



Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

**1 Key words**

1. coulomb
2. ampere
3. electromotive force
4. volts
5. resistance
6. ohms
7. nichrome
8. kilowatt-hours

K • 4

Each carries 0.5 mark.

**2 Label the diagram**

1. ammeter in series: the current flows through it
2. bulb
3. cell
4. voltmeter in parallel: across the bulb

K • 2

Each carries 0.5 mark.

**3 Multiple choice**

- i. d. long and thin

U • 1

Resistance grows with length and grows as the wire gets thinner. A long, thin wire has both against it.

- ii. c. it goes out

U • 1

In series there is only one path. A fused filament is a break in that path, so no current can flow anywhere in the circuit, and the other bulb goes out too.

- iii. b. so that all the loads are connected to the same potential difference

U • 1

In parallel, every appliance gets the full supply voltage it was made for. The currents through them are **different** (a heater takes far more than a bulb), and adding loads in parallel **decreases** the total resistance.

- iv. b. A changes more energy per second than B.

A • 1

Power  $P = VI$ . A:  $220 \times 0.5 = 110 \text{ W}$ . B:  $220 \times 0.45 = 99 \text{ W}$ . A has more power, so it changes more energy every second. The last option is not always true: it depends on how much longer B is used.

- v. d.  $3.6 \times 10^6 \text{ J}$

A • 1

$E = Pt = 1000 \text{ W} \times 3600 \text{ s} = 3\,600\,000 \text{ J} = 3.6 \times 10^6 \text{ J}$ . That is 1 kWh, one unit.

**4 Very short answers**

- a. MARKING SCHEME

K • 1

✓ The rate of flow of charge (the charge passing a point in one second),  $I = Q/t$ .

- b. MARKING SCHEME

K • 1

✓ The cell gives 1.5 J of energy to each coulomb of charge it drives round a circuit (its e.m.f. is 1.5 V).



## 5 Short answers

### a. MARKING SCHEME

U · 2

- ✓ The energy a source gives to each coulomb of charge to drive it round the whole circuit (unit: volt,  $1 \text{ V} = 1 \text{ J/C}$ ).
- ✓ It is not a force: a force is a push or pull measured in newtons; e.m.f. is energy per unit charge, measured in volts.

### b. MARKING SCHEME

U · 2

- ✓ Two cells in series give twice the e.m.f. ( $3 \text{ V}$ ), so the p.d. across the bulb doubles and a larger current flows ( $I = V/R$ ).
- ✓ Its power ( $P = VI$ ) is larger, so it changes more electrical energy into light every second.

### c. MARKING SCHEME

U · 2

- ✓ Every appliance gets the full supply voltage it is made for.
- ✓ Each can be switched on and off by its own switch, and if one fails the others keep working.

### d. MARKING SCHEME

K · 2

- ✓ The electrical energy changed into other forms in one second ( $P = E/t = VI$ ; unit: watt).
- ✓ The charger changes  $5 \text{ J}$  of electrical energy every second when it works at full rating.

## 6 Long answer

### ANSWER

U · 4

The diagram shows the three resistors joined end to end, with the cell, the current  $I$  and the p.d.s  $V_1$ ,  $V_2$  and  $V_3$  across them. In series there is only one path, so the same current  $I$  flows through every resistor, and the p.d. of the source is shared:  $V = V_1 + V_2 + V_3$ . By Ohm's law, each p.d. is the current times the resistance, so  $IR = IR_1 + IR_2 + IR_3$ . Dividing by  $I$ :  $R = R_1 + R_2 + R_3$ .

### MARKING SCHEME

- ✓ A circuit diagram with the three resistors in series with a cell, the current  $I$  and the p.d.s  $V_1$ ,  $V_2$ ,  $V_3$  marked.
- ✓ The same current  $I$  flows through all three, and the p.d. is shared:  $V = V_1 + V_2 + V_3$ .
- ✓ Using  $V = IR$  for each:  $IR = IR_1 + IR_2 + IR_3$ .
- ✓ Dividing by  $I$ :  $R = R_1 + R_2 + R_3$ .

## 7 Numerical problems

### a. ANSWER

A · 2

$$V = 3 \text{ V}, I = 500 \text{ mA} = 0.5 \text{ A}$$

$$\text{Power: } P = VI = 3 \text{ V} \times 0.5 \text{ A} = 1.5 \text{ W}$$

$$\text{Resistance: } R = V/I = 3 \text{ V} \div 0.5 \text{ A} = 6 \Omega$$

### MARKING SCHEME

- ✓  $P = VI = 3 \text{ V} \times 0.5 \text{ A} = 1.5 \text{ W}$ .
- ✓  $R = V/I = 3 \text{ V} \div 0.5 \text{ A} = 6 \Omega$ .



Daily consumption,  $E = P \times n \times t$  (with P in kW and t in hours):

- LED bulbs:  $7/1000 \times 10 \times 6 = 0.42$  kWh
- TV:  $150/1000 \times 1 \times 8 = 1.2$  kWh
- fans:  $150/1000 \times 4 \times 10 = 6$  kWh
- iron: 40 minutes a week =  $40/60$  h  $\div 7 \approx 0.0952$  h a day, so  $750/1000 \times 1 \times 0.0952 \approx 0.0714$  kWh

Total in a day  $\approx 0.42 + 1.2 + 6 + 0.0714 = 7.6914$  kWh

In a month  $\approx 7.6914 \times 30 \approx 230.7$  units (kWh)

Bill  $\approx 230.7 \times \text{Rs } 10 \approx \text{Rs } 2,307$

#### MARKING SCHEME

- ✓ Each appliance's daily energy with P in kW and t in hours, e.g. LED bulbs  $7/1000 \times 10 \times 6 = 0.42$  kWh and TV  $150/1000 \times 8 = 1.2$  kWh.
- ✓ Fans  $150/1000 \times 4 \times 10 = 6$  kWh; iron  $750/1000 \times (40/60 \div 7) \approx 0.071$  kWh; total  $\approx 7.69$  kWh a day.
- ✓ Monthly consumption  $\approx 7.69 \times 30 \approx 230.7$  units.
- ✓ Bill  $\approx 230.7 \times \text{Rs } 10 \approx \text{Rs } 2,307$ .

## 8 Think

#### ANSWER

The element and the cable are in **series**, so the same current flows through both, but the heat produced depends on the **resistance** too. The element is made of nichrome, thin and coiled, so its resistance is large. The cable is thick copper, with a tiny resistance. Almost all the energy is turned into heat in the element, and very little in the cable.

#### MARKING SCHEME

- ✓ The element and the cable are in series, so the same current flows through both; the heat produced depends on the resistance.
- ✓ The element is thin, coiled nichrome with a large resistance; the cable is thick copper with a tiny resistance, so almost all the heat is produced in the element.

## 9 Activity: A pencil lead as a resistor (Activity 11.4)

(not marked)

#### WHAT STUDENTS SHOULD FIND

For the same length,  $V \div I$  is the same with one cell or two: the resistance of the lead doesn't depend on the voltage (Ohm's law). With the clips closer, the current is larger and  $V \div I$  is smaller: half the length gives about half the resistance.

## See it at Science Playground

Exhibits and plants at the center, Bhaktapur, that go with this unit. Book a class visit at [science-playground.com/booking](http://science-playground.com/booking).

- **The Fun Circuit (exhibit):** Current flows only round a closed loop: unfold the drawing to follow its path.

| Marks by level | Knowledge | Understanding | Application | Higher ability | Total |
|----------------|-----------|---------------|-------------|----------------|-------|
| Marks          | 10        | 13            | 8           | 2              | 33    |

