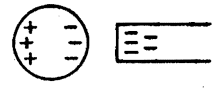
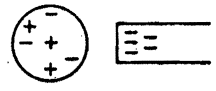
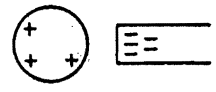
TOPIC 16 Static Electricity

1 A polythene rod is negatively charged. It is brought close to, but not touching, an uncharged metal sphere. The sphere is insulated from its surroundings.

Which diagram best shows the distribution of charge on the sphere?

A 

B 

C 

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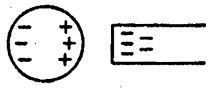
E 

J90/I/28

2 Which of the following statements about an electrical insulator is correct?

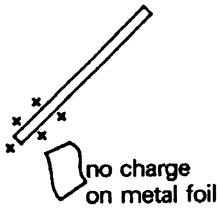
A It contains some electrons but more protons.
B It contains some protons but more electrons.
C It contains electrons but they are not free to move.
D It contains no electrons at all.
E It contains only neutrons. N90/I/27

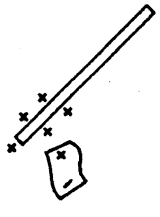
3 When a plastic rod is charged positively by friction,

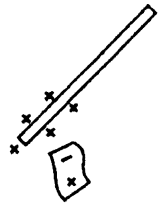
A it gains electrons.
B it gains neutrons.
C it gains protons.
D it loses electrons.
E it loses protons. N91/I/26

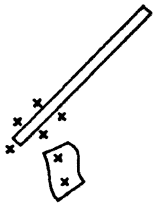
4 A piece of metal foil, which is initially uncharged, is attracted by a charged rod.

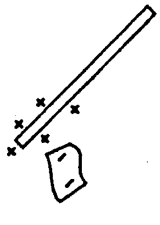
Which diagram shows the electric charges involved?

A 

B 

C 

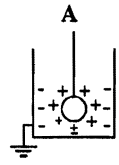
D 

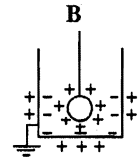
E 

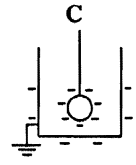
J93/I/26

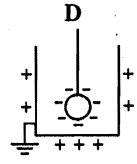
5 A charged sphere is suspended by an insulating thread inside a metal can. The outside of the can is earthed.

Which diagram shows the resulting charges on the sphere and on the can?

A 

B 

C 

D 

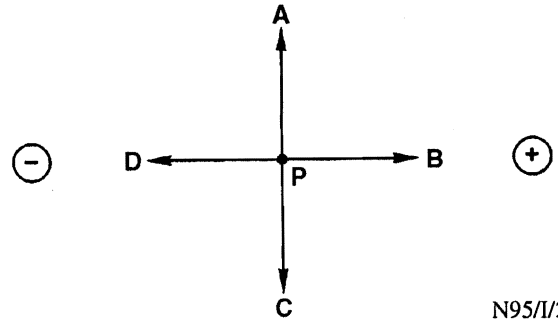
J94/I/26, J96/I/28, N97/I/25

6 When an ebonite rod is rubbed with a duster, the rod becomes negatively charged.

Why is this?

A The duster gains protons.
B The duster loses electrons.
C The rod gains protons.
D The rod loses electrons. N94/I/25

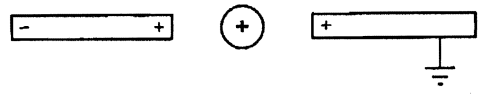
7 In which direction does the electric field act at the point **P** between the two charges shown?

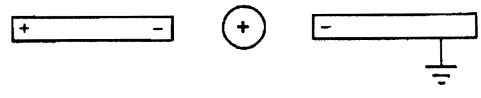


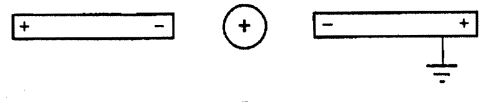
N95/I/28

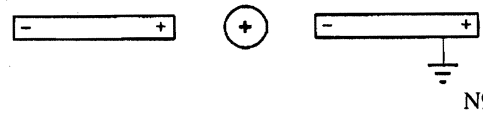
8 A positively charged metal sphere is placed halfway between two previously uncharged metal rods, one of which is connected to earth.

Which diagram correctly shows how the charges are arranged on the rods?

A 

B 

C 

D 

N95/I/29

9 Forces exist between two masses, between two charges or between two magnetic poles.

In which line are there forces only of attraction and not of repulsion?

A	(+)	electric force	(+)	(N)	magnetic force	(S)
B	(+)	electric force	(−)	(m)	gravitational force	(m)
C	(m)	gravitational force	(m)	(N)	magnetic force	(N)
D	(N)	magnetic force	(N)	(+)	electric force	(−)

J96/I/9; J99/I/40

10 A pupil wants to charge a metal ball by induction, using a strip of polythene. She uses the following steps but not in this order.

1 the metal ball is earthed momentarily
2 the polythene strip is brought up to the ball
3 the polythene strip is removed
4 the polythene strip is rubbed with a woollen cloth

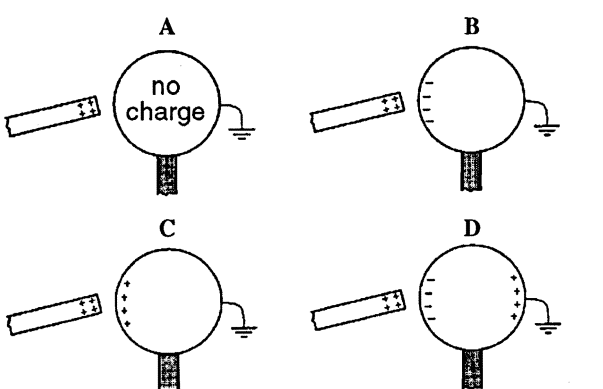
To charge the ball correctly, in which order should she carry out the steps?

