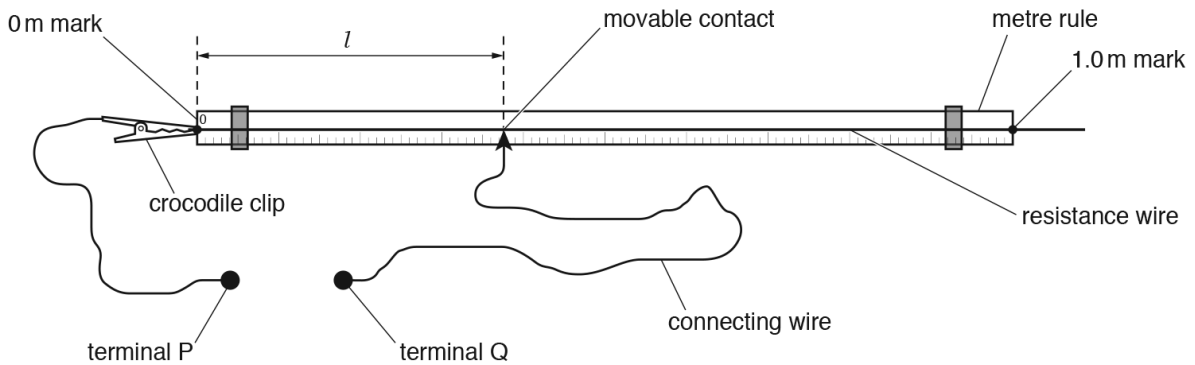


Fig. 7.1

A second terminal Q is connected to a movable contact using a long length of connecting wire. The movable contact is in contact with the resistance wire at a length l from the 0 m mark on the rule.

The movable contact is placed at different points on the resistance wire. The resistance R of the length l of the wire depends on l .

- (a) On Fig. 7.2, sketch a graph to show how R varies with l for values of l between $l = 0$ and $l = 1.0$ m. Mark appropriate values on the axes of the graph.



Fig. 7.2

[2]

4.2. ELECTRICAL QUANTITIES

(b) Fig. 7.3 shows a battery of electromotive force (e.m.f.) 12V connected across the 1.0 m length of the resistance wire.

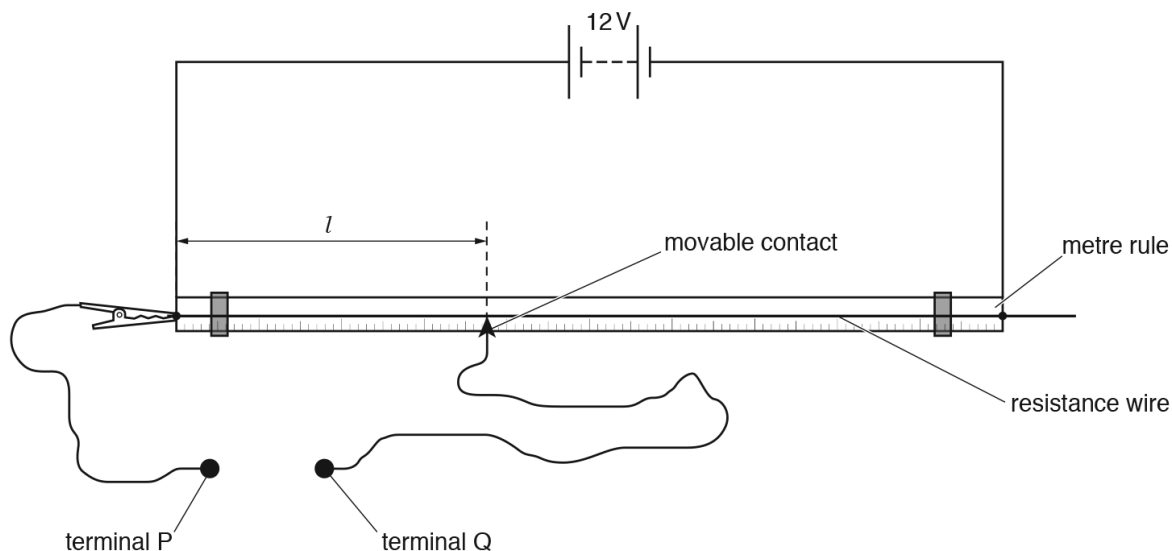


Fig. 7.3

(i) State what is meant by *electromotive force (e.m.f.)*.

