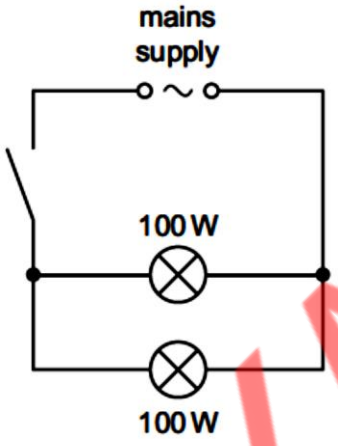
Chapter # 21
Electrical Safety
Electric Energy/Electric Power

Q-1: Two 100 W lamps are connected in parallel to the mains supply, as shown.



How much electrical energy is supplied by the mains when the switch is closed for 36 minutes?

A 0.030 kW h **B** 0.060 kW h **C** 0.12 kW h **D** 7.2 kW h

Q-2: There is a current of 2.0 A in a resistor for 30 s. The potential difference (p.d.) across the resistor is 12 V. How much energy is transferred in the resistor?

A 1.25 J **B** 5.0 J **C** 180 J **D** 720 J

Q-3: An electric fire is connected to a 240 V supply and transfers energy at a rate of 1.0 kW. How much charge passes through the fire in 1.0 h?

A 42 C **B** 250 C **C** 1.5×10^4C **D** 2.4×10^5C

Q-4: A student calculates the amount of energy used by an electric heater. What is the equation for calculating the energy *E* in kW h?

A *E* = *I* (ampere) x *V* (volt) x *t* (second)
B *E* = *I* (ampere) x *V* (volt) x *t* (hour)
C *E* = *I* (ampere) x *V* (volt) x (second) x 1000
D *E* = *I* (ampere) x (volt) x *t* (hour) x 1000

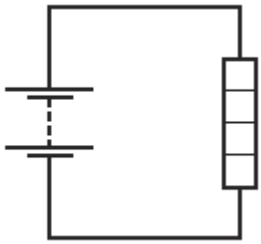
Q-5: A 240 V mains circuit contains eight 60 W lamps in parallel. At the time when the lamps Are switched on, the filaments are cold and the current is four times as large as the final steady current in the circuit. What is the initial current supplied by the mains?

A 0.25 A **B** 1.0 A **C** 2.0 A **D** 8.0 A

Q-6: A 100 W lamp is switched on for five hours each day for three weeks. The cost of one unit of electricity is $0.24. How much does it cost to run the lamp for this time?

A $0.36 **B** $0.84 **C** $2.52 **D** $25.20

Q-7: An ammeter and a voltmeter are connected into the circuit shown when determining the power produced by a heater



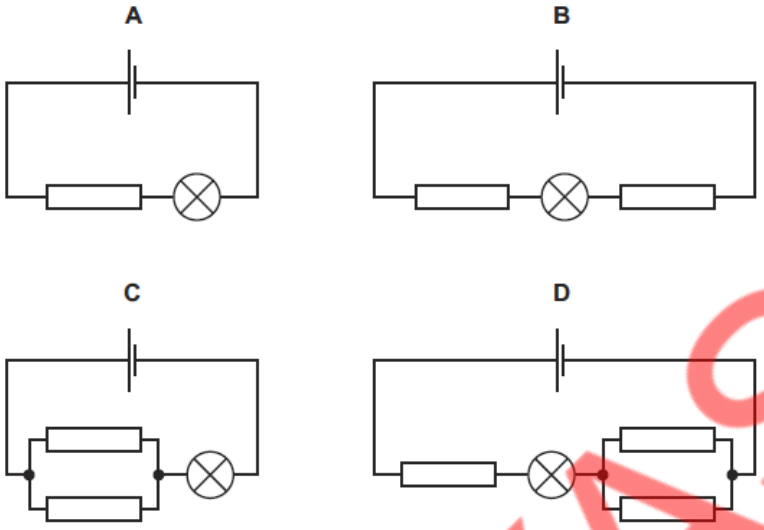
How are these meters connected, in relation to the heater?

	ammeter	voltmeter
A	in parallel	in parallel
B	in parallel	in series
C	in series	in parallel
D	in series	in series

Q-8: A lamp is rated at 12 V, 600 mW. What is the current in the lamp?

A 20 mA **B** 50 mA **C** 2.0 A **D** 5.0 A

Q-9: The cells, lamps and resistors in the circuits are identical. In which circuit is the lamp the brightest?



Q-10: V is a potential difference, I is a current, R is a resistance, and t is a time.
Which expression has units of energy?

A It **B** I^2R **C** VIt **D** V^2/R

Q-11: A defibrillator is a device that is used to give an electric shock to a patient's heart.
It supplies an electric shock with energy 240 J at an average voltage of 2000 V for 10 ms.
What is the average current it supplies?

A 0.012 A **B** 1.2 A **C** 12 A **D** 120 A

Q-12: An immersion heater is labelled 24 V, 120 W. What is the current in the heater when it is connected to a 24 V supply?

A 0.20 A **B** 5.0 A **C** 24 A **D** 120 A

Q-13: There is a current of 0.25 A in a lamp connected to a 240 V supply. What is the input power to the lamp?

A 15 W **B** 60 W **C** 240 W **D** 960 W

Q-14: An immersion heater is labelled 12 V, 60 W. What is the current in the heater when connected to a 12 V supply?