A	2	3	4	1
B	2	4	3	1
C	4	1	2	3
D	4	2	1	3

N96/I/26

11 A metal ball is to be charged by induction. A charged rod is held close to one side of the ball and the other side is earthed.

Which diagram shows the charge distribution at this stage of the experiment?



J97/I/24

12 A piece of polythene is rubbed with a cloth duster. The polythene becomes negatively charged and the cloth becomes positively charged.

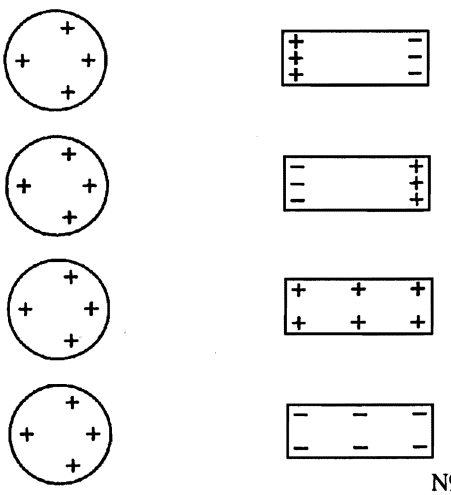
What has happened to the polythene and the cloth to cause this?

	polythene	*cloth*
A	gained electrons	gained protons
B	gained electrons	lost electrons
C	lost protons	gained protons
D	lost protons	lost electrons

J98/I/25

13 A positively charged sphere is moved close to an isolated metal cylinder.

Which diagram shows the charges induced on the cylinder?

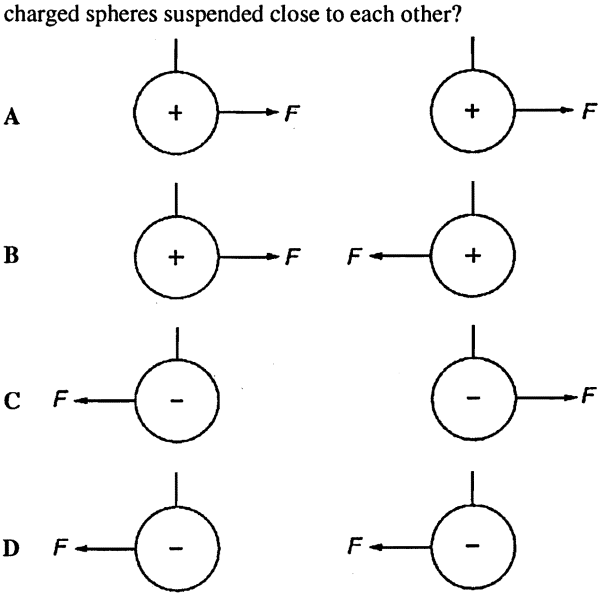


N98/I/26

14 Why is a positively charged object made neutral (discharged) by someone touching it?

A Electrons flow from the object.
B Electrons flow on to the object.
C Protons flow from the object.
D Protons flow on to the object. J99/I/26

15 Which diagram correctly shows the forces *F* that act on two charged spheres suspended close to each other?



N99/I/25

16 Materials can be classed, in electrical terms, as either conductors or insulators.

Which two materials are correctly identified?

	conductor	insulator
A	aluminium	copper
B	copper	polythene
C	glass	aluminium
D	polythene	glass

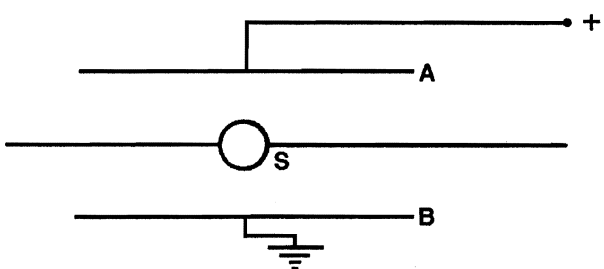
J2000/I/25

17 An electrostatically charged object will pick up small pieces of paper.

Which of the following will **not** pick up pieces of paper?

A an earthed metal rod rubbed with a duster
B a plastic comb pulled through dry hair
C a polythene rod rubbed with a woollen cloth
D a rubber balloon rubbed on a nylon shirt N2000/I/25

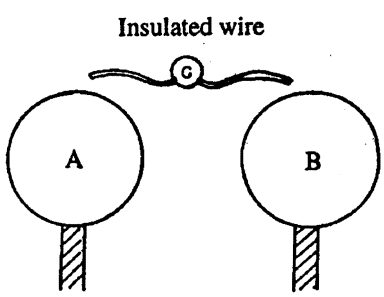
18 *(a)* The diagram shows a light polystyrene sphere S which is coated with aluminium paint and is uncharged. It is held by non-conducting threads midway between two horizontal metal plates A and B. A is now connected to a high positive potential and B is earthed. Show, on a diagram, the charges on the plates A and B and the separated charges on the sphere S.



The threads are then cut. State and explain the subsequent movement of the sphere.

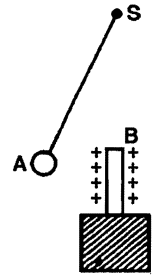
With the aid of a diagram, describe an experiment to show that an electric current is a flow of electric charges. J79/II/11*(a)*

19 Two metal spheres, A and B, on insulating stands, are charged, A positively and B negatively. The two spheres are now connected electrically through the sensitive centre-zero galvanometer G by touching the bared ends of the insulated wires shown in the diagram, one to each sphere.



