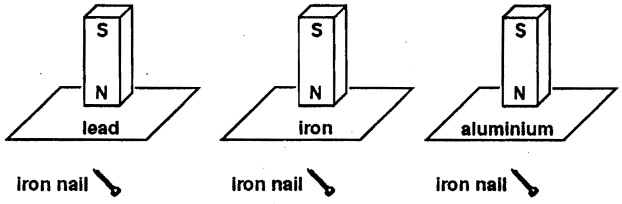
TOPIC 20 Magnetism

20.1 Laws of magnetism
20.2 Magnetic properties of matter

1 Three sheets of material are placed between magnets and iron nails as shown in the diagram.



Which of the following describes the force on the nail for each material?

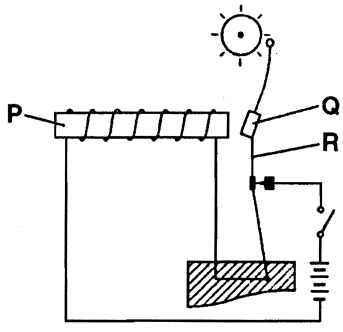
	lead	*iron*	*aluminium*
A	attraction	attraction	attraction
B	attraction	attraction	repulsion
C	attraction	no force	attraction
D	no force	no force	no force
E	repulsion	attraction	repulsion

J90/I/25

2 It can be deduced that a piece of metal is already a magnet if

A copper wire is attracted to it.
B both ends of a compass needle are attracted to it.
C a magnet is attracted to it.
D one end of a compass needle is repelled by it.
E copper wire is repelled by it. J90/I/26

3 The diagram shows an electric bell.



What materials would be suitable for the parts labelled **P, Q** and **R**?

	P	**Q**	**R**
A	brass	soft iron	spring steel
B	soft iron	brass	soft iron
C	soft iron	soft iron	spring steel
D	soft iron	brass	copper
E	spring steel	soft iron	spring steel

J90/I/33

4 Which two materials are most likely to be used for the coil and core of an electromagnet?

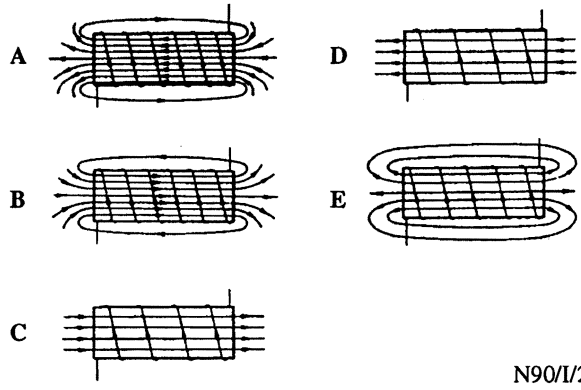
	coil	*core*
A	copper	air
B	copper	iron
C	copper	steel
D	iron	iron
E	iron	steel

N90/I/33

5 Which of the following statements describes an example of induced magnetism?

A Two North poles repel each other, but a North pole attracts a South pole.
B A bar magnet, swinging freely, comes to rest pointing North-South.
C A bar magnet loses its magnetism if it is repeatedly dropped.
D A bar magnet attracts a piece of soft iron.
E It is hard to magnetise steel, but easy to magnetise soft iron. N90/I/25

6 Which diagram shows the magnetic field pattern associated with a solenoid carrying a current in the direction indicated?



N90/I/24

7 A metal bar **P – Q** hung by a thin thread always comes to rest with end **P** pointing North. Another bar **X – Y** of the same metal settles in no definite direction.

What happens if the two bars are brought near one another?

A End **P** attracts end **X** but repels end **Y**.
B End **P** repels end **X** but attracts end **Y**.
C End **P** neither attracts nor repels end **X**.
D End **P** attracts end **X** but end **Q** repels end **Y**.
E End **P** and end **Q** both attract end **X**. J91/I/25

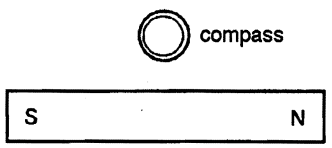
8 A coil of copper wire wrapped around a core could be used as an electro-magnet.

Which of the following combinations would produce the strongest electro-magnet?

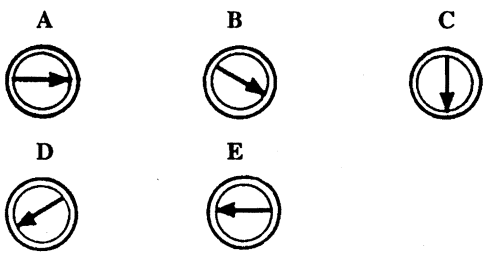
	number of turns	*core*
A	few	soft-iron
B	few	steel
C	many	copper
D	many	soft-iron
E	many	steel

J91/I/26

9 A small compass is placed beside a bar magnet.

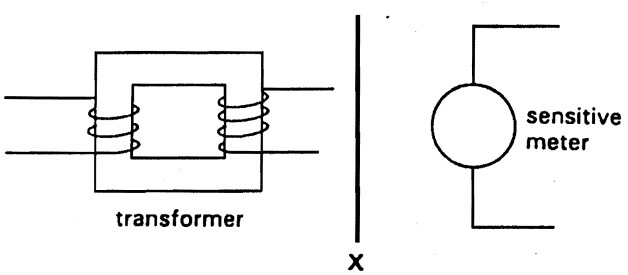


In which direction will the compass needle point?



N91/I/24

10 The diagram shows a sheet **X** of material used to provide magnetic shielding for a sensitive meter near a transformer.



Which material is suitable for **X**?

A copper
B glass
C iron
D lead
E perspex

N91/I/25

11 Which of the following could be used for the needle of a plotting compass?

A aluminium
B brass
C copper
D iron
E steel

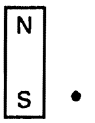
J92/I/24

12 Which of the following materials is correctly described?

	material	*property*	*use*
A	iron	not easily demagnetised	electro-magnet
B	iron	not easily demagnetised	permanent magnet
C	iron	easily demagnetised	electro-magnet
D	steel	not easily demagnetised	electro-magnet
E	steel	easily demagnetised	permanent magnet

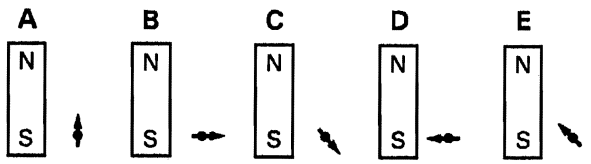
N92/I/25

13 A permanent magnet is placed on a flat horizontal surface. A plotting compass is placed on the spot shown on the diagram.



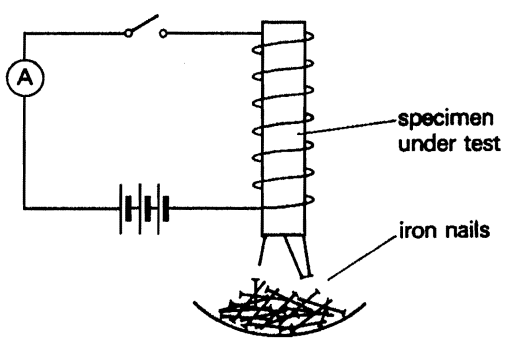
In which direction will the plotting compass point?

(Ignore any effect of the Earth's magnetic field.)



N92/I/24

14 Three specimens of magnetic material were tested using the apparatus shown in the diagram.



When the switch is closed, the specimen picks up some of the iron nails but when the switch is opened, many or most of the nails fall off. The number of nails picked up and left on were found for the three specimens. The table shows the results.

specimen	*number of nails picked up*	*number of nails left on*
X	35	4
Y	20	10
Z	40	3

What can be deduced from these results?