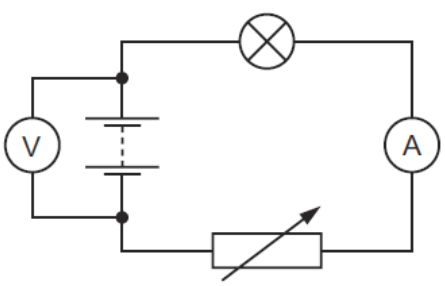
A 0.20 A **B** 5.0 A **C** 12 A **D** 60 A

Q-15: A lamp is rated at 60 W on a 240 V supply. What is the current in the lamp when used normally?

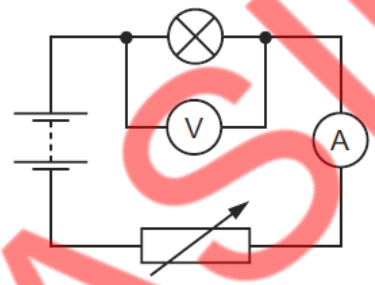
A 0.25 A **B** 4.0 A **C** 60 A **D** 180 A

Q-16: Which diagram shows the arrangement of the ammeter and voltmeter to obtain readings to find the power of a lamp?

A



B



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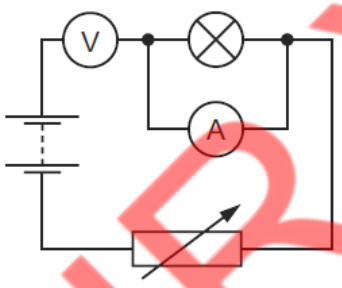
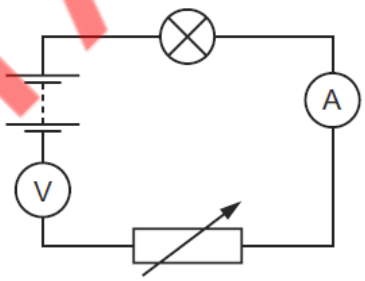


D



Q-17: The power input to a filament lamp when connected to a 12 V supply is 20 W.

a) State what is meant by *power*.

b) Calculate:

i) the current in the filament

ii) the resistance of the filament.

c) The filament in another lamp is made from thinner wire of the same length and made from the same material. Both lamps are connected to a 12 V supply.
State and explain how using thinner wire in the filament affects the power input to the lamp.

Q-18: The power supply used in an electric vehicle contains 990 rechargeable cells each of electromotive force (e.m.f.) 1.2 V. The cells are contained in packs in which all the cells are in series with each other. The e.m.f. of each pack is 54 V.

a) Calculate the number of packs in the power supply.

b) When in use, each pack supplies a current of 3.5 A.

i) Calculate the rate at which each cell is transferring chemical energy to electrical energy.

ii) The packs are connected in parallel to supply a large current to drive the electric vehicle. Explain why it is necessary to use thick wires to carry this current.

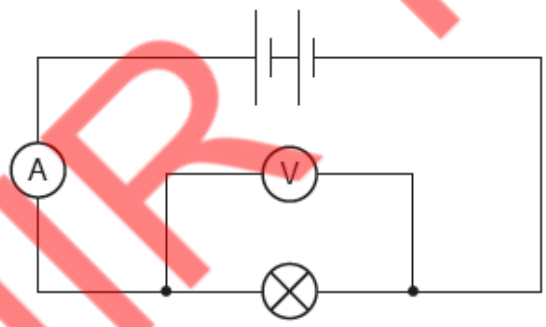
Q-19: A 60 W filament lamp is powered by the 240 V mains electricity supply. The lamp is switched on.

a) Calculate:

i) the current in the lamp

ii) the resistance of the lamp.

b) The lamp is now unplugged from the mains supply and connected in series with two 1.5 V cells. Fig. 6.1 is the circuit diagram.



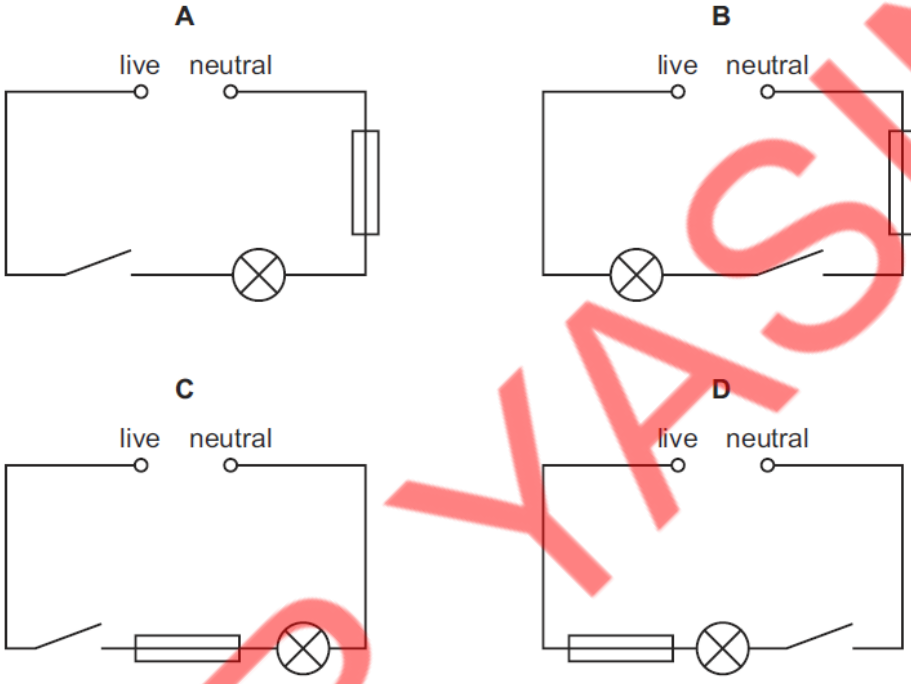
i) State the reading on the voltmeter.