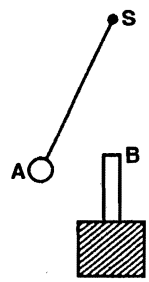
Describe and explain what is observed on the centre-zero galvanometer. N79/I/9

20

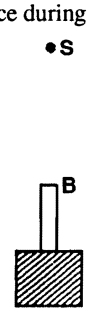


The diagram shows the position of rest of a small light charged metal sphere A, which is suspended from S by an insulating thread, so that it is near a fixed insulated metal plate B which is positively charged.

(a) Explain why A does not hang vertically, and deduce the sign of the charge it carries.



(b) The plate B is now earthed momentarily by touching it with a finger, which is quickly removed. The diagram above shows the situation *before* the sphere has had time to move. Describe and explain the flow of charge which takes place during the earthing of B.



(c) Describe and explain the subsequent motion of the sphere A until it comes to rest. Draw on the diagram below the final position of rest. J80/II/6

21

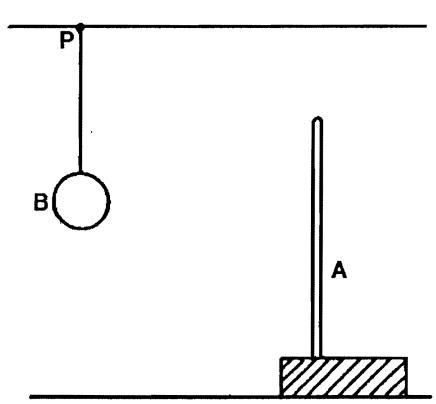


Fig. 1

Fig. 1 illustrates two conductors, A and B. A is mounted on an insulating stand and B, which is very light, is suspended by an insulating thread from **P**. There are no charges on A or B.

A is then charged positively. Complete Fig. 2 below to show the new rest position of B. Show also the charges induced on the conductor B.

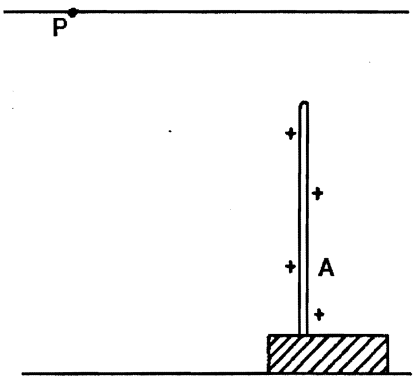
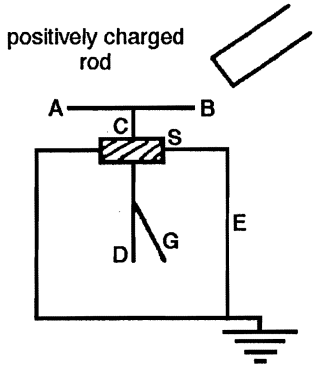


Fig. 2

A free positive charge, carried on a very small and very light sphere, is placed between A and the new position of B.

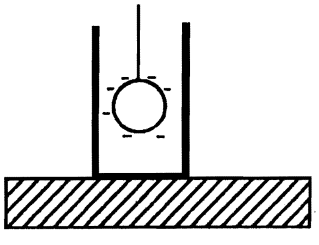
In which direction will the very light sphere move? Give a reason for your answer. N80/I/13

22 The diagram shows a gold leaf electroscope. AB and C D are made of metal and are insulated from the metal case E by the insulating plug S. The gold leaf G is attached at its upper edge to CD.



A positively charged rod is brought into the position shown and the gold leaf rises. Show on the diagram the distribution of charges on the electroscope. J81/I/13

23 A negatively charged sphere on an insulating thread is lowered into the uncharged metal can standing on an insulating slab.

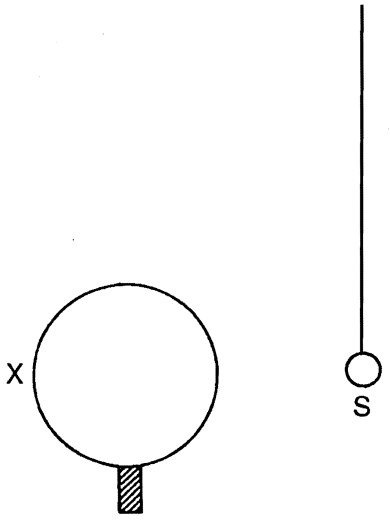


Indicate on the diagram the distribution of the charges produced on the can.

State, with a reason, the effect of touching the outside of the can with a wire which is connected to earth.

J82/I/14

24 A large conducting sphere X mounted on an insulating pillar is given a positive charge. The small, uncharged metal sphere, S, suspended on an insulating thread, is brought near to X.



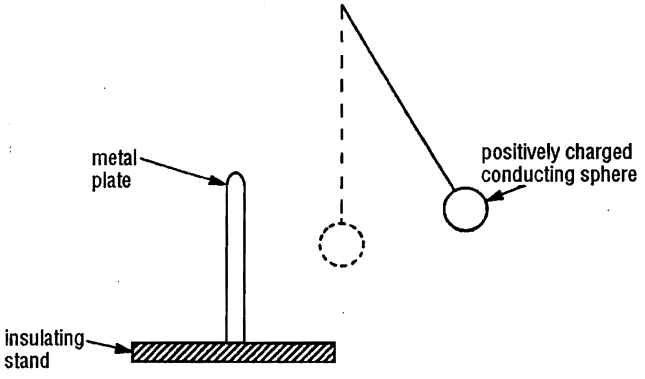
(a) Show on the diagram the charges induced on S.