.....

 [2]

(ii) Calculate:

1. the current in the resistance wire

current = [2]

2. the potential difference (p.d.) between terminal P and terminal Q when $l = 0.35\text{ m}$

p.d. = [1]

3. the charge that passes through the resistance wire in 5.5 minutes.

charge = [2]

[Total: 9]

15. 0625_w19_qp_42 Q: 9

(a) Describe what is meant by the term *electric field*.

.....
 [1]

(b) Fig. 9.1 shows two parallel conducting plates connected to a battery.

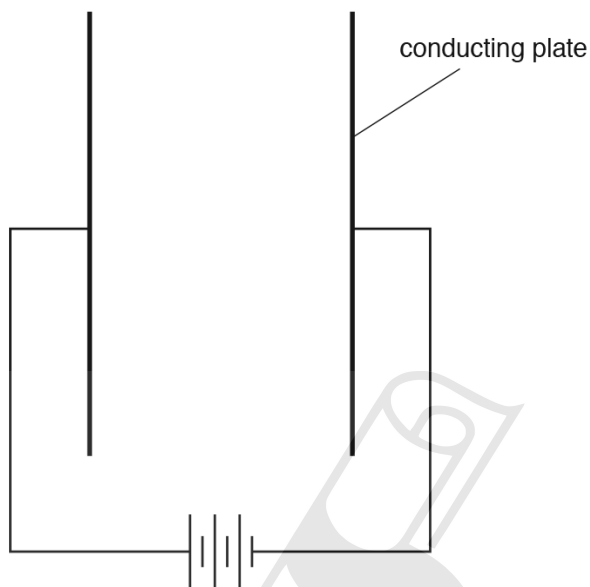


Fig. 9.1

On Fig. 9.1, draw **five** lines to show the electric field pattern between the two plates. [2]

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4.2. ELECTRICAL QUANTITIES

(c) When fully charged, a 1.2V rechargeable battery can deliver a current of 210mA for 10 hours.

(i) Calculate the charge that can be delivered by the fully charged battery.

charge = [3]

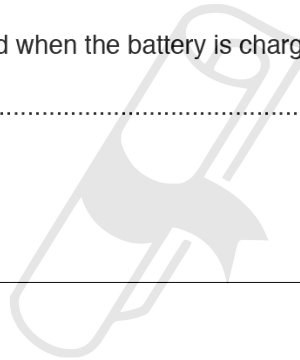
(ii) Calculate the energy stored in the battery when fully charged.

energy stored = [2]

(iii) State the type of energy stored when the battery is charged.

..... [1]

[Total: 9]



16. 0625_w19_qp_43 Q: 8

(a) Fig. 8.1 shows a negatively charged conducting sphere.

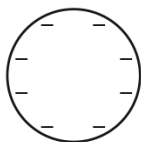


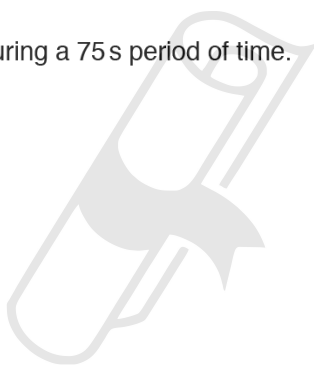
Fig. 8.1

On Fig. 8.1, draw the electric field pattern around the sphere.

[2]

(b) The current in an electrical device is 0.21 A.

Calculate the charge that flows during a 75 s period of time.



charge = [2]

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4.2. ELECTRICAL QUANTITIES

17. 0625_m18_qp_42 Q: 8

(a) The lamp of a car headlight is rated at 12 V, 50 W.

Calculate the current in the lamp when operating normally.

current = [2]

(b) A car is driven at night.

In a journey, the total charge that passes through the 12 V battery is 270 kC.

(i) Calculate the electrical energy transferred.

energy = [3]

(ii) The fuel used by the car provides $3.6 \times 10^4 \text{ J/cm}^3$.