A **X** would make the best electromagnet.
B **X** would make the best permanent magnet.
C **Y** would make the best electromagnet.
D **Z** would make the best electromagnet.
E **Z** would make the best permanent magnet.

J93/I/25

15 Which of the following methods of magnetising a steel rod will produce the strongest magnet?

A bringing a permanent magnet near to the rod
B holding the heated rod in an N-S direction and tapping strongly
C passing an electric current through the rod
D placing the rod in a solenoid carrying a large direct current
E stroking the rod with a permanent magnet

N93/I/25

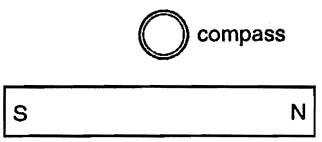
16 In which device is a permanent magnet used?

A an electric bell
B an electromagnet
C a plotting compass
E a transformer
D a relay N93/I/26

17 Which of the following proves that a piece of metal is already a magnet?

A A magnet is attracted to it.
B Both ends of a compass needle are attracted to it.
C Copper wire is attracted to it.
D One end of a compass needle is repelled by it. J94/I/25

18 A small compass is place beside a bar magnet.



In which direction will the compass needle point?

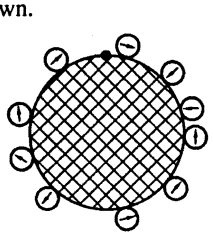
A **B** **C** **D**

J95/I/24; J2000/I/24

19 Which statement describes an example of induced magnetism?

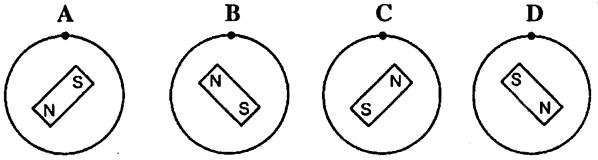
A A bar magnet attracts a piece of soft iron.
B A bar magnet loses its magnetism if it is repeatedly dropped.
C A bar magnet, swinging freely, comes to rest pointing North-South.
D Two North poles repel each other, but a North pole attracts a South pole. N95/I/25

20 The diagram shows a box which has a bar magnet hidden inside it. Compasses are placed around the outside and their needles point as shown.



Which diagram shows the position of the magnet inside the box?

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



N95/I/26

21 It is sometimes necessary to protect electrical apparatus from magnetic fields.

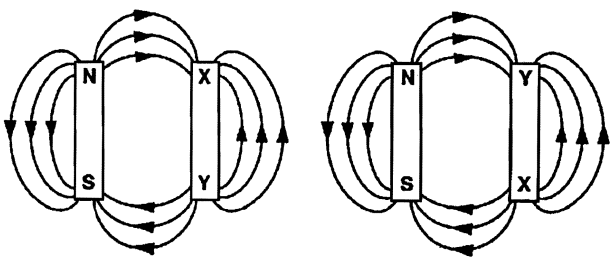
This can be done by surrounding the apparatus with a box made from

A aluminium.
B iron.
C rubber.
D steel. N95/I/27

22 Diagram 1 shows the magnetic field pattern near a bar magnet and an object **XY**.

Diagram 2 shows the pattern that is obtained when **XY** is turned round.

diagram 1 *diagram* 2



What is **XY**?

A a copper rod
B a magnet with the N pole at **X**
C a magnet with the N pole at **Y**
D a rod of soft iron J96/I/25

23 Iron and steel cylinders can both be magnetised by placing them inside a solenoid (coil) connected to a d.c. supply.

Which pair of statements about the magnetic strengths of the iron and steel cylinders is correct?

	supply on	*supply on, then off*
A	iron stronger	iron stronger
B	iron stronger	steel stronger
C	steel stronger	iron stronger
D	steel stronger	steel stronger

J96/I/26

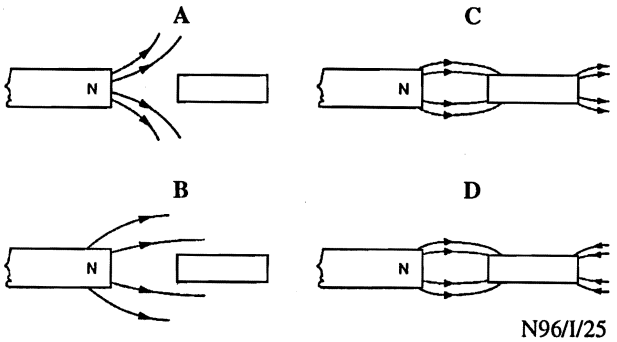
24 Which statement about magnetism is correct?

A A magnet attracts small pieces of aluminium.
B Steel makes a better permanent magnet than iron does.
C There is no limit to the magnetic strength of a magnet made from a steel bar.
D Two like poles always attract one another.

N96/I/24

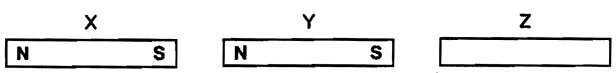
25 The diagram shows a short length of iron placed near the N pole of a magnet.

Which diagram best represents the resulting magnetic field pattern?



N96/I/25

26 The diagram shows three bars placed in a line. X and Y are both magnets, Z is soft iron.



What are the magnetic forces on X and Z due to magnet Y?

	force on X	*force on* Z
A	attraction	attraction
B	attraction	repulsion
C	repulsion	attraction
D	repulsion	repulsion

J97/I/23

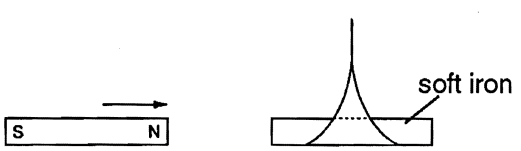
27 A scrap metal dealer uses a large electromagnet.

Which pair of metals will it pick up?

A aluminium and brass
B brass and copper
C copper and iron
D iron and steel

J98/I/23

28 In an experiment, the north pole of a bar magnet is brought close to each end of a freely suspended soft-iron rod in turn.



What is the result of this experiment?

A Both ends of the rod are attracted to the north pole.
B Both ends of the rod are repelled by the north pole.
C Neither end of the rod is attracted by the magnet.
D One end of the rod is attracted and one is repelled by the north pole.

J98/I/24

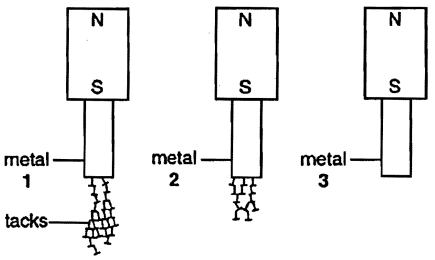
29 One end X of a metal rod attracts the N-pole of a compass needle.

What does this show about the rod?

A It could be made of copper but is unmagnetised.
B It could be made of copper with a S-pole at X.
C It could be made of steel but is unmagnetised.
D It could be made of steel with a N-pole at X.

N98/I/23

30 Three bars of metal are known to be brass, iron and steel. A magnet is placed at one end of each metal bar.



The diagrams show how many tacks are picked up by each metal bar.

What are metals **1**, **2** and **3**?

	metal 1	metal 2	metal 3
A	iron	brass	steel
B	iron	steel	brass
C	steel	brass	iron
D	steel	iron	brass

J99/I/23

31 Recorded audio tapes should not be left near the back of a working television set.

This is because they could be damaged by

A high-energy electrons.
B high-energy X-rays.
C strong electric fields.
D strong magnetic fields.