ii) State and explain how the resistance of the lamp now differs from the value calculated in **(a)(ii)**.

iii) When a filament lamp blows, it very often does so immediately after being switched on. Suggest why this is the case.

Safe Use of Electricity
(Fuse/Circuit Breaker/Switch/Earth connection)

Q-20: Which diagram shows a lamp wired correctly to the mains supply in a house?



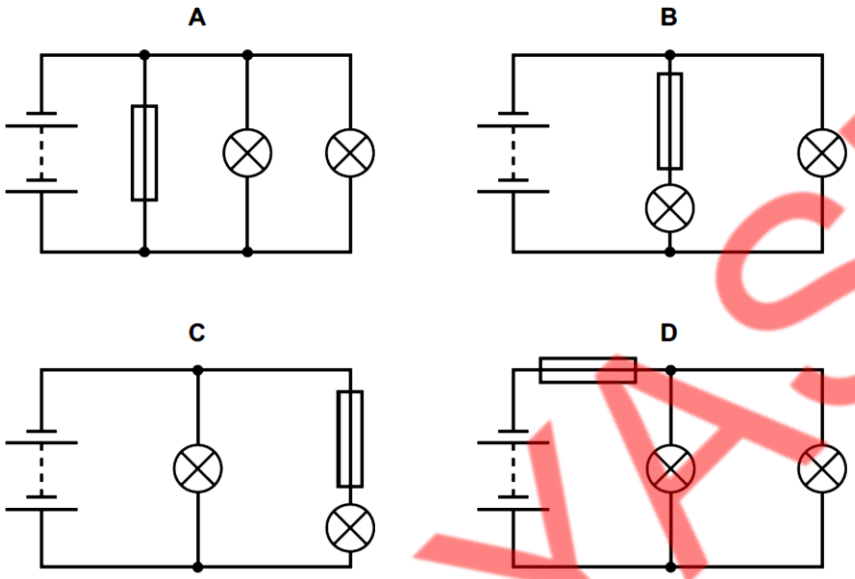
Q-21: Which components are designed to improve the safe working of a mains electrical supply?

	circuit breaker	earth wire	fuse
A	✓	✓	✗
B	✓	✗	✓
C	✗	✓	✓
D	✓	✓	✓

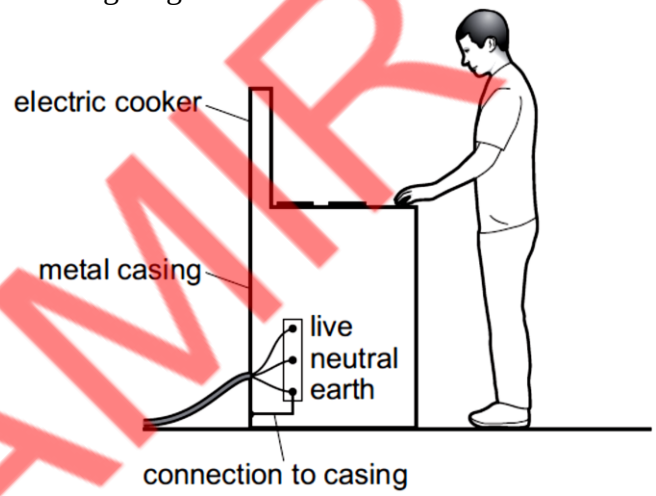
Q-22: Where must a fuse be connected in a mains electric circuit?

A the earth wire only
B the live wire only
C the neutral wire only
D the live wire and the earth wire

Q-23: A student constructs four circuits, each containing a fuse. The fuse blows in one circuit and both lamps in the circuit go out. In which circuit does the fuse blow and both lamps go out?



Q-24: A simple wiring diagram for an electric cooker is shown.



Why is there a wire connecting the metal case of the cooker to earth?

A It improves the efficiency of the cooker.
B It prevents the metal case from becoming too hot when the cooker is left on.
C It reduces the risk of an electric shock if the live wire touches the metal case.
D The electric cooker will not switch on without it.

Q-25: Three statements about a relay are given.

1 A relay has a coil that becomes a temporary magnet when in operation.
2 A large current in a relay coil is used to switch off a smaller current.
3 A small current in a relay coil is used to switch on a larger current.

Which statements are correct?

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

Q-26: Circuit breakers and fuses are devices used to protect a circuit from overloading.
Which statement correctly describes the difference between a circuit breaker and a fuse?

A Circuit breakers can be reset if they operate but fuses need to be replaced.
B Circuit breakers need to be replaced if they operate but fuses can be reset.
C Circuit breakers can be used in an a.c. circuit but fuses cannot.
D Circuit breakers cannot be used in an a.c. circuit but fuses can.

