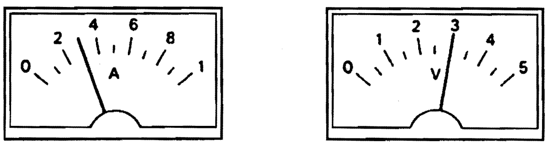
TOPIC 19 Practical Electricity

1 The electric current in a resistor and the potential difference across the resistor are measured. The readings are shown in the diagram.

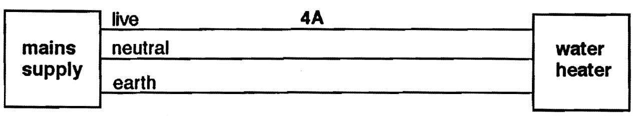


What is the power dissipated in the resistor?

A 0.10 W
B 0.75 W
C 0.90 W
D 9.0 W
E 10 W

J90/I/31

2 The diagram shows the three wires of an electrical mains supply connected to an electric water heater.



What are the currents in the neutral and earth wires corresponding to a current of 4 A in the "live" wire?

	neutral	*earth*
A	4 A	4 A
B	4 A	0 A
C	2 A	2 A
D	0 A	4 A
E	0 A	0 A

J90/I/32; N93/I/30

3 A house-owner replaced a failed fuse for the lights of his house. When the lights were switched on the new fuse also failed. The house-owner put another fuse in with a higher rating than the previous two.

Why was this **not** a sensible thing to do?

A Fuses only work if the rating is exactly right.
B Using a fuse with too high a rating would cause electric shocks.
C Higher rating fuses only work for power points.
D The fuse had already failed because the rating was too high.
E A fuse with a higher rating might work but the fault would not be corrected.

N90/I/31

4 V represents a potential difference, I a current, R a resistance, and t a time.

Which of the following has units of energy?

A IRt
B I^2R
C V/I
D V^2/R
E VIt

J91/I/31

5 An electric lamp is marked '240 volts 150 watts'. It is used on a ring main socket marked '30 amps Maximum'.

Which fuse is best to use in series with the lamp?

A 40 amp
B 30 amp
C 13 amp
D 3 amp
E $\frac{1}{2}$ amp

J91/I/32

6 A 40 W fluorescent lamp turns half the electrical energy it uses into light energy.

How much light energy does it give out in 10 s?

A 8 J
B 20 J
C 200 J
D 400 J
E 800 J

N91/I/10

7 The earth wire to an electric toaster should be connected to

A the heating element.
B the metal case.
C the ON/OFF switch.
D the plastic legs.
E the toast.

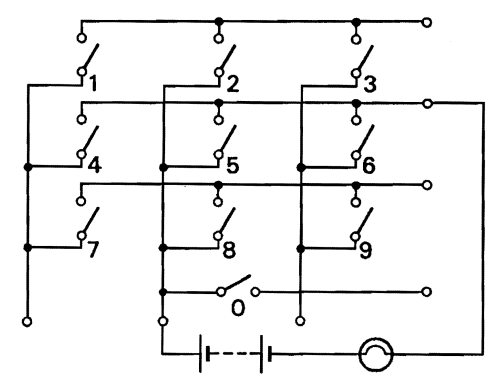
N91/I/30

8 The fuse rating for a fuse used in the plug of an electrical heater should be

A much less than the normal heater current.
B just less than the normal heater current.
C exactly equal to the normal heater current.
D just greater than the normal heater current.
E much greater than the normal heater current.

N91/I/31

9 A student tests the circuit of a press button telephone with a bulb and battery.



Which single switch can be pressed to make the bulb light?

A 0
B 1
C 5
D 6
E 8

J92/I/28

10 Why is a fuse used in an electrical appliance?

A to earth the appliance
B to protect the appliance and its cable
C to change the efficiency of the appliance
D to change the current rating of the appliance
E to change the voltage of the supply to the appliance

J92/I/30

11 Five electrical appliances are left switched on for different times.

In which appliance is the greatest amount of energy converted?

	appliance	*time*
A	3 kW water heater	0.5 hour
B	1.5 kW hot-plate	1.5 hour
C	1 kW fan	3 hour
D	750 W clothes pressing iron	1 hour
E	100 W light bulb	12 hour

J92/I/31

12 An electric motor runs with a steady input of 250 V and 4 A while raising a load of 1000 N.

Assuming the motor and transmission to be 100% efficient, what time is taken to lift the load vertically through a distance of 10 m?