Calculate the volume of fuel used to provide the energy calculated in (b)(i).

volume = [2]

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18. 0625_s18_qp_42 Q: 10

- (a) An uncharged conducting metal plate rests on insulating supports. Fig. 10.1 shows the plate and a positively charged insulating plastic sheet placed on top of the metal plate.

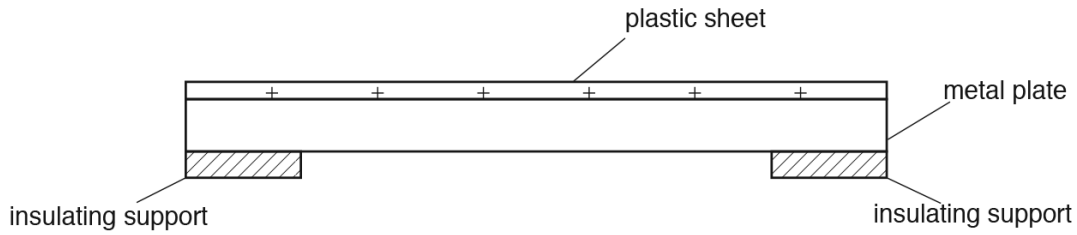


Fig. 10.1

- (i) Describe any flow of charge that takes place when the plastic sheet is placed onto the metal plate.

.....
 [1]

- (ii) On Fig. 10.1, draw how charges are now arranged within the metal plate. [1]

- (iii) State and explain if this arrangement of charge helps to keep the plastic sheet in place.

.....

 [2]

4.2. ELECTRICAL QUANTITIES

(b) Fig. 10.2 shows two uncharged conducting spheres suspended on insulating threads.

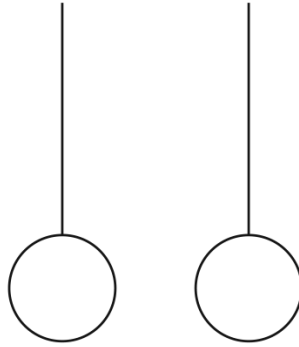


Fig. 10.2

1. The spheres are now both given positive charges. On Fig. 10.2, draw a possible position of each sphere and thread.
2. Explain the positions you have drawn.

.....
.....

[2]

[Total: 6]

19. 0625_w18_qp_42 Q: 8

- (a) (i) Fig. 8.1 shows a positively charged cube of insulating material. The cube is fixed to a piece of wood that is floating on water. A negatively charged rod is held above the piece of wood and brought close to the cube, as shown.

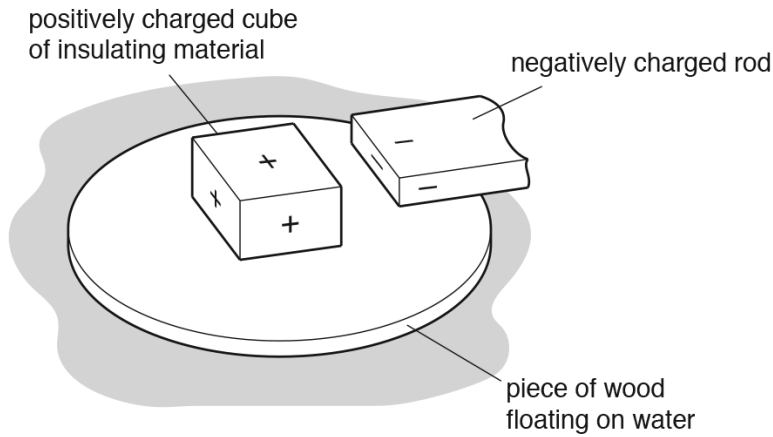


Fig. 8.1

State and explain any movement of the piece of wood.

.....

.....

.....

.....[2]

- (ii) Fig. 8.2 shows two cubes of insulating material. One is positively charged and the other is negatively charged. The cubes are fixed to a piece of wood that is floating on water. Charged rods are held above the piece of wood and brought close to the cubes, as shown.