Q-27: The current in a lamp connected on its own to the mains supply is 0.60 A. A table decoration has three of these lamps connected in parallel. Which rating of fuse is suitable to protect this circuit?

A 0.2 A **B** 0.6 A **C** 1.0 A **D** 5.0 A

Q-28: The metal cases of electrical appliances are connected to an earth wire. Which statement is **not** correct?

A The live wire may become loose and touch the metal case.
B If the metal case becomes live, the earth wire conducts current to the ground.
C The earth wire needs to have a high resistance.
D Earthing metal cases helps prevent a person from receiving an electric shock.

Q-29: A teacher asks, 'Why do we put a fuse in a mains circuit?'
Student 1 says, 'It protects the wiring from overheating.'
Student 2 says, 'It protects us from getting a shock if we touch the live wire.'
Who is correct?

A both students
B neither student
C student 1 only
D student 2 only

Q-30: A lamp is connected to a mains plug. Where are the switch and the fuse connected so that the lamp is safe to use?

	switch	fuse
A	live wire	live wire
B	live wire	neutral wire
C	neutral wire	live wire
D	neutral wire	neutral wire

Q-31: A mains electric circuit is fitted with a circuit breaker rather than a fuse. Where the circuit breaker connected and what is happens when the current is too large?

	A circuit breaker is connected in…	When the current is too large…
A	the live wire.	a thin wire melts and breaks the circuit.
B	the live wire.	an electromagnet opens a switch.
C	the neutral wire.	a thin wire melts and breaks the circuit.
D	the neutral wire.	an electromagnet opens a switch.

Q-32: The information on the back of an electric room heater is shown.

rating 220–240 V

~50 Hz

4.2 A

What is a suitable fuse rating for this room heater?

A 4.0 A **B** 4.2 A **C** 5.0 A **D** 13.0 A

Q-33: P, Q and R are electrical symbols.

P Q R

What do these symbols represent?

	P	Q	R
A	fuse	resistor	relay coil
B	relay coil	fuse	resistor
C	relay coil	resistor	fuse
D	resistor	fuse	relay coil

Q-34: The metal case of an electric heater is earthed. The plug to the heater contains a 5 A fuse. There is a current of 4 A when the heater works normally. The cable to the heater becomes so worn that the live wire makes electrical contact with the case. What happens?

A The current flows to earth and the fuse is not affected.

B The fuse melts and switches off the circuit.

C The metal case becomes live and dangerous.

D The metal case becomes very hot.

Q-35: What causes the fuse to blow in a mains electrical circuit?

A a person touches the live wire

B a person touches the neutral wire

C the live wire touches the earth wire

D the neutral wire touches the earth wire

Q-36: Which electrical component is used to store charge?

A capacitor

B relay

C resistor

D thermistor

Q-37: Five electrical appliances are connected to the same socket and there is a very large current. Why is this dangerous?

A The fuses blow in the appliances.

B There is a greater risk of an electrical shock.

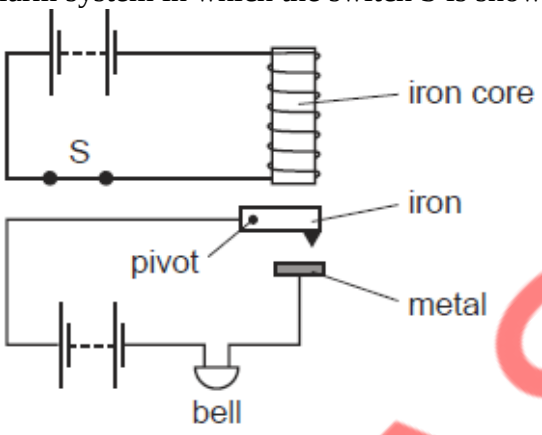
C There is overheating in each appliance.

D There is overheating in the socket.

Q-38: An appliance uses a current of 3 A. Which row is correct for the fuse in this appliance?

	most suitable fuse rating / A	fuse connected in
A	5	earth wire
B	5	live wire
C	13	earth wire
D	13	live wire

Q-39: The diagram shows an alarm system in which the switch S is shown closed



What happens when the switch S is opened?

	iron	bell
A	drops	rings
B	drops	stops ringing
C	moves up	rings
D	moves up	stops ringing

Q-40: The current in a filament lamp is 0.25 A when working normally. The lamp is connected to a plug and the mains a.c. supply. When the lamp is switched on, it does not light. What is a possible cause for this?

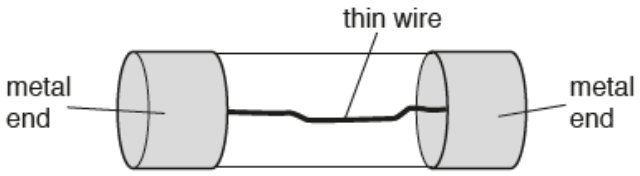
A The earth wire in the plug is not connected.

B The fuse in the plug is 3 A.

C The lamp only works on a d.c. power supply.

D The live wire in the plug is not connected.

Q-41: Fig. 1 shows the fuse inside the plug of a hairdryer.



a) State how the fuse protects the wires in the hairdryer.

b) The hairdryer is rated at 240 V, 1500 W. It is switched on.

i) Calculate the current in the hairdryer.

ii) Suggest a suitable current rating for the fuse.

c) The hairdryer does not contain an earth wire to connect to the plug.
State the feature of the hairdryer which ensures that it is safe to use without an earth wire.

