4.1 Simple phenomena of magnetism

Name: _____ Class: _____ Date: _____ **Total: 23 marks**

0 Vocabulary

Word	Example
magnet /'mægnɪt/ 磁体	The **magnet** attracts an iron nail. **磁体**吸引一枚铁钉。
poles /pəʊlz/ 磁极	A magnet has two **poles**: north and south. 磁体有两个**磁极**：北极和南极。
north pole /nɔːθ pəʊl/ 北极	Field lines leave a magnet at its **north pole**. 磁感线从磁铁的**北极**出发。
south pole /saʊθ pəʊl/ 南极	Field lines enter a magnet at its **south pole**. 磁感线进入磁铁的**南极**。
repel /rɪ'pel/ 排斥	Two positive charges **repel** each other. 两个正电荷相互**排斥**。
repulsion /rɪ'pʌlʃn/ 排斥力	Two north poles show **repulsion**. 两个北极之间有**排斥力**。
attract /ə'trækt/ 吸引	A positive and a negative charge **attract** each other. 正电荷和负电荷相互**吸引**。
attraction /ə'trækʃn/ 吸引力	A north and a south pole show **attraction**. 一个北极和一个南极之间有**吸引力**。
magnetic material 磁性材料 /mæg'netɪk mə'tɪərɪəl/	Iron is a **magnetic material**. 铁是一种**磁性材料**。
induced magnetism 感应磁性 /ɪn'djuːst 'mægnɪtɪzəm/	A magnet makes a nail magnetic by **induced magnetism**. 磁体通过**感应磁性**使铁钉具有磁性。
magnetise /'mægnɪtaɪz/ 磁化	Stroke a needle with a magnet to **magnetise** it. 用磁体沿同一方向摩擦针，使它**磁化**。
temporary magnet 临时磁体 /'temprəri 'mægnɪt/	A soft iron nail is a **temporary magnet**. 软铁钉是**临时磁体**。
steel /stiːl/ 钢	**Steel** is stronger than iron. **钢**比铁更坚固。

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Word	Example
permanent magnet 永磁体 /ˈpɜːmənənt ˈmægnɪt/	A fridge magnet is a **permanent magnet**. 冰箱贴磁铁是**永磁体**。
unmagnetised 未磁化 /ʌnˈmægnɪtaɪzd/	An **unmagnetised** iron bar has no poles. **未磁化**的铁棒没有磁极。
magnetic field 磁场 /mægˈnetɪk fiːld/	A magnet has a **magnetic field** around it. 磁铁周围有**磁场**。
region /ˈriːdʒn/ 区域	The inequality $y > x^2$ describes a **region** above the curve. 不等式 $y > x^2$ 表示曲线上方的一个**区域**。
magnetic field lines 磁场线 /mægˈnetɪk fiːld laɪnz/	**Magnetic field lines** go from north to south. **磁场线**从北极指向南极。
iron filings /ˈaɪən ˈfaɪlɪŋz/ 铁屑	**Iron filings** show the field around a magnet. **铁屑**可以显示磁体周围的磁场。
compass /ˈkʌmpəs/ 指南针	A **compass** shows sailors which way is north. **指南针**告诉水手北方在哪里。
electromagnet 电磁铁 /ɪˌlektrəʊˈmægnɪt/	An **electromagnet** picks up scrap iron. **电磁铁**吸起废铁。
electron /ɪˈlektrɒn/ 电子	An **electron** has a negative charge. **电子**带负电。
electric field /ɪˈlektrɪk fiːld/ 电场	A charged ball has an **electric field** around it. 带电小球周围有**电场**。
• **point charge** /pɔɪnt tʃɑːdʒ/ 点电荷	Treat the small ball as a **point charge**. 把小球看作一个**点电荷**。
relay /ˈriːleɪ/ 继电器	A **relay** uses a small current to switch a large one. **继电器**用小电流控制大电流的通断。
solenoid /ˈsəʊlənɔɪd/ 螺线管	A **solenoid** is a long coil of wire. **螺线管**是一个长导线线圈。
loudspeaker /ˈlaʊdspiːkə/ 扬声器	A **loudspeaker** turns electrical signals into sound. **扬声器**将电信号转化为声音。