(b) Explain the observation that S is attracted towards X.

(c) Given that S makes contact with X, explain what happens to S.

N82/I/13

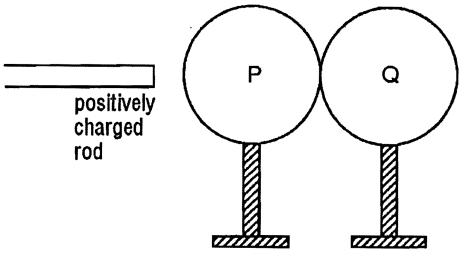
25 A light conducting sphere, positively charged, hangs vertically on an insulating thread. When a metal plate on an insulating stand is brought near, the sphere is immediately deflected as shown in the diagram.



(a) Explain why the sphere moves immediately to the new position.

(b) How does the movement of the ball illustrate the meaning of the term *electric field*? J83/I/13

26



In the diagram, P and Q are two initially uncharged metal spheres in contact, each supported on an insulating pillar. A positively charged rod is placed in the position shown. By holding its insulating pillar, Q is then taken away a large distance to the right of the diagram and the charged rod is taken away to the left.

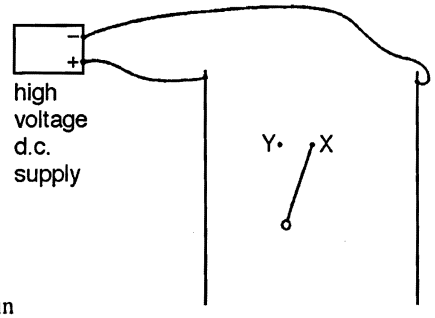
What charges are now present on

(a) P,.....

(b) Q?.....

Using the insulating pillar, Q is moved so that is again in contact with P. State and explain what happens to the charges on P and Q. N83/I/15

27 A light, charged sphere is suspended vertically by an insulating thread. It is placed between two metal plates that are connected to the terminals of a high voltage d.c. supply.



Explain

(a) why the sphere moves to the position shown in the diagram,

(b) why it remains at rest in this position.

When the point of suspension is moved to Y shown in the diagram, the angle to the vertical at which the thread hangs remains the same as it was at X. Give a reason for this.

N84/I/10

28 A positively charged light metal sphere is hung on an insulating thread as shown in Fig. 3.1.

Fig. 3.1

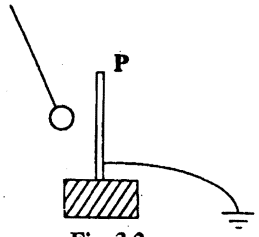


Fig. 3.2

A metal plate **P** mounted on an insulating stand and connected to earth is brought near to the sphere, which moves into the deflected position shown in Fig. 3.2.

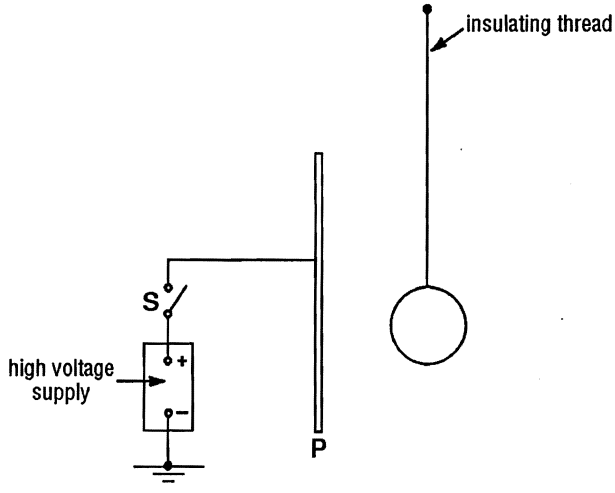
(i) Mark on the diagram the charges on the metal plate **P**.

(ii) Explain why the sphere is deflected as shown.

(iii) Why are the charges on **P** called induced charges?

J85/I/12

29 An uncharged metal sphere is suspended on an insulating thread near a metal plate P as shown in the diagram. The switch S is now closed and P becomes positively charged.



Show on the diagram

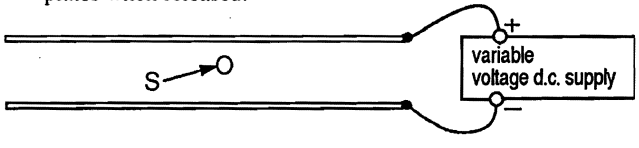
(i) the resulting distribution of charges on the sphere,

(ii) the direction of the resultant force exerted on the sphere by the charge on P.

Explain why the force acts in the direction you have shown.

N85/I/14

30 A variable voltage d.c. power supply is connected across two parallel conducting plates. A small polystyrene sphere, S, is given a negative electric charge and is held in position between the plates. The voltage between the plates is adjusted until the sphere remains stationary between the plates when released.



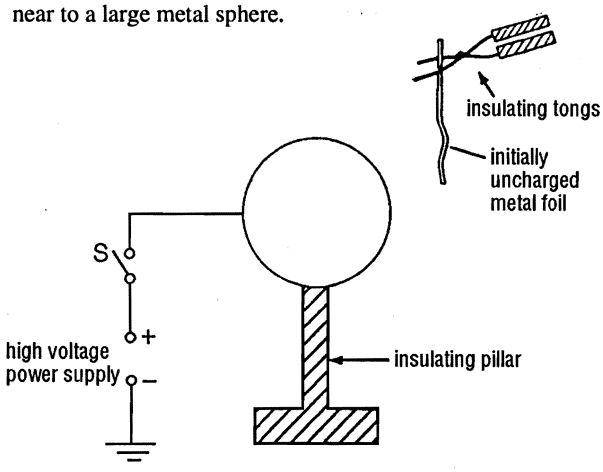
Draw on the diagram an arrow showing the direction of the force on the sphere due to the electric field.