Q-42: A washing machine is working normally with both the water heater and the motor switched on. The washing machine is connected to the mains supply by a cable.

a) The current in the live wire in the cable is 13 A.
State the size of the current in:

i) the neutral wire in the cable

ii) the earth wire in the cable.

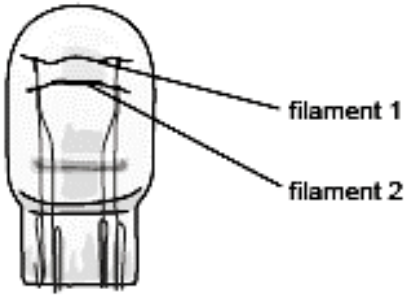
b) The insulation on the mains cable is now damaged and, as the washing machine vibrates, the live wire touches the metal casing.

i) Explain how the earth wire and the fuse together prevent any more damage.

ii) Explain why it is the live wire into which the fuse is connected.

voltage immediately next to (switch and blown) fuse **or** it / live wire at high / maximum voltage / potential no part of the washing machine / casing is live **or** no current to casing

Q-43: Fig. 1 shows a lamp from a car. It contains two metal filaments.



a) **i)** Complete the boxes to describe the transfer of energy that takes place when the lamp is switched on.

ii) The efficiency of the metal filament lamp is less than 10%.
State what is meant by *efficiency*.

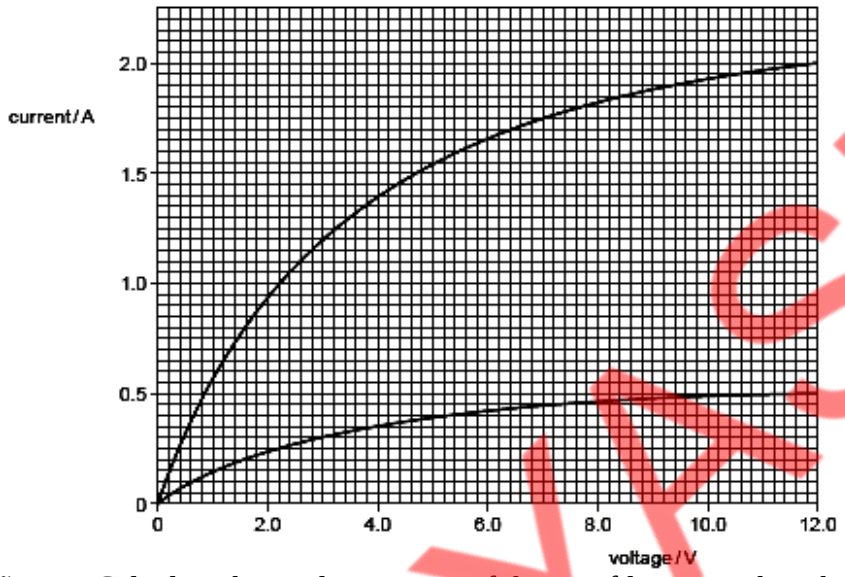
b) The two filaments are usually connected in parallel to a car battery.
A student investigates what happens when the filaments are connected in series, rather than in parallel. He uses the same battery for the investigation.
State whether the current, the voltage across each filament and the total power produced *increases*, *decreases* or *stays the same* when the two filaments are connected in series.

Current:

Voltage:

Power:

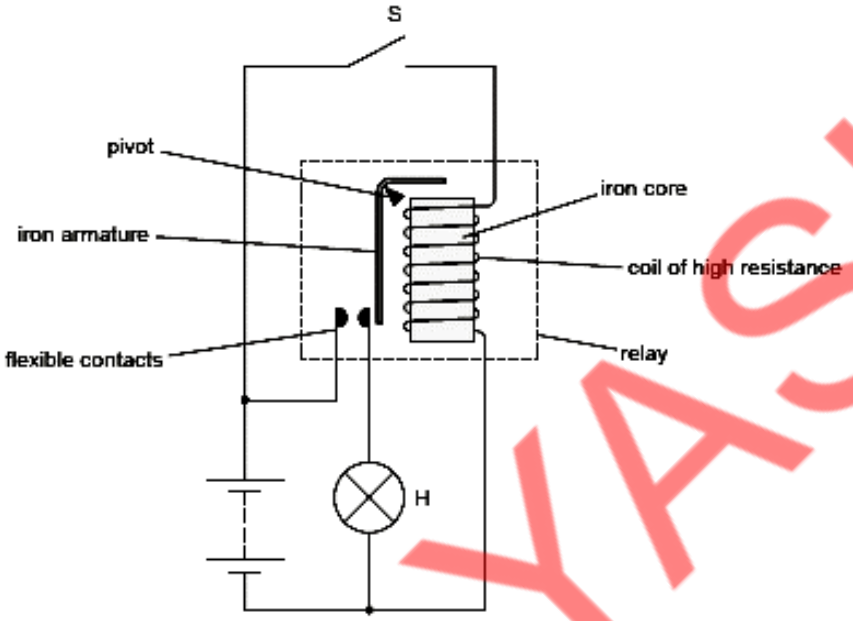
c) Fig. 2 shows the current–voltage graph for the two filaments.



i) Calculate the total resistance of the two filaments when they are connected in parallel to a voltage of 12 V.

ii) The two filaments are made from the same type of metal and have the same length, when uncoiled. They both operate at the same temperature. Suggest why one filament has a resistance that is greater than that of the other filament.

d) Fig. 3 shows a relay used to switch on a car headlamp.