1 Key knowledge and worked examples

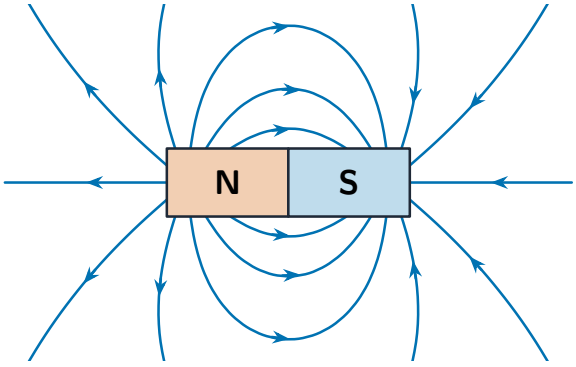
Study these first. Each one shows the method for a question type used later: follow the steps and you can do the Practice and Exam-style questions yourself.

Poles, materials and induced magnetism

- Every magnet has a N pole and a S pole. **Like poles repel; unlike poles attract.**
- **Magnetic materials** 磁性材料 are attracted by a magnet: iron, steel, nickel, cobalt. Copper, aluminium and plastics are not.
- A magnet **induces** magnetism in a nearby piece of iron or steel: the near end becomes the **opposite** pole, so the two attract.

	soft iron	**steel**
magnetises	easily	less easily
when the magnet is removed	loses its magnetism	keeps it
use	**temporary** magnets: electromagnet cores, relays	**permanent** magnets: fridge doors, motors, loudspeakers

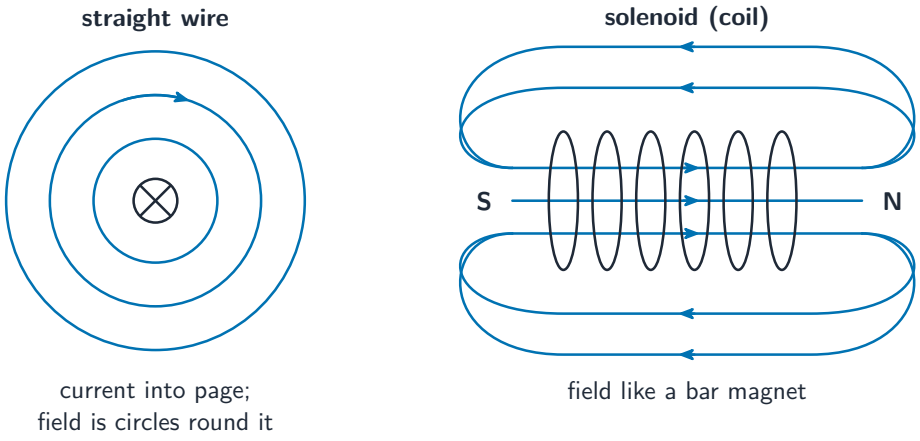
Magnetic fields



field lines leave N and enter S; they never cross,
and they are closest together at the poles, where the field is strongest

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

- A **magnetic field** 磁场 is the region where a magnet exerts a force on a magnetic material or another magnet.
- Field lines point from **N to S** outside the magnet: the way a compass needle's N end points.
- The field is **strongest where the lines are closest together**: at the poles.



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

■ Worked example: plotting a field with a compass

Describe how to plot the field lines of a bar magnet.

1. Place the magnet on paper and draw round it. Put a small **plotting compass** 指南针 near the N pole.
2. Mark a dot at the end the compass needle points to, then move the compass so its other end is on that dot. Repeat until you reach the S pole.
3. Join the dots with a smooth line and add an arrow from N to S. Start again from another point for the next line.

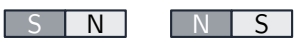
■ Worked example: is it a magnet?

A steel bar is attracted to both ends of a bar magnet. Is the steel bar a magnet?