J99/I/24

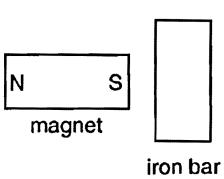
32 A length of copper wire, coiled around a core, is used as an electromagnet.

Which combination produces the strongest electromagnet?

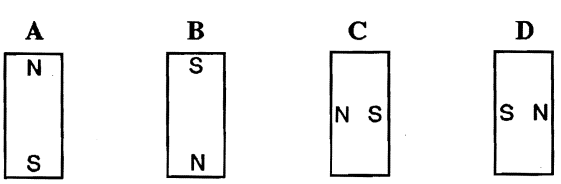
	number of turns	core
A	few	soft-iron
B	few	steel
C	many	copper
D	many	soft-iron

N99/I/24

33 An iron bar is placed near a magnet as shown.



Which diagram correctly shows the induced magnetisation of the iron bar?



J2000/I/23

34 The answer to which question will distinguish between a magnetic material and a non-magnetic material?

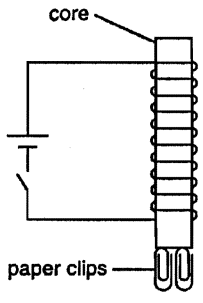
A Is it a metal or a non-metal?

B Is it a conductor or an insulator?

C Can it be given an electric charge?

D Does it affect the direction in which a compass needle points? N2000/I/22

35 Four different substances are tested by using each as the core of an electromagnet to find the most suitable one for use as the core of a transformer.



The number of paper clips each will hold is recorded when there is a current in the electromagnet and when the current is switched off.

Which substance will be the best for making a core for a transformer?

substance	number of paper clips held with a current	number of paper clips held when current is switched off
A	8	4
B	6	0
C	5	1
D	4	0

N2000/I/24

36 Tests are carried out on four metal specimens **A, B, C** and **D** with the results shown below.

A Good conductor of electricity, non-magnetic.

B Conductor of electricity, easily magnetised and very easily loses its magnetism.

C Non-conductor of electricity, non-magnetic.

D Conductor of electricity, moderately difficult to magnetise, but retains its magnetism very well.

(a) Which of the four would be most suitable for the core of an electromagnet?

Explain your answer and name a suitable metal.

(b) Which of the four would be most suitable for a permanent magnet? J79/I/10

37 Describe how you would use a solenoid to magnetize strongly a piece of metal in the form of a rod. How would you confirm that the piece of metal is still magnetized after it has been removed from the solenoid?

Two pieces of different metals are magnetized separately in a solenoid and removed from the solenoid. After testing it is found that one piece remains magnetized strongly while the other does not. State, with a reason for your choice in each case, which piece of metal is useful for

(i) the core of an electromagnet,

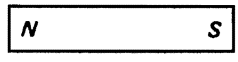
(ii) a permanent magnet.

An electromagnet is used to separate iron waste from crushed ore passing on a conveyor belt; the electromagnet causes the waste to be lifted clear. The power used by the electromagnet in lifting the iron waste is 132 W.

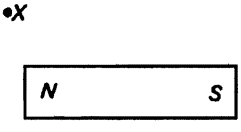
(a) Calculate the minimum current which must be passed through the coils of the electromagnet to provide the lifting power of 132 W, when the supply voltage is 220 V.

(b) Suggest **one** reason why the actual current passing through the electromagnet while it is producing a lifting power of 132 W would be *greater* than the answer you have calculated, the supply voltage remaining 220 V. N79/II/10

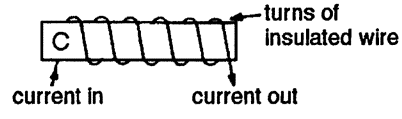
38 *(a)* Draw the pattern of the magnetic field around the magnet shown below. (Neglect the Earth's magnetic field.)



(b) The diagram below shows a point labelled X near a magnet. Show on the diagram how you would arrange a thin sheet of soft iron to reduce the magnetic field at X due to the magnet to zero.



(c)



The arrangement shown above could be used to magnetise the core C. Name a suitable material for the core when the arrangement is used

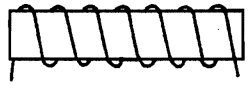
(i) for the electromagnet in a electric bell,

(ii) to make a permanent magnet

In *each* case, state a reason for your choice.

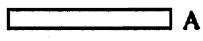
(d) Complete and label the diagram below to show a simple relay.

Show clearly the terminals of the circuit which is to be switched on and off by the relay.



J82/II/5

39 The diagram below represents a bar of soft iron which is to be magnetised with a north pole at end A.



Complete the diagram to show how you would arrange a coil, connected to an accumulator, to achieve this. Make clear on your diagram the windings of the coil and the polarity of each accumulator terminal.

What would be the effect on the magnetisation of the bar of disconnecting the accumulator?

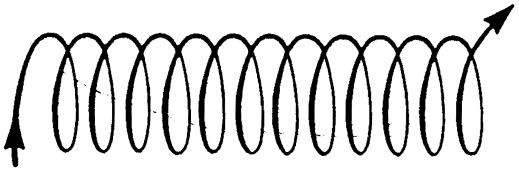
J83/I/10

40 Describe carefully how you would use a pivoted compass needle to plot the magnetic field lines (lines of force) around a bar magnet.

Draw a diagram to show the pattern you would obtain, ignoring the effect of the Earth's magnetic field.

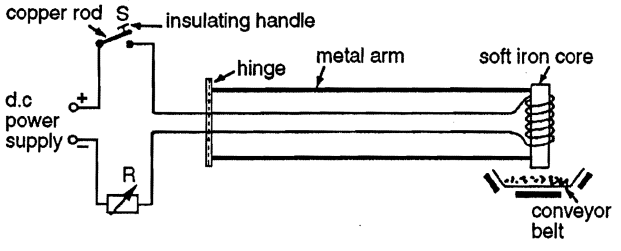
N84/I/9

41



The diagram shows a solenoid with a current flowing in the direction indicated. Draw field lines (lines of force) to show the pattern of the magnetic field produced by the current. Show by an arrow on each field line the direction in which N-pole of a compass needle would point. N85/I/11

42 The diagram shows the essential features of a device used to remove magnetic objects from a mixture moving past on a conveyor belt. Switch S is closed during collection; the arm is then swung over to a container and the switch opened to deposit the collected objects.



(a) Suggest reasons for the inclusion of the variable resistor R in the circuit.

(b) Explain why each of the following modifications, made on its own, would result in the device not working satisfactorily:

(i) a plastic rod substituted for the copper rod in switch S.

(ii) a copper core instead of the soft-iron core.

(iii) A hard steel core in place of the soft-iron core.

(c) State and explain whether the device will work

(i) if the polarity of the d.c. power supply is reversed,

(ii) if the d.c. supply is replaced by an a.c. supply.

J86/II/3

43 *(a)* Fig. (i) shows a magnet enclosed by a piece of metal, X, in order to prevent the magnetic field extending outside X.

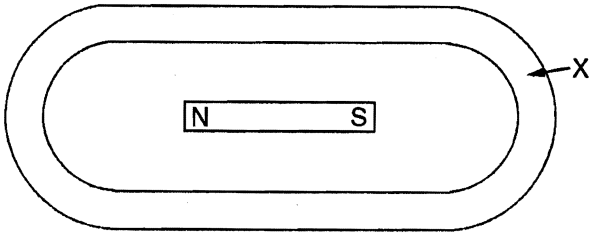


Fig. (i)

Name a suitable metal for X .....