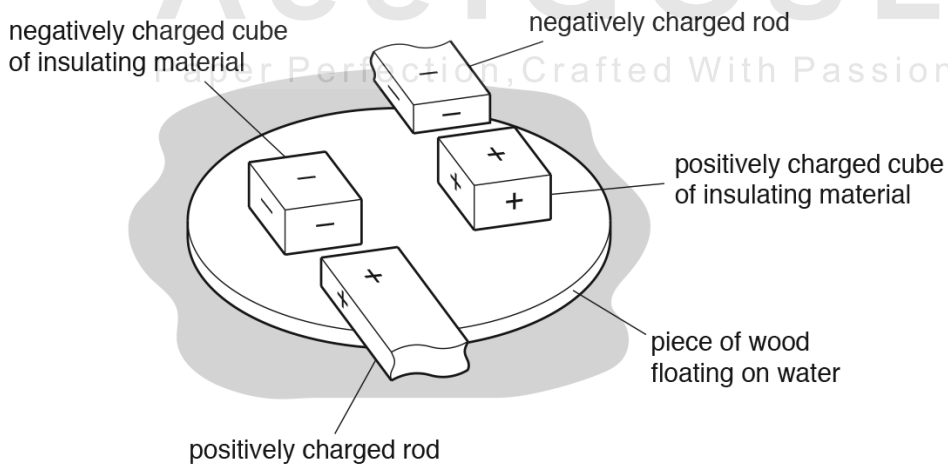


Fig. 8.2

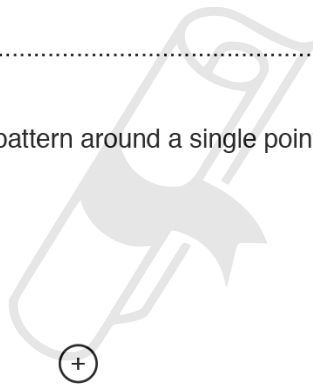
State and explain any movement of the piece of wood.

.....
.....
.....
.....[2]

(b) In terms of a simple electron model, describe the differences between conductors and insulators.

conductors
.....
.....
insulators
.....
.....[2]

(c) On Fig. 8.3, draw the electric field pattern around a single point positive charge.



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Fig. 8.3

[1]

[Total: 7]

20. 0625_w18_qp_43 Q: 7

A defibrillator is a machine that sends an electrical charge through the heart of a patient whose heart is not beating correctly. Doctors learn to use a defibrillator by practising on a medical dummy.

Fig. 7.1 shows the two contacts of a defibrillator attached to a medical dummy.

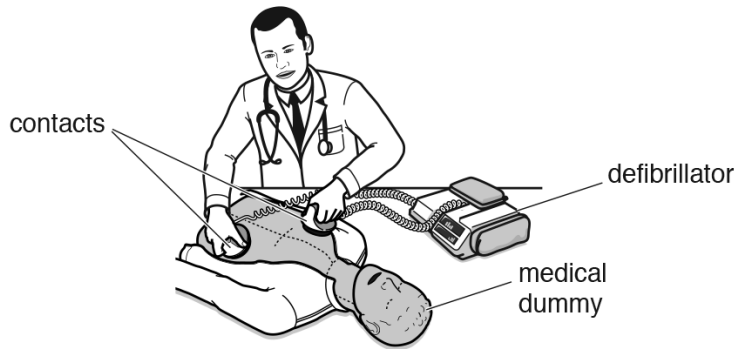


Fig. 7.1

The contacts that touch the dummy are made from metal, and when the defibrillator is being used, one contact becomes strongly negatively charged and the other contact becomes strongly positively charged. The handles of the contacts are made from plastic, which is an electrical insulator.

(a) (i) State how the structure of an electrical insulator differs from the structure of a conductor.

.....
 [1]

(ii) Suggest why the handles are made from an electrical insulator.

.....

 [2]

(b) Explain, in terms of the particles involved, how one contact becomes negatively charged and how the other contact becomes positively charged.

.....

 [2]

(c) The defibrillator passes a charge of $9.1 \times 10^{-3} \text{ C}$ through the medical dummy in $6.5 \times 10^{-4} \text{ s}$.

Calculate the average current in the dummy.

current = [2]

[Total: 7]

4.2. ELECTRICAL QUANTITIES

21. 0625_m17_qp_42 Q: 10

- (a) Describe, in terms of particles and the terminals of the battery, the movement of charge in an electric circuit.

.....
 [2]

- (b) Fig. 10.1 shows a lightning flash between a cloud and the ground beneath.