Explain why headlamp H lights up when switch S is closed.

Q-44: The cable of a washing machine contains three separate wires. There is a fuse in one of the wires.

a) Explain how the earth wire and the fuse work together to make the washing machine safer

b) **i)** State the name of the wire in which the fuse is connected.

ii) Explain why the fuse is connected into this wire.

c) The cable of a hair-dryer contains only **two** wires.

i) State the name of each of these wires.

ii) Suggest why the hair-dryer does not need an earth wire.

Hazards of Electricity

Q-45: Why might it be dangerous to use an electrical appliance in damp conditions?

A It might lead to the fuse blowing.
B It might lead to the insulation on the supply cable becoming damaged.
C It might lead to an electric shock.
D It might lead to the supply cable overheating.

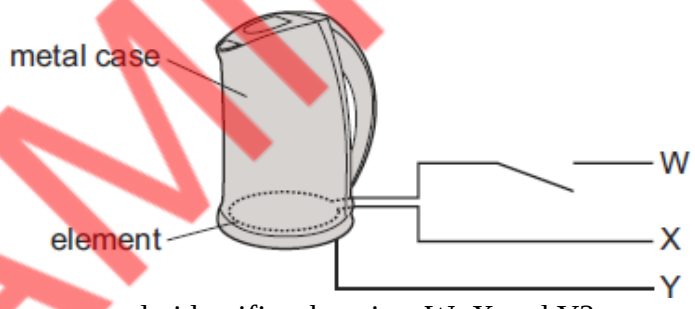
Q-46: Why are the metal casings of electrical appliances earthed?

A to complete the circuit
B to ensure the casing is not at a dangerous voltage
C to ensure the fuse blows when the current in the appliance is too large
D to protect the appliance from overheating

Q-47: An electrical appliance is plugged into a socket in the wall. The plug contains a fuse. What is the main purpose of the fuse?

A to earth the appliance
B to earth the plug
C to protect the user from electric shock
D to protect the wiring from overheating

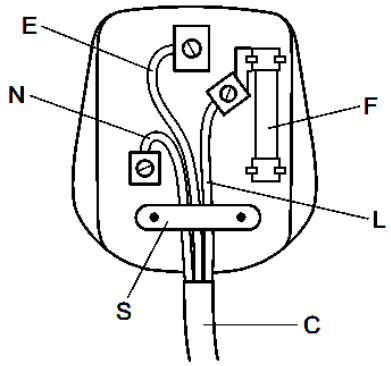
Q-48: The diagram represents part of a household circuit containing an electric kettle



Which row correctly identifies the wires W, X and Y?

	W	X	Y
A	earth	live	neutral
B	live	neutral	earth
C	live	earth	neutral
D	neutral	live	earth

Q-49: The diagram shows the wiring of a three-pin mains plug. There is an error in the diagram



What is the error?

A The cable cover C is not under the clip S.

B The earth wire E is connected to the wrong terminal.

C The fuse F is connected to the live wire L.

D The live wire L is connected to the wrong end of the fuse F.

Q-50: Many electrical appliances have metal cases.
To prevent the case from becoming 'live', with the possibility of an electric shock, the earth wire of the electric cable is attached to the case. How does the earth wire prevent an electric shock?

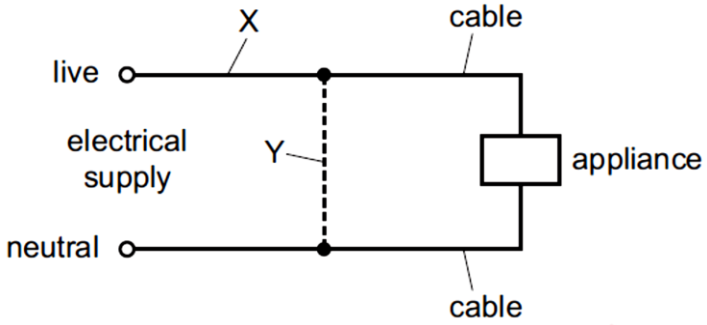
A It allows a current to flow to earth, so that the appliance continues working.

B It allows a large current to flow to earth, blowing the fuse.

C It prevents the fuse from blowing.

D It reduces the current to a safe level.

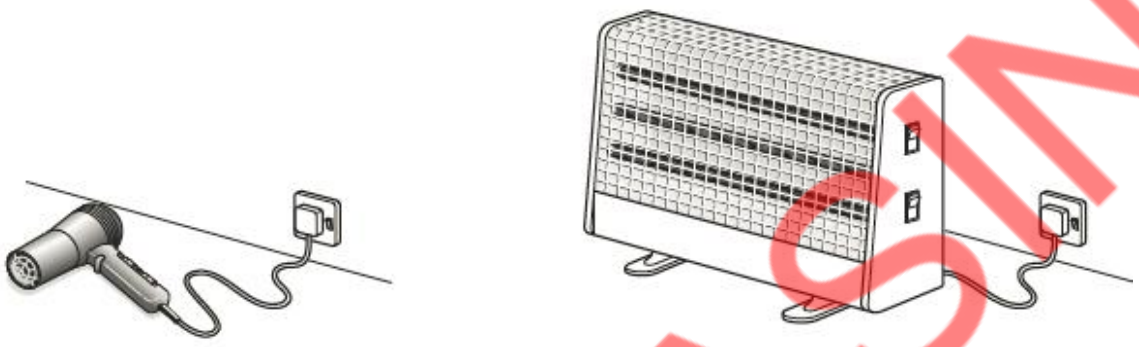
Q-51: Either a fuse or a circuit-breaker can be used to protect electrical cables from large currents that could cause overheating.