Draw field lines (lines of force) on Fig. (i) to show the magnetic field between the magnet and X.

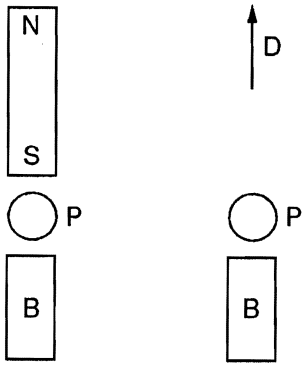


Fig. (ii)

Fig. (iii)

(b) Fig. (ii) above shows a bar of soft iron, B, which is placed close enough to the magnet shown, so that it becomes an induced magnet. A plotting compass, P, is placed midway between the magnet and the soft iron bar B. Mark the magnetic poles induced in B, and indicate on P the direction in which the compass needle will point.

Assume that the earth's magnetic field has no effect.

In Fig. (iii) the magnet has been moved away in the direction D until it no longer has any effect on the compass. Mark on P the direction in which the compass needle now points and explain your choice of direction.

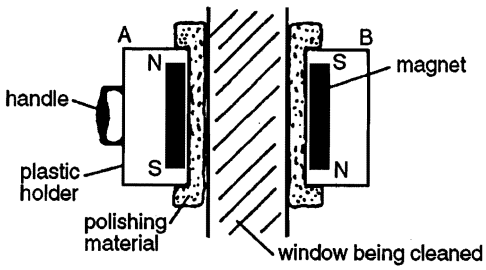
(c) The bar in Fig. (ii) is replaced by one of the same size, made of steel. The magnet is then removed as in Fig. (iii). Would there be any difference in the direction in which the compass pointed? Explain your answer.

N86/II/5

44 The diagram shows a two-piece device designed for cleaning both sides of a window pane at the same time. When part A is moved over the inside surface, part B follows it, moving over the outside surface.

(a) Explain why

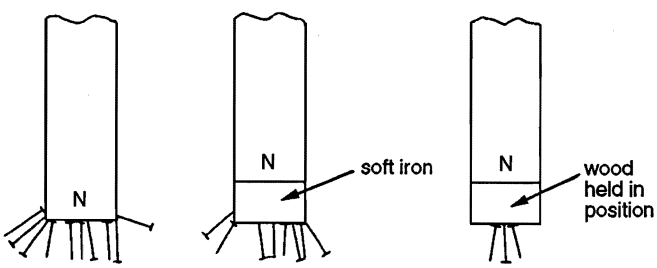
(i) B follows the movement of A,



(ii) there is a practical limit to the thickness of the window glass for which the device works.

(b) When A and B are placed on opposite sides of a vertical sheet of iron, B remains where it is even when A is removed. Suggest a reason for this. J87/I/12

45 In experiments with a vertically held bar magnet, its ability to attract soft iron tacks was tested. The results are shown by the diagrams below.



In the various cases, the average number of tacks attracted was as follows;

N pole of magnet, 10 tacks,

N pole of magnet covered by a piece of soft iron, 8 tacks,
N pole of magnet covered by a piece of wood, 3 tacks.

(i) What happened to the soft iron as it was placed in contact with the magnet?

(ii) Suggest why the magnet covered by the soft iron picked up almost as many tacks as the magnet alone.

(iii) If the soft iron was gently slid off the end of the magnet whilst holding 8 tacks, state and explain what would happen.

(iv) Although wood is a non-magnetic material, a few tacks are attracted when the wood is held covering the end of the magnet. Suggest a reason for this. N87/I/10

46 Fig. 7 represents an unmagnetised bar of soft iron and the terminals of a low-voltage d.c. supply.

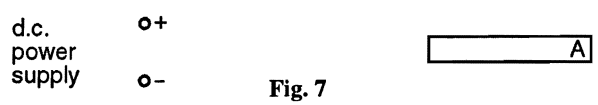


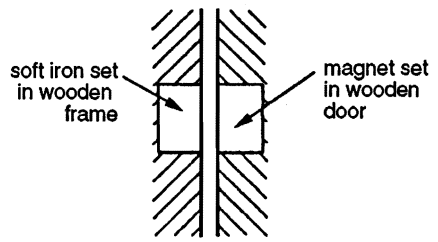
Fig. 7

By adding to the diagram, show the electrical circuit you would connect to the power supply in order to magnetise the bar so that the end A becomes a north pole. [2]

Indicate briefly how you would check that A is a north pole. [1]

State and explain the effect of using the same arrangement with an aluminium bar in place of the soft iron. [1]
J88/I/9

47 The diagram shows the arrangement of a magnetic catch on a wooden door.



(a) Describe what takes place as the magnet in the door approaches the soft iron in the frame. [2]

(b) Why is soft iron used rather than copper? [1]

(c) State one advantage of using a magnetic catch rather than a mechanical one. [1]
N88/I/11

48 *(a)* Explain what is meant by

(i) a magnetic field,

(ii) an electric field. [2]

(b) Complete Fig. 1.1 to show the pattern and direction of the magnetic field in the space around a bar magnet.

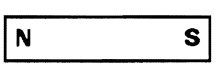


Fig. 1.1

(c) Fig. 1.2 shows the electric field between two small charges.

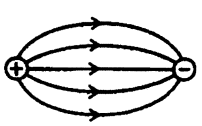


Fig. 1.2

Describe a simple experiment which could be used to confirm the presence the field. [2]
J89/II/4

49 Two magnets **A** and **B** are placed with their poles as shown in Fig. 2.

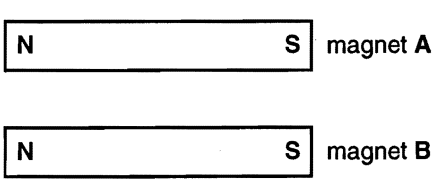


Fig. 2

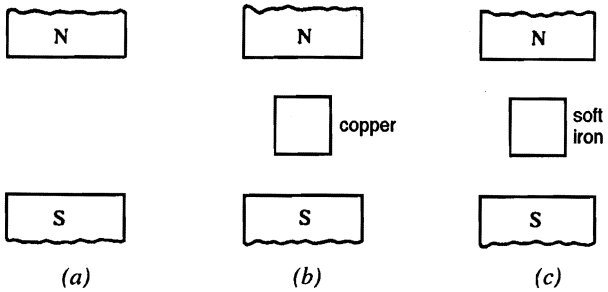
(a) Draw arrows to show the directions of the forces exerted on the north pole of magnet **A** by each of the poles of magnet **B**. [1]

(b) Draw arrows to show the directions of the corresponding forces exerted on the south pole of **B** by each of the poles of **A**. [1]

(c) Draw an arrow to show the direction of the resultant force exerted by magnet **B** on magnet **A**. Label the arrow with the letter **R**. [1]

(d) Explain why the resultant force acts in the direction you have shown in *(c)*. [1] N89/I/9

50 The diagrams in Fig. 3 show the region between two magnetic poles. In *(b)* there is a piece of copper between the poles, and in *(c)* there is a block of soft iron. Sketch the magnetic field line pattern on each diagram.



(a) *(b)* *(c)*

Fig. 3 [5] J90/II/6

51 *(a)* Fig. 4.1 shows a bar magnet and four circles which represent four positions for a plotting compass. Inside each circle draw an arrow to show which way the compass needle would point.

