4.4 Electrical safety

Name: _____ Class: _____ Date: _____ **Total: 24 marks**

0 Vocabulary

Word	Example
electric charge 电荷 /ɪ'lektrɪk tʃɑ:dʒ/	A rubbed balloon has an **electric charge**. 摩擦过的气球带有**电荷**。
positive charge 正电荷 /'pɒzɪtɪv tʃɑ:dʒ/	A proton carries a **positive charge**. 质子带有**正电荷**。
negative charge 负电荷 /'negətɪv tʃɑ:dʒ/	An electron carries a **negative charge**. 电子带有**负电荷**。
insulator /'ɪnsju:leɪtə/ 绝缘体	Plastic is an **insulator**. 塑料是**绝缘体**。
mains supply /meɪnz sə'plaɪ/ 市电	The **mains supply** in China is 220 V. 中国的**市电**电压为 220 V。
watt /wɒt/ 瓦特	One **watt** means one joule every second. 一**瓦特**表示每秒一焦耳。
electrical energy 电能 /ɪ'lektrɪkl 'enədʒi/	A battery gives **electrical energy** to the lamp. 电池向灯提供**电能**。
joule /dʒu:l/ 焦耳	Lifting an apple by one metre takes about one **joule** of energy. 把一个苹果举高一米大约需要一**焦耳**的能量。
appliance /ə'plaɪəns/ 电器	A kettle is an electrical **appliance**. 水壶是一种**电器**。
switch /swɪtʃ/ 开关	Press the **switch** to turn on the lamp. 按下**开关**打开灯。
fuse /fju:z/ 保险丝	The **fuse** melts if the current is too big. 电流过大时，**保险丝**会熔断。
hazard /'hæzəd/ 危险	Falling masses are a **hazard** to your feet. 下落的砝码会对脚造成**危险**。
insulation /ˌɪnsju:'leɪʃn/ 绝缘层	Plastic **insulation** covers the copper wire. 塑料**绝缘层**包裹着铜线。

Word	Example
overheating /ˌəʊvəˈhiːtɪŋ/ 过热	**Overheating** can cause a fire. **过热**可能引发火灾。
damp /dæmp/ 潮湿	Never touch a switch with **damp** hands. 千万不要用**潮湿**的手触摸开关。
overloading /ˌəʊvəˈləʊdɪŋ/ 过载	**Overloading** a socket with too many plugs is dangerous. 一个插座接入太多插头而导致**过载**是危险的。
socket /ˈsɒkɪt/ 插座	Plug the kettle into the **socket**. 把水壶的插头插入**插座**。
live wire /laɪv ˈwaɪə/ 火线	The **live wire** carries the high voltage. **火线**带有高电压。
neutral wire /ˈnjuːtrəl ˈwaɪə/ 零线	The **neutral wire** completes the circuit. **零线**使电路形成回路。
earth wire /ɜːθ ˈwaɪə/ 地线	The **earth wire** protects you if the metal case becomes live. 如果金属外壳带电，**地线**会保护你。
fuse rating /fjuːz ˈreɪtɪŋ/ 额定值	A kettle needs a 13 A **fuse rating**. 水壶需要使用**额定值**为 13 A 的保险丝。
trip switch /trɪp swɪtʃ/ 跳闸开关	A **trip switch** cuts the power when there is a fault. 发生故障时，**跳闸开关**会切断电源。
casing /ˈkeɪsɪŋ/ 外壳	The **casing** of the hair dryer is plastic. 吹风机的**外壳**是塑料制的。
earthed /ɜːθt/ 接地	The metal case is **earthed** for safety. 为了安全，金属外壳已**接地**。
double-insulated 双重绝缘 /ˈdʌbl ˈɪnsjuːleɪtɪd/	A **double-insulated** appliance needs no earth wire. **双重绝缘**的电器不需要地线。

1 Key knowledge and worked examples

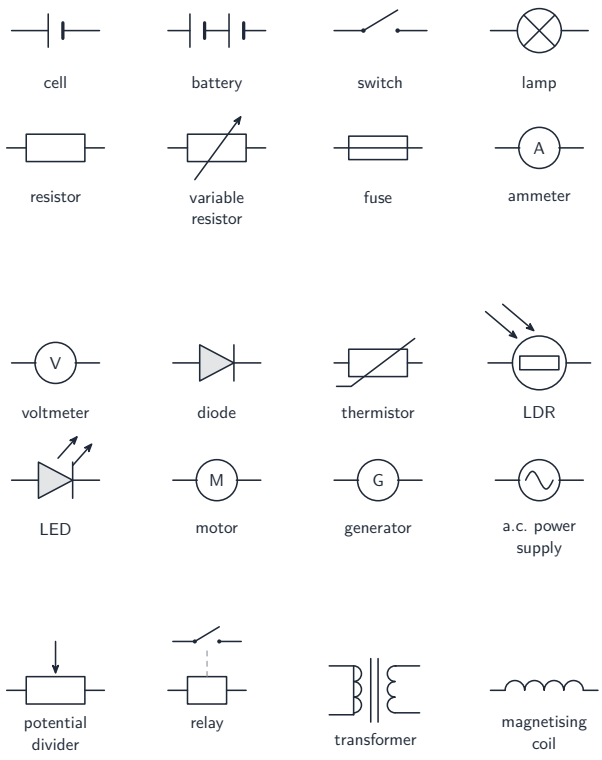
Study these first. Each one shows the method for a question type used later: follow the steps and you can do the Practice and Exam-style questions yourself.