When a fuse is used, where should it be connected, and when a circuit-breaker is used, where should it be connected?

	position of fuse	position of circuit-breaker
A	X	X
B	X	Y
C	Y	X
D	Y	Y

Q-52: An electric hairdryer and an electric heater are connected to the mains supply, as shown in Fig.



The cable from the heater to the mains supply has a live, a neutral and an earth wire.

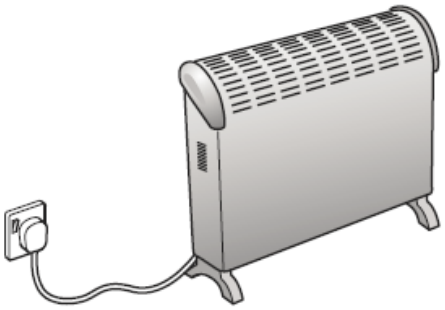
a) State the purpose of the neutral wire.

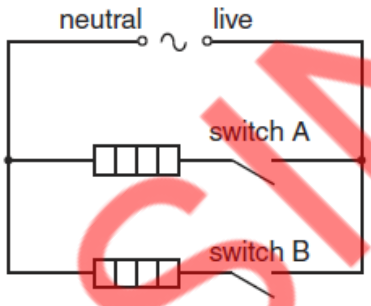
b) The live wire in the electric heater touches the outer metal case.
Explain how the earth and the fuse together protect the user from electric shock.

c) The hairdryer does not have an earth wire. Explain why this hairdryer is still safe to use.

d) In some modern homes, circuit breakers are used instead of fuses.
Suggest one advantage of using a circuit breaker rather than a fuse.

Q-53: Fig. 1a shows a room heater. Fig. 1b is a diagram of the electric circuit of the heater.





The fuse has not been drawn on the circuit diagram in Fig. 1b.

a) **i)** On Fig. 1b, draw the symbol for a fuse in the correct position.

ii) State the part of the room heater to which the earth wire is connected.

iii) The earth wire reduces the chance of an electric shock if a fault develops in the room heater.

1. State one fault that causes an electric shock when a person uses the room heater without an earth connection.

2. Explain how using an earth connection prevents an electric shock.

b) **i)** This type of room heater is very efficient. Explain what this means.

ii) The room heater is a convector heater. Describe and explain how thermal energy (heat) passes around a room by convection.

c) Fig. 2 shows the power output of the room heater when each switch is closed

	power / W
switch A only closed	600
switch B only closed	
both switches closed	2100

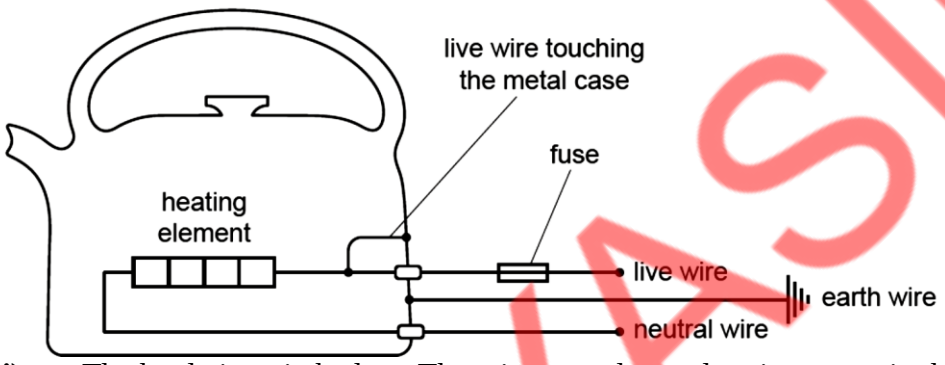
i) Determine the power output of the room heater when only switch B is closed.

ii) The room heater is used with both switches closed for 2.5 hours.
Calculate the energy output of the room heater

1. in kilowatt-hours,

2. in joules.

Q-54: Fig. shows a metal kettle used for heating water. The kettle is connected to the mains power supply. The metal case is connected to earth. A fault causes the live wire to come loose and touch the metal case, as shown.



a) **i)** The kettle is switched on. There is a very large electric current in the live wire. Explain why this large electric current can be dangerous.

ii) Explain how a fuse helps to protect against the danger of a large electric current.

iii) Explain why the kettle is **not** safe to use with the fuse connected into the neutral wire instead of the live wire.

b) The current in a device when operating normally is 3.1 A. State a suitable value for the fuse. Choose **one** of these values: 3 A, 5 A, 10 A and 13 A.

c) A small kettle has a potential difference (p.d.) of 12 V (d.c.) across its heating element. The current in the heating element is 2.5 A. Calculate the resistance of the heating element.