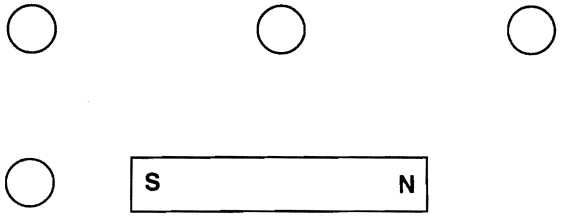


Fig. 4.1 [2]

(b) Fig. 4.2 is a diagram of a uniform magnetic field.

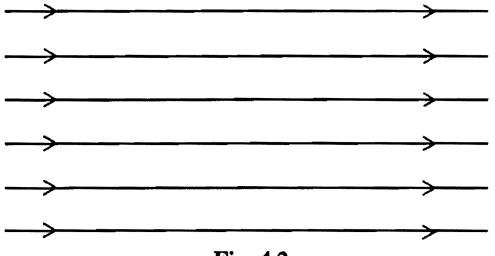


Fig. 4.2

A soft-iron ring is placed in the field.

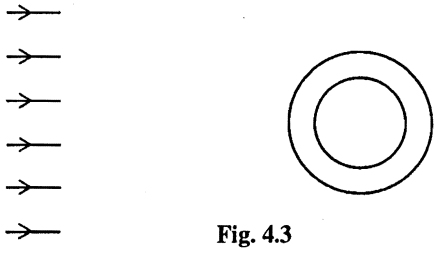


Fig. 4.3

Complete the field lines in Fig. 4.3 to show the effect of the soft-iron ring on the magnetic field pattern. [2] J92/II/4

52 *(a)* State the effects that the poles of a magnet have on the poles of other magnets. [2]

(b) Figure 5.1 is a diagram of a bar magnet.

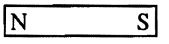


Fig. 5.1

Copy Fig. 5.1 and on your copy, draw a diagram of the magnetic field pattern around such a magnet. [3]

(c) Figure 5.2 shows a soft-iron bar placed near the end of a magnet.

Fig. 5.2

(i) Copy Fig. 5.2 and on your copy, draw the magnetic field pattern around the soft-iron bar and the S-pole of the magnet.

(ii) Name the magnetic effect shown by your answer to *(c)* (i).

(iii) State **one** application of this effect. [4]

(d) Explain briefly, with the aid of a series of diagrams, how you would use a plotting compass to show that your answer to *(c)* (i) is correct. [6] J94/II/11

53 *(a)* You are given two bars of metal which look to be the same. However, one is a bar magnet and the other is a soft-iron bar. Explain how, without the use of any additional equipment, you could show which bar is the magnet. [3]

(b) Figure 6 shows a small compass placed in a uniform horizontal magnetic field. The compass needle is held in the position shown, so that it cannot move.

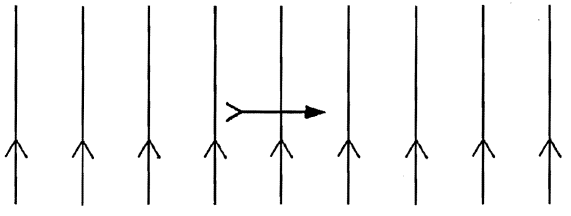


Fig. 6

(i) Copy Fig. 6 and on your copy draw arrows to show the directions of the two magnetic forces acting on the compass needle.

(ii) State and explain what would happen if the compass needle were no longer held in the position shown. [6] J95/II/11*(a, b)*

54 *(a)* Fig. 71 shows a thin flat rectangular bar magnet 40 mm long and 10 mm wide.

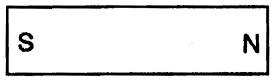


Fig 7.1

(i) **On your answer sheet,** draw the magnet and the magnetic field pattern around it.

(ii) The magnet is placed at the centre of a soft-iron ring of internal diameter 70 mm and external diameter 90 mm, as shown in Fig. 7.2.

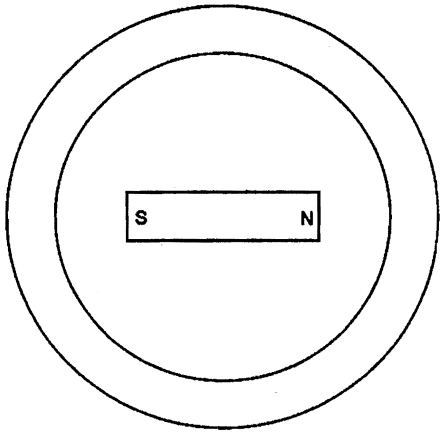


Fig. 7.2

On your answer sheet, draw a diagram to show the new magnetic field pattern.

(iii) State an application of the effect shown in your answer to (ii). [6]

(b) (i) Describe how you would use a 12 V battery and a solenoid of length 50 mm and internal diameter 10 mm to magnetise the steel arrow, shown full-size in Fig. 7.3, in such a way that the arrowhead becomes the N-pole. The solenoid has negligible resistance and its maximum safe current is 6 A. Your answer should include a circuit diagram, and you should state the resistance of any resistor used.

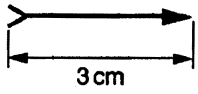


Fig. 7.3

(ii) Describe how you would use the same solenoid to demagnetise the steel arrow. [9]

N97/II/11

55 *(a)* Fig. 8 shows a view from above of a compass needle placed near a solenoid which contains a bar of unmagnetised steel. In the diagram, the switch has not been closed and the compass needle is pointing North.

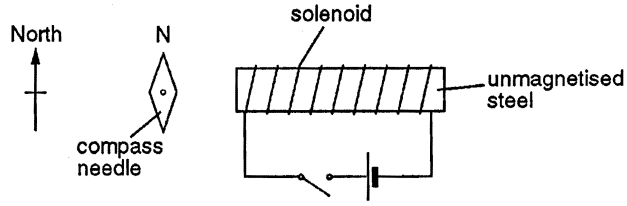


Fig. 8.1

On Fig. 8.1,

(i) mark the direction of current in the wire after the switch has been closed;

(ii) draw the direction of the compass needle after the switch has been closed. [2]

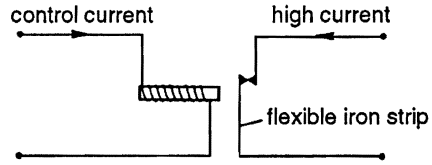
(b) State what happens to the compass needle when the switch is opened again. [1]

(c) Describe **one** method by which a magnetised steel bar could be demagnetised. [2] N98/II/6

20.3 Magnetic effect of a current

20.4 Applications of the magnetic effect of a current

1 An iron-cored electromagnet is to be used in a simple relay to switch off a high current by attracting a flexible iron strip as shown in the diagram.



During a trial, it is found that the relay does not operate when the control current is switched on.

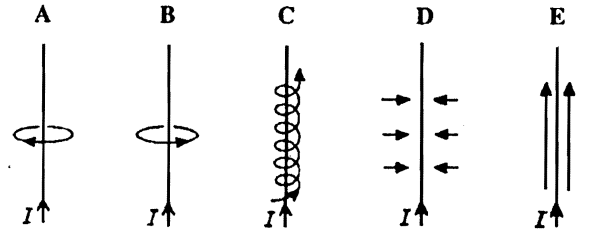
Which of the following changes might make it work?

A replacing the iron core by a steel core
B using fewer turns on the electromagnet
C using a thicker iron strip
D moving the strip further away from the electromagnet
E passing a larger current through the electromagnet.