Given that the mass of the sphere S is 0.003 kg calculate the magnitude of this force.

[Take the weight of 1 kg to be 10 N]

What would you expect to happen when the voltage of the power supply is slightly reduced? J86/I/14

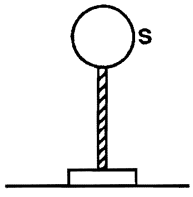
31 The diagram shows a length of initially uncharged metal foil held by its upper end in a pair of insulating tongs so that it is near to a large metal sphere.



When the switch S is closed the large sphere becomes charged. Explain why the end of the foil is attracted to the sphere.

Explain why, if the end of the foil touches the sphere, it does not remain in contact. N86/I/14

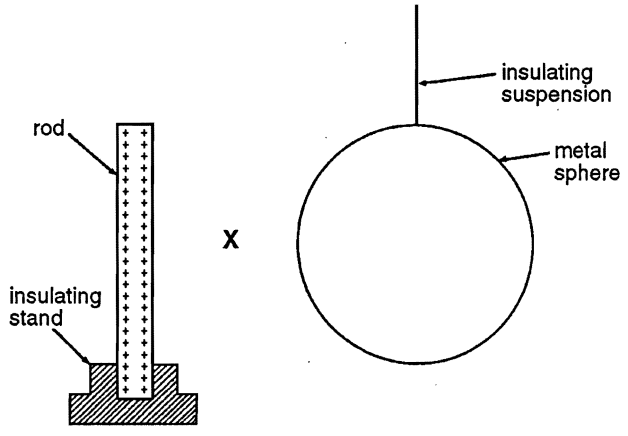
32 The diagram shows a metal sphere S mounted on an insulating stand.



Describe a simple test you could perform, and which does not alter any charge there may be on the sphere, to determine whether or not the sphere is charged.

Given that the sphere is charged, how could you test whether the charge is positive or negative, without altering the charge on the sphere? J87/I/13

33 The diagram shows an unchanged metal sphere on an insulating suspension, placed near a positively charged rod which is supported in an insulating stand.



(a) Show the distribution of the charges induced on the metal sphere.

(b) In the space between the charged rod and the sphere there is an electric field. What is meant by the term *electric field*?

(c) Show on the diagram the direction of the electrical force on a positively charged particle placed at X. N87/I/14

34 Two uncharged metal spheres, A and B, mounted on insulating supports are positioned so that they touch. A rod carrying a positive electric charge is brought near to them as shown in Fig. 4.1.

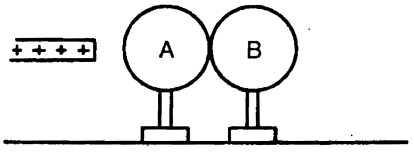
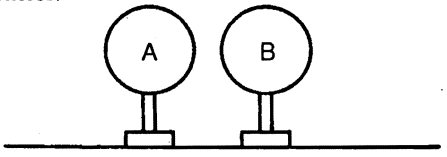


Fig. 4.1

The spheres are now moved slightly apart and the charged rod is then removed. Show, on Fig. 4.2, the resulting charges on the spheres.



[3]

Fig. 4.2

Sphere A is moved until it again touches B. Describe the movement of charge that occurs when they touch. [1] J88/I/13

35 Two vertical metal plates are mounted on insulating stands a short distance apart. A high voltage d.c. power supply is used to charge the plates shown in Fig. 5.1.

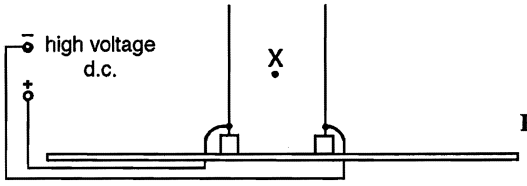


Fig. 5.1

(a) Indicate by an arrow on Fig. 5.1 the direction of the force due to the electric field on a positive charge placed at point X. [1]

(b) A charged conducting ball is now suspended between the plates by a nylon thread clamped at Y as shown in Fig. 5.2.

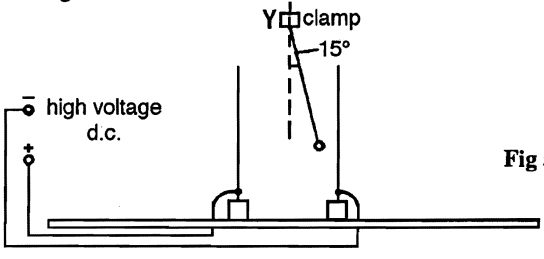


Fig 5. 2

The rest position of the ball and thread is such that the thread makes an angle of 15° with the vertical. State whether the charge on the ball is positive or negative and give a reason for your answer. [2]

(c) When the clamp is moved horizontally (making sure that the ball does not touch either plate), it is found that the thread is always inclined at the same angle to the vertical. What conclusions can be drawn about

(i) the force on the ball due to the electric field,

(ii) the electric field between the plates? [2]

(d) The clamp is returned to the central position and the plates are moved closer together until the righthand plate touches the ball, as shown in Fig. 5.3.