1. Attraction proves nothing: a magnet attracts any unmagnetised steel by inducing an opposite pole in it.
2. Only **repulsion** proves a magnet, because only like poles repel. Bring each end of the bar up to the magnet's N pole; if one end is pushed away, the bar is a magnet.
3. Here neither end is repelled, so the bar is **not** a magnet.

2 Practice

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



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

soft iron steel

2.3 Name two metals that are attracted by a magnet. [1]

magnetic metals

2.4 An iron nail is held near the N pole of a bar magnet. State which pole is induced at the end of the nail nearer the magnet. [1]



2.5 State one difference between a permanent magnet and an induced magnet. [1]

permanent magnet induced magnet

3 Exam-style questions

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



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

3.2 Which statements about magnets are correct? [1]

1. Soft iron is used to make permanent magnets.
2. A magnet can induce magnetism in a steel bar.
3. An electromagnet loses its magnetism when the current is switched off.

soft iron steel electromagnet

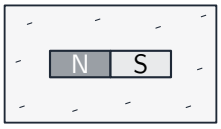
- ☐ **A** 1, 2 and 3
- **B** 1 and 2 only
- **C** 1 and 3 only
- **D** 2 and 3 only

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3.3 State the direction of the magnetic field outside a bar magnet, and where the field is strongest. [2]

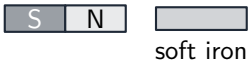


3.4 Describe how you could show the magnetic field pattern of a bar magnet using iron filings. [2]



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

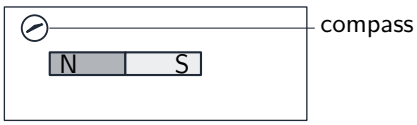
Explain why the iron becomes magnetised and is attracted to the magnet. [2]



3.6 A student has a steel bar and a bar magnet with labelled poles. Describe a test to decide whether the steel bar is itself a magnet, and explain why attraction alone does not prove it. [3]



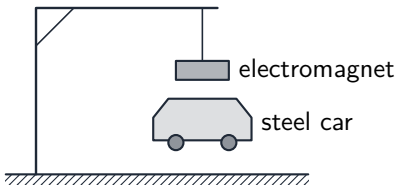
3.7 A student places a bar magnet on a sheet of paper. Describe how she can use a plotting compass to draw one magnetic field line, including its direction. [3]



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3.8 A crane in a scrapyard lifts steel cars with an electromagnet that has a soft iron core.

(a) Explain why the core is made of soft iron and not steel. [2]



(b) Explain why an electromagnet is used here rather than a permanent magnet. [1]

(c) The crane also lifts some aluminium cans. State and explain what happens to them. [1]

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Solutions

Each answer shows the steps, then the **result**.

2.1

- they repel (push apart)

2.2

- steel

2.3

- any two of: iron, nickel, cobalt (steel is an alloy of iron)

2.4

- a **S** pole: unlike poles attract

2.5

- a permanent magnet stays magnetised on its own; an induced magnet is magnetised only while it is near a magnet

3.1 B

- field lines run from N to S outside the magnet

3.2 D

- 2 and 3 are correct; permanent magnets are made of steel, not soft iron, so 1 is wrong

3.3

- from the N pole to the S pole
- strongest at the poles, where the field lines are closest together

3.4

- place paper over the magnet and sprinkle iron filings on top
- tap gently – the filings line up along the field lines, showing the pattern

3.5

- the magnet's field induces magnetism in the iron
- the near end gains the opposite pole, so the two attract

3.6

- bring each end of the steel bar in turn near the N pole of the magnet
- if one end is **repelled**, the bar is a magnet: only like poles repel
- attraction is not enough: a magnet induces magnetism in an unmagnetised steel bar, so it is attracted too

3.7

- place the compass near the N pole and mark the point the compass needle's N end points to
- move the compass so its tail is on that mark, mark again, and repeat until the S pole is reached
- join the marks with a smooth line and add an arrow pointing from N to S

3.8

(a)

- soft iron magnetises strongly when the current flows
- and loses its magnetism when the current is switched off, so the cars can be dropped; steel would stay magnetised

(b)

- it can be switched off to release the load

(c)

- they are not lifted: aluminium is not a magnetic material

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