N90/I/34

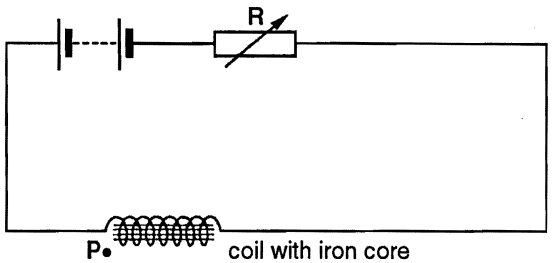
2 A direct current *I* flows upwards in a vertical wire.

Which diagram shows the direction and shape of the magnetic field in the region of the wire?



N91/I/32

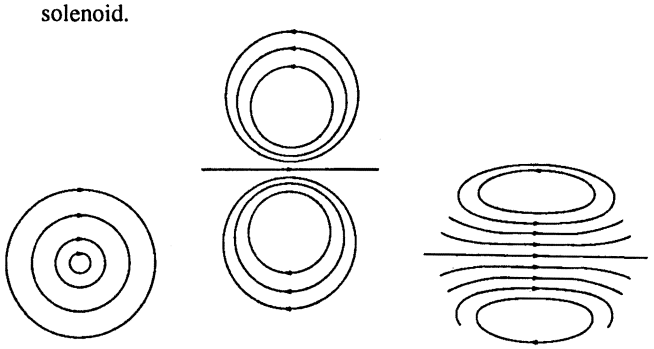
3 The diagram shows a circuit which includes a length of wire. Some of the wire is coiled around an iron core.



How could the magnetic field at **P** be increased?

A Increase the resistance of the variable resistor **R**.
B Remove the iron core.
C Replace the iron core with a steel core of the same size.
D Unwind some of the coils on the core.
E Using wire already in the circuit, wind more coils of wire around the core. J93/I/32

4 The diagrams shows the magnetic fields obtained from a current flowing through a straight wire, a circular coil and a solenoid.

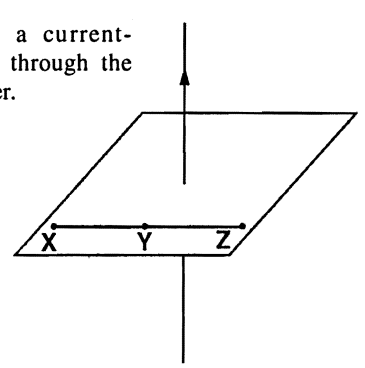


Which of the following correctly lists the origins of the magnetic fields illustrated?

	straight wire	*circular coil*	*solenoid*
A	X	Y	Z
B	X	Z	Y
C	Y	X	Z
D	Y	Z	X

N97/I/33

5 The diagram shows a current-carrying wire passing through the centre of a sheet of paper.

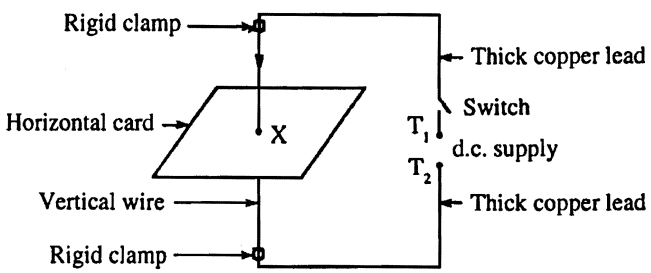


How do the strengths of the magnetic field at points **X, Y** and **Z** compare?

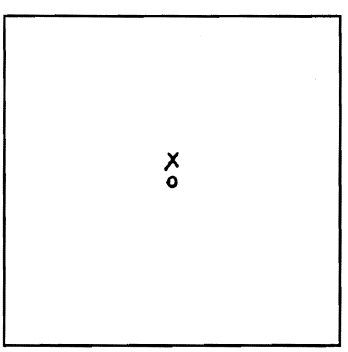
A equal at **X, Y** and **Z**
B equal at **X** and **Z,** but stronger at **Y**
C equal at **X** and **Z,** but weaker at **Y**
D stronger at **X** than **Y** and stronger at **Y** than **Z**

J2000/I/32

6 The diagram shows a vertical wire passing through a horizontal card. When the switch is closed a current flows down the wire in the direction shown by the arrow on the wire.



(a) On the diagram of the upper surface of the card shown below, sketch the shape and indicate the direction of the lines of force (field lines) of the magnetic field due to the current. (Neglect any effect of the Earth's magnetic field.)



(b) Describe one method of plotting the lines of force and determining experimentally the direction of the magnetic field.

(c) What will be the effect on the magnetic field closed to X when

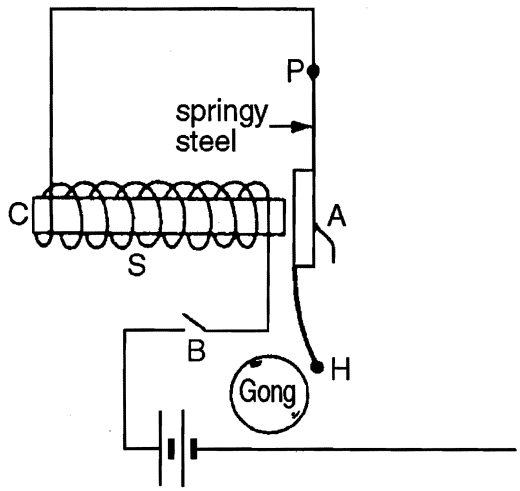
(i) the potential difference of the d.c. supply is reduced,

(ii) the connections of the d.c. supply to T_1 and T_2 are reversed?

(d) A second wire identical with the first passes, through a second hole in the card close to the first hole so that there are two vertical wires close to each other but not touching. The second wire is connected by means of leads to the terminals T_1 and T_2. The current through the first wire is 4.0 A. What is the current in the second wire?

The first vertical wire has a resistance of 0.50 Ω. Calculate the effective resistance between the terminals T_1 and T_2. J79/II/4

7 The diagram shows an incomplete diagram of an electric bell and circuit. The armature A is attached to a fixed pillar P by a strip of springy steel and is situated near the end of a solenoid S.

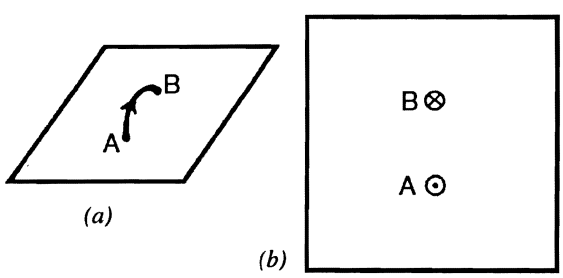


Complete the diagram to show the additions required to enable the bell to ring continuously when the switch B is closed. Label your additions to the diagram.

State the materials which are used for the armature A and for the core C of the solenoid S.

J80/I/15

8

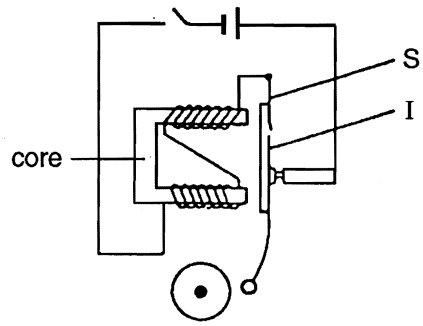


A steady electric current is passed through a flat circular coil in the direction shown in diagram *(a)*. The plane of the coil is vertical and cuts a horizontal board at A and B. Draw on diagram *(b)* the pattern of the magnetic field which results from the current in the coil. You are to neglect the earth's magnetic field.

Show the direction of the magnetic field by an arrow on a field line at a point near A and another on a field line at a point near B. J81/I/10

9 *(a)* What is meant by a *strong* magnet?

(b) Describe, with the aid of a diagram, how you would use a solenoid in an attempt to increase the strength of a magnet.