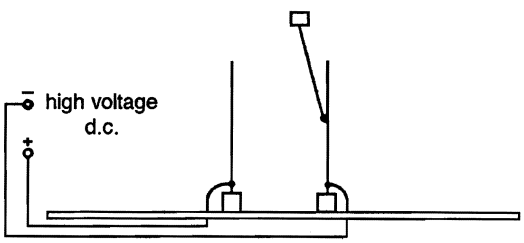
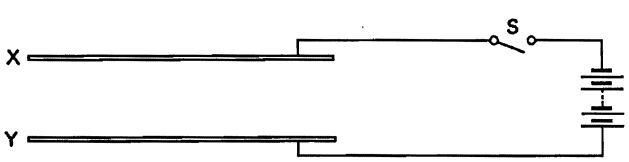


Fig. 5.3

Describe and explain the subsequent motion of the ball.

(e) The connections are now disconnected from the power supply and are touched together so as to discharge the plates. Estimate the time taken to reduce the charge on the plates by 1.5×10^{-6} C, given that the average electric current which flows during the discharge is 2.0×10^{5} A. [2] J88/II/5

36 *(a)* The diagram shows two horizontal plates X and Y connected to a source of high p.d. through a switch.

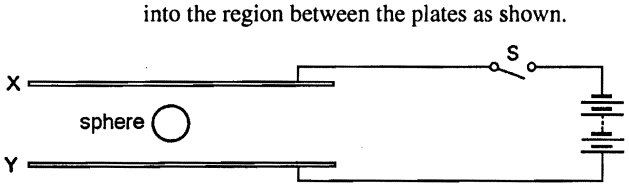


(i) State the sign of the charges produced on each plate when the switch S is closed.

X..... Y .....

Explain in terms of electron flow how this comes about. [4]

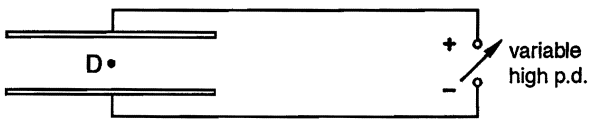
(ii) An uncharged conducting sphere is introduced into the region between the plates as shown.



Indicate on the diagram the charges induced on this sphere.

The sphere falls towards the plate Y. Explain why the fall takes place and state what happens to the charges on the sphere when it makes contact with Y. [3]

(b) In a similar experiment using a source of variable p.d., a *charged* oil-drop **D** is introduced into the space between the horizontal plates as shown below.



The p.d. between the plates is adjusted until the drop is stationary. Deduce the sign of the charge carried by the drop.

Show on the diagram by an arrow labelled **F** the force on the drop exerted by the electric field between the plates. [2]

What happens to the drop when the p.d. between the plates is reduced? [1]
N88/II/5

37 In Fig. 6, **L** is a large conducting sphere connected through a switch to the positive terminal of a supply of high voltage. A light conducting sphere **S** hangs from an insulating thread as shown. Both spheres are initially uncharged.

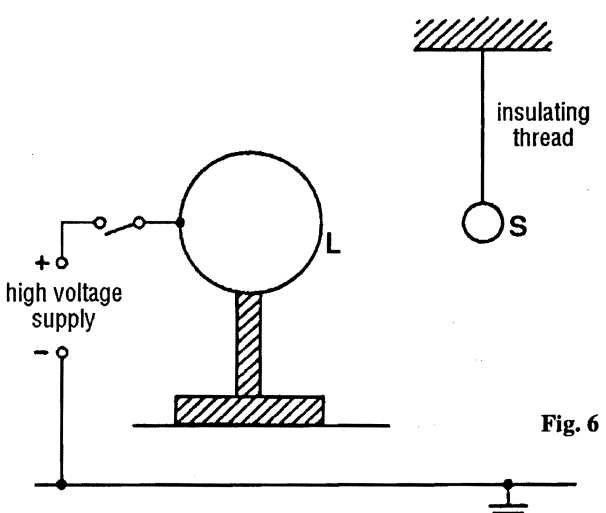


Fig. 6

(a) Describe the movement of electrons which takes place when the switch is closed and sphere **L** becomes charged. [2]

(b) Describe and explain the effect produced by the charge on sphere **L** on the conducting sphere **S**. [2]

(c) Sphere **S** is now connected to earth. Describe the effect this has on (i) the charge on **S**, (ii) the position of **S**. [3]

(d) Describe an experiment you could carry out to identify the sign of any charge remaining on **S** after the earth connection has been removed. [3]
N89/II/5

38 *(d)* (i) Fig. 7.1 shows a positively charged sphere **S** placed near to an initially uncharged isolated conductor **AB**. Complete the diagram to show the charges induced in the conductor.

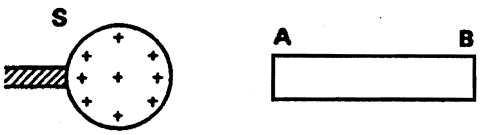


Fig. 7.1

(ii) Complete Fig. 7.2 to show the corresponding charges when S is negatively charged.

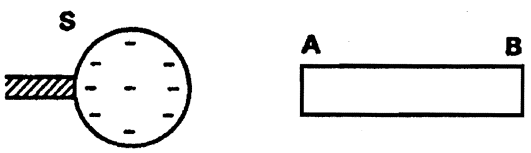


Fig. 7.2

(iii) Describe the motion of the electrons in **AB** when the charge on S alternates from positive to negative several times per second.

State one effect this motion will produce. [4]

J89/II/4*(d)*

39 An electrically charged sphere **C** is brought near a small uncharged conducting sphere **S** suspended as shown in Fig. 8.1. **S** is first attracted towards **C** until it touches the surface of **C** and then repelled to the position shown in Fig. 8.2.