The mains wires

wire	colour	job
live	brown	carries the alternating p.d. (230 V) to the appliance
neutral	blue	completes the circuit, close to 0 V
earth	green and yellow	safety wire: joins a metal case to the ground

Hazards 危险: damaged insulation (bare live wire), overheating cables (too much current for their thickness), damp conditions (water conducts), and overloading one socket with many appliances.

Fuses, circuit breakers and earthing



A fuse is a thin wire that melts and breaks the circuit if the current is too large

- A **fuse** 保险丝 is a thin wire that melts when the current is too large, breaking the circuit before the cable overheats.
- A **circuit breaker** 断路器 is an automatic switch that trips open when the current is too large. It acts faster than a fuse and is reset rather than replaced.
- The switch, fuse and circuit breaker go in the **live** wire, so that when they open, the appliance is cut off from the high p.d.
- **Earthing** 接地: if a fault makes a metal case live, a large current flows through the low-resistance earth wire and blows the fuse.
- **Double insulation:** an appliance with a plastic (insulating) case needs no earth wire, because the case cannot become live.

■ **Worked example: choosing a fuse**

A 1.2 kW hairdryer runs on the 230 V mains. Fuses of 3 A, 5 A and 13 A are available. Which should be fitted?

1. Normal current from $P = IV$, so $I = \dfrac{P}{V}$:

$$I = \frac{P}{V} = \frac{1200\ \text{W}}{230\ \text{V}} = 5.2\ \text{A}$$

2. The fuse must carry the normal current without melting but melt on a fault, so choose the **lowest rating above** 5.2 A: the **13 A** fuse. The 5 A fuse would melt in normal use.

2 Practice

2.1 Name the three wires in a mains cable. [2]



2.2 State one hazard of using mains electricity in damp conditions. [1]

mains damp

2.3 State the colour of the insulation on the live wire and on the earth wire in a mains cable. [2]

live wire earth wire

2.4 State why damaged insulation on a mains cable is dangerous. [1]

damaged



exercises.lol exercises.com.cn

3 Exam-style questions

3.1 A fuse should be fitted in the: [1]

fuse

- ☐ **A** earth wire
- **B** neutral wire
- **C** live wire
- **D** casing

3.2 Explain why a fuse must be connected in the live wire and not in the neutral wire. [2]

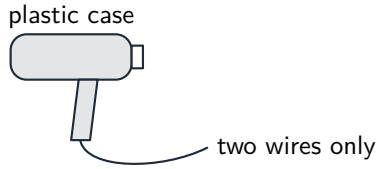
live wire neutral wire

3.3 Many homes now use circuit breakers instead of fuses. Give two advantages of a circuit breaker. [2]



circuit breakers

3.4 A hairdryer has a plastic case and a two-wire cable with no earth wire. Explain why it is still safe to use. [2]



3.5 An appliance normally draws a current of 8 A. Fuses are available rated 3 A, 5 A, 10 A and 13 A.

(a) State which fuse should be used, and why. [2]

3 A 5 A 10 A 13 A appliance: 8 A

(b) Explain how the fuse protects the cable. [2]

exercises.lol exercises.com.cn

3.6 Explain how earthing a metal-cased appliance keeps the user safe if a fault makes the case live. [3]



3.7 A kettle has a power of 2.3 kW and is connected to the 230 V mains supply.

(a) Calculate the current in the kettle. [2]



(b) Fuses rated 3 A, 5 A and 13 A are available. State which fuse should be used, and why. [2]

exercises.lol exercises.com.cn

Solutions

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

2.1

- live, neutral and earth

2.2

- water lets current pass into a person, increasing the risk of an electric shock

2.3

- live: brown
- earth: green and yellow stripes

2.4

- a person could touch the exposed live wire and get an electric shock (or the bare wires could touch, causing a short circuit and a fire)

3.1 C

- the fuse (and switch) must be in the live wire

3.2

- when the fuse melts, it must disconnect the appliance from the high potential of the live wire
- a fuse in the neutral wire would melt, but the appliance would still be connected to the live wire, so touching it could still give a shock

3.3

- it trips (switches off) faster than a fuse melts
- it can be reset by pressing a switch, with nothing to replace

3.4

- the plastic case is an electrical insulator, so it cannot become live if a wire inside comes loose
- so there is no risk of a shock from touching the case, and no earth wire is needed (double insulation)

3.5

(a) the 10 A fuse

- it is just above the normal working current of 8 A, so it carries normal current but blows on a fault

(b) if the current gets too large, the thin fuse wire melts and breaks the circuit before the cable overheats

3.6

- if a live wire touches the metal case, the earth wire provides a low-resistance path to the ground
- a large current flows to earth
- this blows the fuse, cutting off the supply so the case cannot give a shock

3.7

(a) $P = IV$, so $I = P/V$

$$I = \frac{P}{V} = \frac{2300\ \text{W}}{230\ \text{V}} = \mathbf{10}\ \text{A}$$

(b) the **13** A fuse

- it is the lowest rating above the normal current of 10 A: the 3 A and 5 A fuses would melt in normal use