Mark clearly on your diagram the direction of the current and the N pole of the magnet.

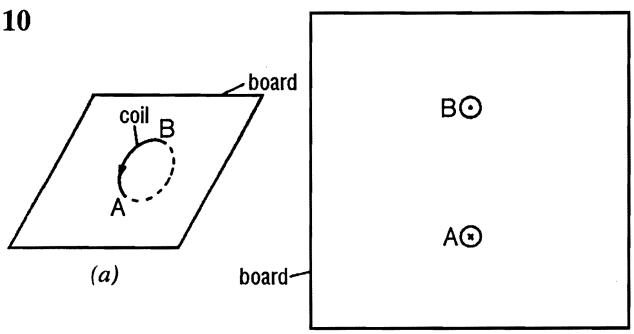
(c) the diagram illustrates an electric bell operated by a battery. Describe

(i) the magnetic properties of soft iron which make it suitable for the core of the electromagnet and for the armature I,

(ii) the function of the steel strip S.

(d) Explain why the bell works when connected to a low-voltage a.c. supply instead of the battery. N81/II/6

10



In the flat circular coil shown in diagram *(a)* a steady electric current flows in the direction shown. The plane of the coil is vertical and cuts a horizontal board at A and B, as indicated in the diagrams.

Draw on diagram *(b)* the pattern of the magnetic field which results from the current in the coil. You are to neglect the Earth's magnetic field and your diagram should contain at least **four** field lines.

By means of arrows on **two** field lines, one near A and one near B, show the direction of the magnetic field.

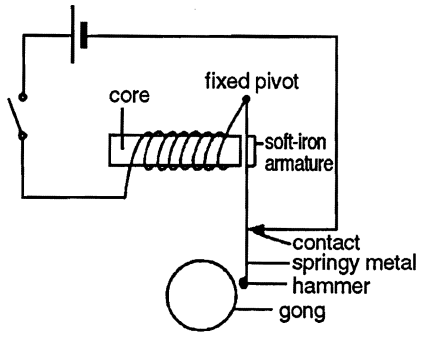
N82/I/12

11 *(a)* Describe how you would determine experimentally

(i) the magnetic field pattern round a bar magnet,

(ii) the direction of the magnetic field at a particular point in the field.

Sketch the pattern of field lines you would expect to obtain. (Neglect the influence of the Earth's magnetic field.)

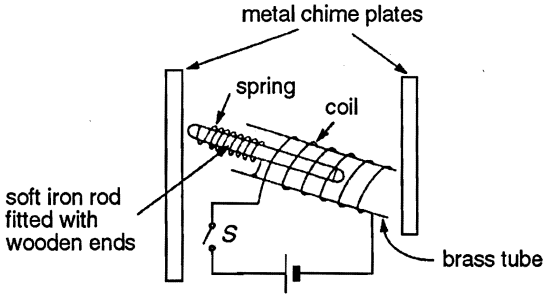


The diagram shows the essential features of a bell operated by a battery. Explain why the hammer repeatedly strikes the gong after the switch has been closed.

A student decided to investigate the effect of using different materials to form the core. He used, successively, cores made of (i) plastic, (ii) steel, (iii) copper.

In each case, state and explain what happen when the switch was closed. J84/I/11

12 The diagram illustrates the structure and operating circuit of a set of door chimes.



(a) State and explain what happens when the switch *S* is closed.

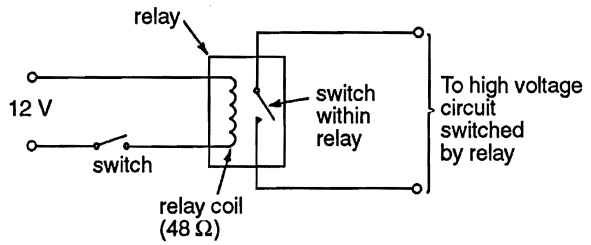
(b) What happens when the switch is opened again?

Give a reason for your answer.

(c) State, with a reason, whether the chimes will work if the polarity of the battery is reversed.

(d) Why is soft iron a suitable material for the moving part? J85/II/5

13



The diagram above illustrates the switching of a high voltage circuit by a relay operated by a 12 V supply of negligible internal resistance.

(a) Calculate

(i) the current flowing in the relay coil, if its resistance is 48 Ω.

(ii) the energy transformed into heat in this coil in two minutes.

(b) The relay coil is wound on a metal core.

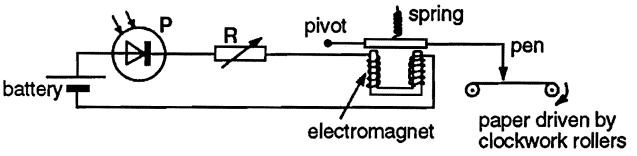
(i) State a suitable metal for this core.

(ii) Explain why you consider this metal suitable.

(iii) What would happen if the core were made of copper?

(c) Give reasons why the high voltage is switched in this way rather than by inserting a switch directly in the high voltage circuit. N85/II/4

14 The arrangement shown below is used to measure the length of the day — i.e. the length of time during which the daylight is above a certain brightness. The circuit incorporates a device, P, which has a high resistance in the dark but which has almost no resistance when light falls on it.



Explain why the pen will begin to draw a trace on the paper when light starts to fall on P and stop when it becomes dark.

Why would the use of a higher resistance at R make the arrangement less sensitive to light? J87/II/11

15 A large electric current is passed, in the direction indicated, through the vertical wire shown in Fig. 1.

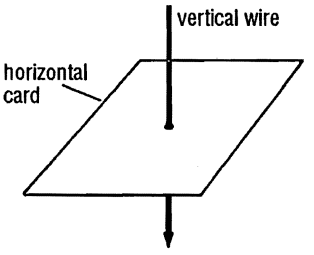


Fig. 1

Sketch on the card shown the pattern of the magnetic field around the wire (ignore the magnetic field of the Earth). Indicate with an arrow the *direction* of the magnetic field at any one point.

How would you check this direction experimentally? [1] J88/I/11

16 Fig. 2.1 is a diagram of a 6 V relay, or electromagnetic switch. The relay consists of a coil **C** wound round a soft-iron core. The soft-iron core is fixed to an L-shaped plate, **Y**, the long arm of which is parallel to the coil; the free end of **Y** is shaped to make a knife-edge pivot.

A shorter, L-shaped soft-iron plate or armature, **A**, is pivotted at this knife-edge.

The switch consists of three strips, **L**, **M** and **N**, fixed parallel to one another in an insulating block. Each strip is very springy. The middle strip, **M**, is fixed by means of a short rod to the armature **A**, pushing the end of the armature down. In this position, strip **M** of the switch is in contact with strip **N** of the switch and there is a gap between the lower end of the armature and the soft-iron core of the coil.

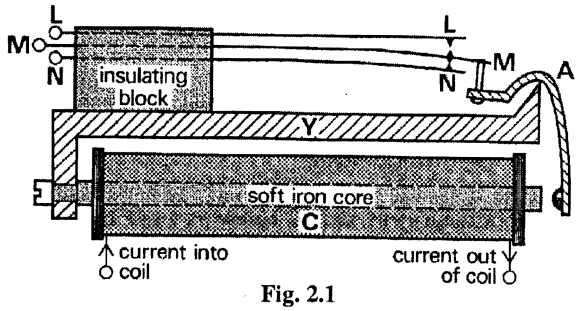


Fig. 2.1

(a) Explain what happens to the armature and the switch when coil **C** is

(i) connected to a 6 V d.c. supply,

(ii) disconnected from the 6 V d.c. supply. [5]

(b) Fig. 2.2 is a diagram of a circuit containing the relay described above together with two mechanical switches, S_1 and S_2.