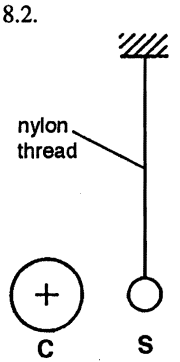


Fig. 8.1

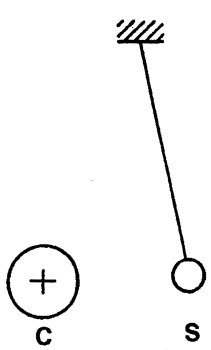


Fig. 8.2

(a) (i) Explain carefully why **S** is first attracted towards **C**.

(ii) Explain why **S** is repelled after touching the surface of **C**. [3]

(b) On Fig. 8.2 mark and label each force acting on **S**. [2]

(c) When a bunsen flame is passed beneath **S**, the sphere falls back towards **C**. Suggest why this happens. [1]

N90/II/6

40 Three hollow copper spheres are placed near each other in air. The large sphere carries a positive charge and the two small spheres touch each other, as shown in Fig. 9.1.

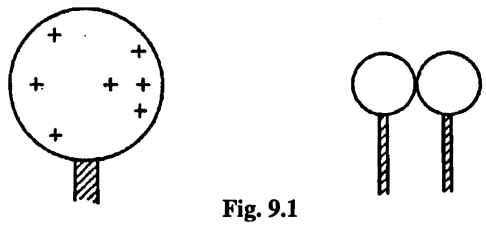


Fig. 9.1

The two small spheres are pulled apart, using their insulated handles, and then taken well away from the large sphere, as shown in Fig. 9.2.

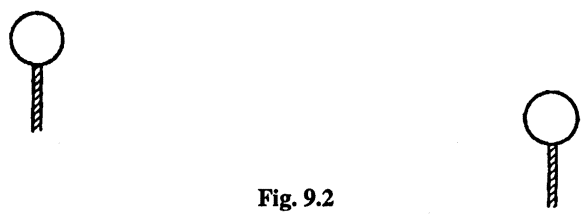


Fig. 9.2

(a) The charge on the large sphere has been drawn in for you. **On Fig. 9.1 and on Fig. 9.2** draw in the charges, if any, on each of the smaller spheres.

(b) Explain why energy is needed to separate the two small spheres. [5]

J91/II/6

41 Fig. 10.1 shows two positively charged conducting spheres mounted on rods made of a good electrical insulator.

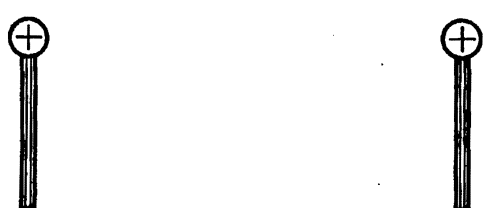


Fig. 10.1

Fig. 10.2 shows a section through oppositely charged parallel plates.

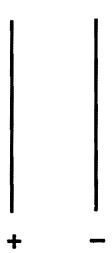


Fig. 10.2

(a) Draw the electric field pattern on each diagram. [3]

(b) Complete the following statements:

(i) A suitable material for the spheres in Fig. 10.1 would be ..... .

(ii) A suitable material for the rods in Fig. 10.1 would be ..... [2]

N92/II/6

42

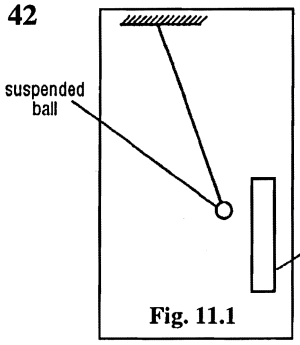


Fig. 11.1

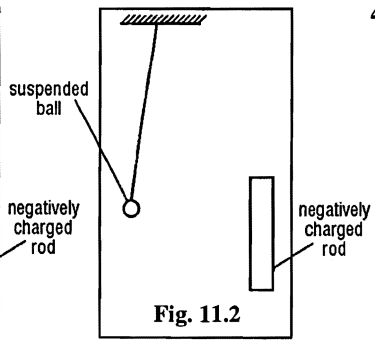


Fig. 11.2

Figure 11.1 shows a negatively charged conducting rod put near a light ball suspended at the end of an insulating thread. The surface of the ball has been coated with conducting paint. Figure 11.2 shows what happens after the ball has been allowed to touch the rod.

(a) Explain why, in Fig. 11.1, the ball is displaced from the vertical. [3]

(b) Explain what happens after the ball has been allowed to touch the rod. [3] N93/II/4

43 *(a)* Figure 12 shows two copper spheres **P** and **Q**; **P** is positively charged and **Q** is negatively charged.

Fig. 12

(i) Copy Fig. 12 and on your diagram draw the electric field pattern set up by the two charges.

(ii) State what would happen if **P** and **Q** were free to move.

(iii) State what would happen if **P** and **Q** were free to move **and both were positively charged**.

(iv) Justify your answers to (ii) and (iii). [6] N94/II/11*(a)*

44 Two isolated copper spheres, **P** and **Q**, are initially uncharged. They are placed near to each other. Fig. 13 shows the charge distribution on **P** when it is given a positive charge.