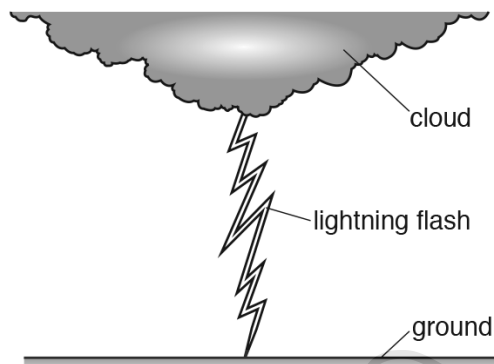


Fig. 10.1

The charge built up on the cloud before the lightning flash is 0.60 C. This charge is completely transferred to the ground by the lightning flash in 5.0×10^{-5} s (0.000050 s).

- (i) Calculate the current between the cloud and the ground.

current = [2]

- (ii) The potential difference (p.d.) between the cloud and the ground during the lightning flash is 2.5×10^8 V.

Calculate the energy transferred during the lightning flash.

energy = [2]

- (iii) Suggest what happens to the energy calculated in (b)(ii).

.....
 [1]

[Total: 7]

22. 0625_s17_qp_41 Q: 10

(a) Describe the movement of charge that causes an object to become positively charged.

.....[1]

(b) Fig. 10.1 shows a negatively charged rod held over an uncharged metal sphere.

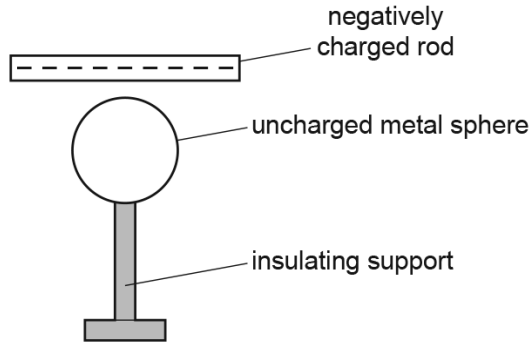


Fig. 10.1

(i) On Fig. 10.1, add + and – signs to represent the results of the movement of charge within the sphere. [2]

(ii) Describe the actions that must be taken to obtain an even distribution of positive charge on the surface of the sphere.

.....
.....
.....[2]

[Total: 5]

4.2. ELECTRICAL QUANTITIES

23. 0625_w17_qp_41 Q: 8

(a) Describe a renewable process by which electrical energy is obtained from the energy stored in water. You may draw a diagram in the space.

.....
.....
.....
.....
.....
.....
..... [4]

(b) Explain why the process described in (a) can be regarded as renewable.

.....
.....
.....
..... [2]

(c) Explain whether the Sun is the source of the energy stored in the water in (a).

.....
.....
..... [2]

[Total: 8]

24. 0625_w17_qp_43 Q: 8

- (a) Fig. 8.1 shows an uncharged conducting sphere on an insulating stand placed close to a positively charged rod.

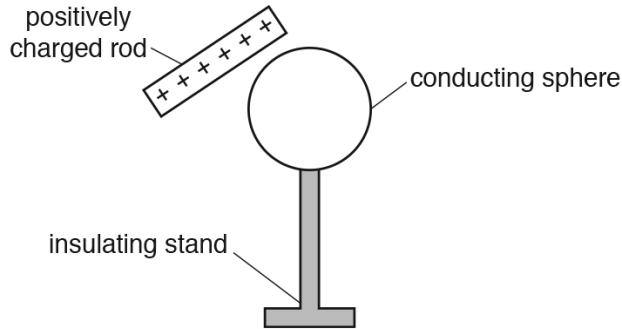


Fig. 8.1

The rod and the sphere are not moved.

Describe how to charge the sphere using a wire connected to earth and explain whether the sphere becomes positively charged or negatively charged.

.....

.....

.....

..... [3]

- (b) Fig. 8.2 shows a small black circle that represents a positive charge.

On Fig. 8.2, draw the pattern and the direction of the electric field in the region around the charge. [2]



Fig. 8.2

- (c) A charge of 7.0 C flows along a wire in 5.0 minutes.

Calculate the current in the wire.

current = [2]

[Total: 7]