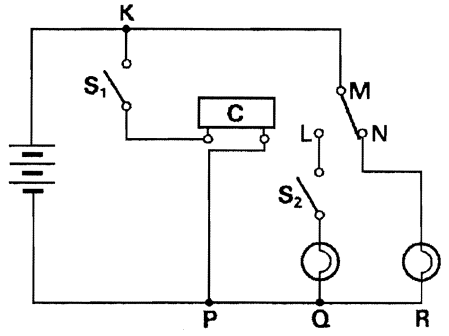


Fig. 2.2

State which, if any, of the branches **KP**, **MQ**, **MR**, of the circuit carry current when

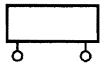
(i) S_1 is closed and S_2 is open,

(ii) S_1 is open and S_2 is closed,

(iii) S_1 is closed and S_2 is closed. [5]

(c) You have been asked to carry out an experiment to determine the smallest coil-current at which the relay described above would work as a switch.

(i) Draw a diagram of the circuit you would use.

Represent the relay coil by the symbol: 

(ii) Write down briefly the main steps you would take. [5]

J92/II/11

17 *(c)* Figure 3.1 shows a coil made of a few turns of wire wrapped round a short cardboard tube. Figure 3.2 shows a cross-section through the tube.

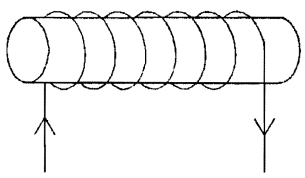


Fig. 3.1

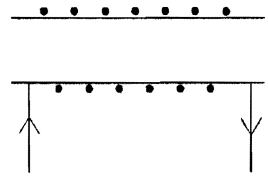


Fig. 3.2

(i) Which end of the coil would be a S-pole if a current were passed through the coil in the direction shown? Explain how you arrived at your answer.

(ii) Copy Fig. 3.2 and on your copy draw the magnetic field pattern due to the current in the coil.

(iii) State **two** ways in which the strength of this magnetic field could be increased. [6]

J95/II/11*(c)*

18 A group of students investigating electromagnetism make the electromagnet shown in fig. 9.1. The core of the magnet is a U-shaped piece of iron. Only a few turns of each of the coils P and Q are shown. Fig. 9.1 also shows an iron plate placed below the electromagnet.

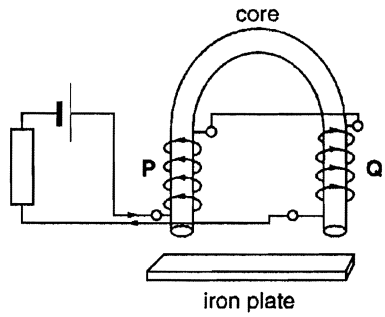


Fig. 9.1

(a) (i) Which of the two ends of the core is the N-pole of the electromagnet? Explain carefully how you decided on your answer.

(ii) The two coils have equal numbers of turns. Explain the effect on the strength of the electromagnet of reversing the connections to coil **Q**.

(iii) When the electromagnet is lowered until the gap between the ends of the core and the iron plate is reduced to a millimetre or so, the plate is rapidly attracted to the ends of the core. Explain why this happens.

(iv) Explain how, without changing the coils or core, the steel plate could be made to jump a larger vertical gap. [9]

J96/II/9*(a)*

19 *(a)* Figs 5.1 and 5.2 give two views of a short solenoid.

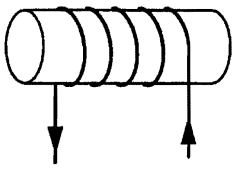


Fig. 5.1

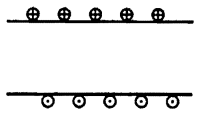


Fig. 5.2

(i) State which end of the solenoid is a N-pole when the current flows in the direction shown. State your reasons for your answer.

(ii) **Copy Fig. 5.2** and, **on your copy**, draw the magnetic field pattern set up by the current. [5]

(b) Fig. 5.3 is a diagram of an electric bell.

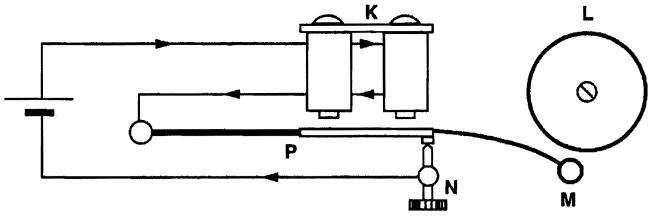


Fig. 5.3

Explain how the bell works. In your answer, you may refer to the letters shown in Fig. 5.3. [5]

N96/II/10*(a, b)*

20 Fig. 6 shows a circuit, that includes an electrical relay, used to switch on a motor M.

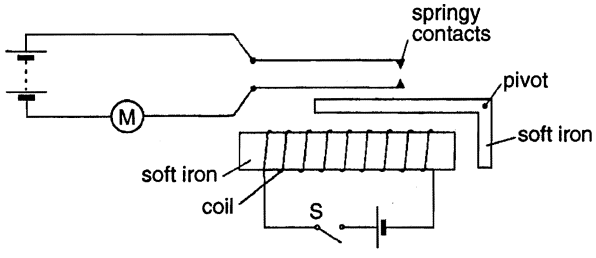


Fig. 6

Explain, in detail, how closing switch S causes the motor M to start. [4]

J98/II/6

21 Plotting compasses may be used to plot magnetic fields.

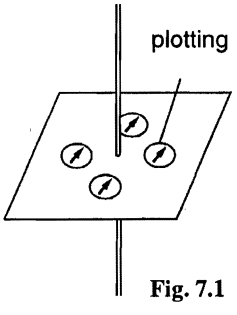


Fig. 7.1

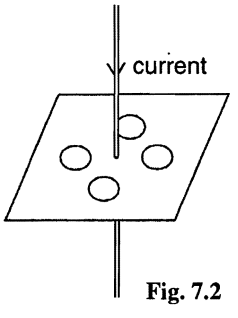


Fig. 7.2

In Fig. 7.1, four plotting compasses are shown near a wire. There is no current in the wire and the arrow in each compass points towards the North.

In Fig. 7.2, the same plotting compasses are shown near a wire in which there is a current downwards. The current creates a strong magnetic field near the compasses.

(a) (i) On Fig. 7.2, draw the direction shown by the arrow in each compass.

(ii) State where the magnetic field due to the current has its greatest strength. [3]

(b) Describe how you would use one compass to plot the lines of the magnetic field around the wire in Fig. 7.2. [3]

N2000/II/6

ANSWERS

20.1 Laws of magnetism

20.2 Magnetic properties of matter

1. **C**	2. **D**	3. **C**	4. **B**	5. **D**
6. **A**	7. **E**	8. **D**	9. **E**	10. **C**
11. **E**	12. **C**	13. **D**	14. **D**	15. **D**
16. **C**	17. **D**	18. **D**	19. **B**	20. **A**
21. **B**	22. **D**	23. **B**	24. **B**	25. **C**
26. **A**	27. **D**	28. **A**	29. **C**	30. **B**
31. **D**	32. **D**	33. **C**	34. **D**	35. **B**

37. *(a)* 0.6 A

20.3 Magnetic effect of a current

20.4 Applications of the magnetic effect of a current

1. **E**	2. **B**	3. **E**	4. **A**	5. **B**

13. *(a)* (i) 0.25 A (ii) 360 J