# 6.2 The motor effect and electrical energy (P)

Name: _____ Class: _____ Date: _____ **Total: 25 marks**

**KEY WORDS** motor effect • kilowatt-hour

## Objective

Build the skills to answer exam questions on **the motor effect and electrical energy** : the force on a wire in a magnetic field, Fleming's left-hand rule, electric motors, electrical power and energy, and the cost of electricity.

**You must be able to:**

- describe the force on a current-carrying wire in a magnetic field
- use Fleming's left-hand rule and explain how a motor works
- use $P = IV$, $P = I^2R$, $E = Pt$ and $E = VQ$
- calculate energy in kWh and the cost of electricity

## 1 Key knowledge and worked examples

### ■ Motor effect and electrical energy

| idea | equation or rule |
|---|---|
| motor effect | a wire with a current in a magnetic field feels a force; biggest when the wire is at 90° to the field; bigger with more current or a stronger magnet |
| Fleming's left-hand rule | First finger: Field (N to S); seCond finger: Current; thuMb: Motion (force) |
| electric motor | forces on the two sides of the coil are in opposite directions, so the coil turns; a split-ring commutator reverses the current every half turn |
| power | $P = IV$ or $P = I^2R$ (W) |
| energy | $E = Pt$ or $E = VQ$ (J) |
| cost | energy in kWh = power in kW × time in hours; cost = kWh × price per kWh |



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**Worked example 1: power.** A heater takes 4.0 A from the 230 V mains. Find its power.

1. Known: $I = 4.0$ A, $V = 230$ V.
2. Rule: $P = IV$.
3. Numbers: $4.0 \times 230$.
4. Result: $P = 920$ **W**.

**Worked example 2: the cost of electricity.** A 2.0 kW heater runs for 3.0 hours. Electricity costs 0.60 yuan per kWh. Find the cost.

1. Known: $P = 2.0$ kW, $t = 3.0$ h.
2. Rule: kWh = kW × h; cost = kWh × price.
3. Numbers: $2.0 \times 3.0 = 6.0$ kWh; $6.0 \times 0.60$.
4. Result: 3.6 **yuan**.

**Answer shapes:** use W and s for joules, but kW and hours for kWh.

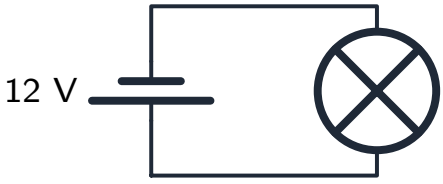
## 2 Practice

**2.1** A wire carries a current into the page between two magnets. Use Fleming's left-hand rule to find the direction of the force on the wire. [2]




current into the page

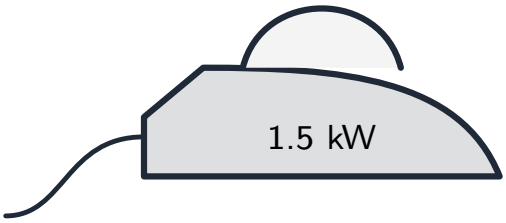
**2.2** A charge of 50 C passes through a 12 V lamp. Calculate the energy transferred. [2]





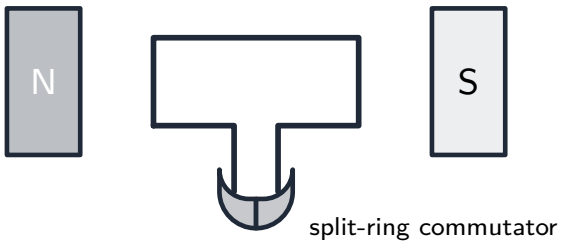

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**2.3** A 1.5 kW iron is used for 2.0 hours. Electricity costs 0.50 yuan per kWh. Calculate the energy in kWh and the cost. [2]




## 3 Exam-style questions

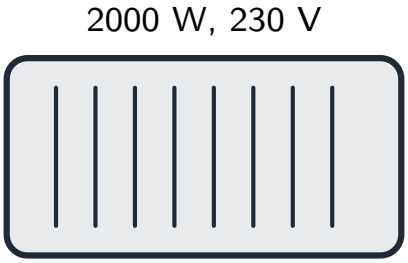
**3.1** The diagram shows a simple electric motor. Explain why the coil turns. Explain why the motor needs a split-ring commutator. [3]





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**3.2** A heater has a power of 2000 W on the 230 V mains. Calculate the current and the resistance of the heater. [3]




**3.3** A family records how they use some appliances each day. Electricity costs 0.60 yuan per kWh.

| appliance | power / kW | hours each day |
|---|---|---|
| kettle | 2.2 | 0.5 |
| TV | 0.10 | 5 |
| fridge | 0.15 | 8 |
| 6 LED lamps | 0.010 each | 6 |

(a) Calculate the energy used each day by the kettle and by the TV, in kWh. [2]

(b) Calculate the energy used each day by the TV in joules. [2]



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(c) Calculate the total energy used by all the appliances each day. Calculate the cost for 30 days. [3]

(d) Suggest and explain ways the family can use less electricity. Use the data in your answer. [6]



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## Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

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

**2.1**

- field from N to S (left to right), current into the page; force **downwards**

**2.2**

- $E = VQ = 12 \times 50 = \mathbf{600}$ J

**2.3**

- $1.5 \times 2.0 = \mathbf{3.0}$ kWh; $3.0 \times 0.50 = \mathbf{1.5}$ yuan

**3.1**

- the current in each side of the coil is in a magnetic field, so each side feels a force
- the currents in the two sides are in opposite directions, so the forces are opposite and make the coil turn
- the commutator reverses the current every half turn, so the coil keeps turning the same way

**3.2**

- $I = \frac{P}{V} = \frac{2000}{230} = \mathbf{8.7}$ A
- $R = \frac{V}{I} = \frac{230}{8.7} = \mathbf{26}\,\Omega$

**3.3**

(a) kettle $2.2 \times 0.5 = \mathbf{1.1}$ kWh; TV $0.10 \times 5 = \mathbf{0.50}$ kWh

(b) $E = Pt = 100 \times 5 \times 3600 = \mathbf{1.8 \times 10^6}$ J

(c) $1.1 + 0.50 + 1.2 + 0.36 = 3.16$ kWh; $3.16 \times 30 \times 0.60 = \mathbf{56.9}$ yuan

(d) points to include:

- the kettle has the largest power: boil only the water needed
- the fridge uses the most energy each day (1.2 kWh): keep the door closed, choose an efficient model
- switch the TV off, not on standby; watch fewer hours
- LED lamps already use little energy (0.36 kWh): switch off lamps in empty rooms
- an efficient appliance wastes less energy as heat, so the same job costs less

Levels: **5–6** a full, logical answer with correct physics and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.



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