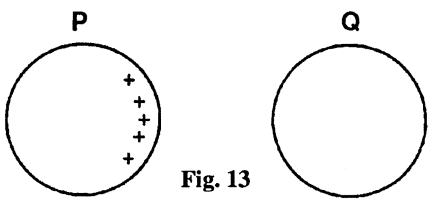


Fig. 13

(a) On Fig. 13, show the charge distribution on **Q**, if any, arising from the positive charge on **P**. [2]

(b) **Q** is momentarily earthed and is then found to be negatively charged. Name the process which gave rise to the charge to **Q**. [1] J96/II/7

45 Fig. 14.1 shows a pair of charged parallel metal plates mounted in a sealed glass tube containing air at very low pressure. Fig. 14.2 shows the plates without the tube. In Fig. 14.3, the two circles represent an electron and a positive ion.

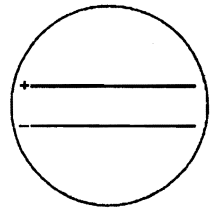


Fig. 14.1

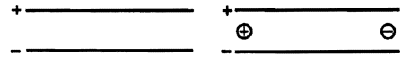


Fig. 14.2

Fig. 14.3

(a) On Fig. 14.2, draw the pattern of the electric field set up by the charged plates. [2]

(b) State what will happen to the electron and to the positive ion. [3] J97/II/6

46 Two vertical metal plates are connected to a high voltage power supply, as shown in Fig. 15.1. An electric field exists in the space between the plates.

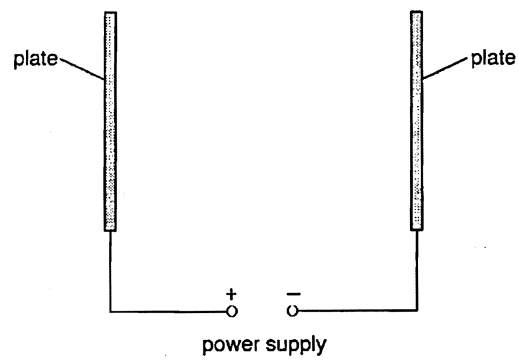


Fig. 15.1

(a) (i) State what is meant by the *electric field* between the plates.

(ii) On Fig. 15.1, draw lines of force to show the electric field between the two plates. [3]

(b) An uncharged metal ball is hung by an insulating thread between the two plates, as shown in Fig. 15.2.

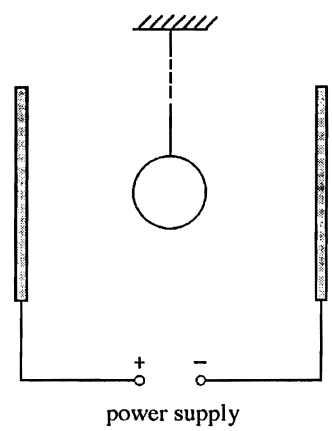


Fig. 15.2

On Fig. 15.2,

(i) draw the distribution of charge that will be found on the metal ball,

(ii) draw lines of force to show the new electric field between the plates. [2]

J99/II/5

47 Some electrical components are easily damaged if electric charge is placed on them. They are often stored by placing them in contact with a conductor.

(a) When the component shown in Fig. 16.1 is rubbed with a cloth, the metal legs become negatively charged. Explain how this happens.

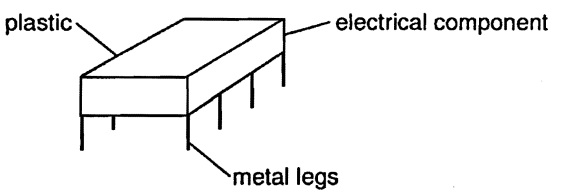


Fig. 16.1 [2]

(b) Fig. 16.2 shows the negatively charged metal legs placed near a piece of aluminium foil which rests on an insulator.

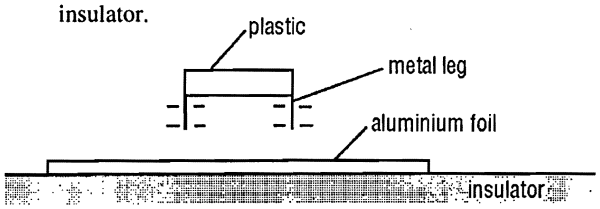


Fig. 16.2

(i) On Fig. 16.2, draw the induced charges that form on the aluminium foil.

(ii) The metal legs are placed in contact with the aluminium foil. Describe what happens to the charges on the foil and on the legs. [3]

N99/II/5

48 Fig. 17 shows an apparatus that demonstrates electrostatic charging. Perspex is an insulator.

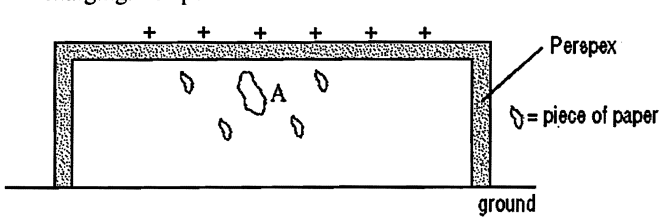


Fig. 17

When rubbed with a cloth, the top of the Perspex becomes positively charged. The small pieces of paper jump up and stick to the lower surface of the Perspex.

(a) Explain, in terms of the movement of electrons, why the Perspex becomes positively charged when rubbed with a cloth. [2]

(b) State the unit in which charge is measured. [1]

(c) Charges are induced on the pieces of paper by the charge on the Perspex. On Fig. 17, draw the charges induced on the piece of paper labelled A. [2]

(d) Explain why the pieces of paper jump up. [1]

J2000/II/8

ANSWERS

1. **E**	2. **C**	3. **D**	4. **C**	5. **A**
6. **B**	7. **D**	8. **B**	9. **B**	10. **D**
11. **B**	12. **B**	13. **B**	14. **B**	15. **C**
16. **B**	17. **A**			