Q-55: a) State and explain why electrical sockets and plugs used outside in a garden need to be different from those that can be used safely in a room inside a house.

b) State and explain why fuses and circuit breakers are installed in electrical circuits connected to the mains supply.

Answers

Q-1: C **Q-2: D** **Q-3: B** **Q-4: D** **Q-5: D** **Q-6: C** **Q-7: C**

Q-8: B **Q-9: C** **Q-10: C** **Q-11: C** **Q-12: B** **Q-13: B** **Q-14: B**

Q-15: A **Q-16: B**

Q-17: a) work done / energy (transfer) per unit time

b) i) (*I* =) *P* / *V* in any form numerical or algebraic
1.7 A

ii) 6.9−7.2 *Ω*

c) resistance (of wire) is larger
power is less and
either current is smaller or $P = V^2 / R$ *or* $P = VI$ and $V = IR$

Q-18: a) 990 / (54 / 1.2) OR 990 / 45 OR (number of cells in pack =) 54 / 1.2 OR 45 22

b) i) (*P* =) *EI* OR 1.2 x 3.5
4.2 W OR 4.2 J / s

ii) thick wires have a smaller resistance
less thermal energy generated in wires
more efficient OR less risk of fire / insulation melting

Q-19: a) i) (*I* =) *P* / *V* or 60 / 240
0.25 A

ii) (*R* =) *V* / *I* or 240 / 0.25
960 Ω

b) i) 3.0 V

ii) resistance is smaller
(filament at a) lower temperature

iii) current surge (due to lower resistance when cold)

Q-20: C **Q-21: D** **Q-22: D** **Q-23: D** **Q-24: C** **Q-25: C** **Q-26: A**

Q-27: D **Q-28: C** **Q-29: C** **Q-30: A** **Q-31: B** **Q-32: C** **Q-33: C**

Q-34: B **Q-35: C** **Q-36: A** **Q-37: D** **Q-38: B** **Q-39: A** **Q-40: B**

Q-41: a) blows / melts / cuts off circuit / stops current
and when the current is high

b) i) (I =) P/V numerical or algebraic
6.2, 6.25 or 6.3 A
ii) any integral value 7–13 A
c) double insulated or outside case / body is plastic / rubber

Q-42: a) i) 13 A
ii) 0 (A)
b) i) resistance of earth wire (and casing) small or disconnects circuit
or no electric shock (possible) or stops current
current in (live and) earth wire (briefly)
fuse (in live wire) blows / melts
ii) voltage (source) disconnected (by fuse's blowing) or live

Q-43: a) i) electrical in first box
heat
light
ii) energy output / energy input
useful output energy / total energy input
b) two decrease
all three decrease
c) i) (R =) V / I in any form numerical or algebraic
total current = 2.5 A
or both resistances 24 (Ω) and 6(.0 Ω)
4.8 Ω
ii) smaller area / diameter / radius
d) current in the coil
coil / core becomes magnetised
attracts iron armature
armature turns and contacts close

Q-44: a) if the live / high voltage wire touches the casing / machine or if the casing / machine becomes live
large current in earth wire or resistance of earth wire small
fuse melts or disconnects supply
b) i) live wire
ii) when the fuse melts the live wire is not connected to any part of the device / is isolated from the mains / supply
c) i) live and neutral
ii) double insulation or it / casing / hair dryer is plastic

Q-45: C Q-46: B Q-47: D Q-48: B Q-49: A Q-50: B Q-51: A

Q-52: a) to provide a complete circuit (with live)
or to pass current back to mains
or provide a return path for the current

b) current / charge / electrons flow to earth / earth wire / ground (when live touches case) fuse melts / blows and disconnects circuit / cuts live / stops current

c) doubly insulated
or case / body made of plastic / insulator / not made of metal
or user cannot touch metal

d) (circuit breaker)
- turns off / acts fast(er)
- can be reset
- easy to see it has tripped / switched
- can detect small difference between live and neutral currents / small (leakage) current to earth

Q-53: a) i) fuse symbol correct
in live wire before junction of two elements

ii) the (metal) case/outside

iii) 1. live wire touches case; live touches person

2. current goes to earth; current does not go through the person
fuse blows

b) i) most of the energy output is useful/heat; little energy is wasted;

ii) hot air rises (not heat rises)
density of hot air is lower
convection current mentioned OR hot air rises and cold air falls

c) i) 1500 W

ii) 1. conversion to kW seen on any power; 2.1 (kW) seen
5.25; 5.2; 5.3 (kW h)

2. E = P × t in any form, algebraic or using any power or time
e.g. 600 × 2.5,
600 × 150
1.89×10^7(J) OR $3.6 \times 10^6 \times$ (c)(ii)1.

Q-54: a) i) (large current produces large) heating effect OR overheating OR (could) cause fire.

ii) fuse melts
breaks circuit OR stops current in circuit

iii) (metal case / kettle) would still be live OR connected to 240 V / mains (when fuse has melted)

b) 5 A

c) (*R* =) $V \div I$ OR $V = IR$
12 ÷ 2.5
4.8 (Ω)

Q-55: a) conditions (outdoors) may be damp / wet
water conducts (electricity) OR clear statement of need for waterproof / outdoor specification (components)

b) protects components / appliances / circuit / wires / user / mains supply
prevents electrical supply overheating / fires / electrocution / shocks
excess current / power in circuit / wires OR fuse melts / blows OR circuit breaker opens