A 1 s
B 1.5 s
C 4 s
D 10 s
E 250 s

N92/I/9

13 Why is tungsten used for the filament of an electric light bulb in preference to copper?

A Tungsten is a better electrical conductor.
B Tungsten has a higher melting point.
C Tungsten is more easily bent to the required shape.
D Tungsten is less likely to burn in the gas in the bulb.
E Tungsten is cheaper and more readily available.

N92/I/26

14 When using 3-core wiring (live, neutral and earth leads), where should the fuse be fitted?

A only in the live lead
B only in the neutral lead
C only in the earth lead
D in either the live or the neutral lead
E in any lead

N92/I/30

15 If the cost of 1 'unit' (1 kW h) of electricity is 8 pence, what is the cost of running a 2 kW electric fire for 6 hours?

A 8 pence
B 12 pence
C 48 pence
D 96 pence
E 192 pence

N92/I/31

16 A heater which is to be used on a 250 V mains circuit, has a 5A fuse in its plug.

Which of the following is the most powerful heater that can be used with this fuse?

A 50 W
B 250 W
C 1000 W
D 2000 W
E 3000 W

J93/I/29

17 A 5 kW immersion heater is used to heat water for a bath. It takes 40 minutes to heat up the water.

How much electrical energy has been converted into thermal energy?

A 2.0×10^2 J
B 1.2×10^3 J
C 2.0×10^4 J
D 2.0×10^5 J
E 1.2×10^7 J

N93/I/31

18 A resistor is used in an electronic circuit but it quickly burns out. What is the reason for this?

A A fuse has blown in the circuit.
B The current flowing is too low.
C The resistor's power rating is too high.
D The resistor's power rating is too low.
E The voltage of the battery is too low.

N93/I/35

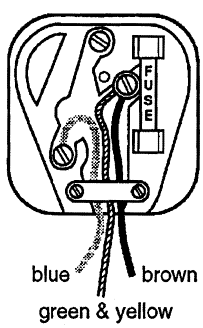
19 A plug connected to a table lamp contains a 3 A fuse.

Why is the fuse needed?

A to increase the resistance of the circuit
B to make it easier for the current to flow
C to protect the wiring from overheating
D to reduce the voltage across the lamp

J94/I/30

20 A plug is **wrongly** wired as shown in the diagram. It is connected to an old vacuum cleaner which has a metal case.



What would be the effect of using the plug wired this way?

A The fuse in the plug would blow.
B The metal case would be live.
C The vacuum cleaner would catch fire.
D The vacuum cleaner would not work.

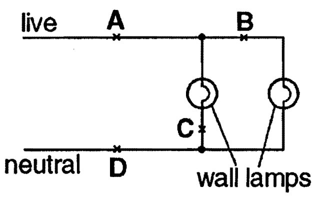
J94/I/31

21 A portable tape-recorder is rated at 12 W, 2 A.

How many 1.5 V batteries are needed in the tape-recorder?

A 2 **C** 6
B 4 **D** 8 J94/I/32

22 Which position on the diagram would be safest for a switch in order to turn off both wall lamps?



N94/I/30

23 A 2 kW electric fire is used for 5 hours.

How long will it take a 100 W electric light bulb to use the same amount of energy?

A 20 hours
B 50 hours
C 100 hours
D 400 hours N94/I/31

24 An electric kettle should always be fitted with an earth connection as a protective device.

What is being 'protected' by the earth connection?

A the cable connecting the kettle
B the fuse in the circuit
C the heating element of the kettle
D the person using the kettle J95/I/28

25 A torch bulb uses a 3 V supply and takes a current of 0.2 A. It is switched on for one minute.

How much electrical energy is used?

A 0.6 J **B** 12 J **C** 36 J **D** 100 J
J95/I/29

26 What is the correct order of steps when replacing a fuse safely?

A find and repair fault, switch off, replace fuse, switch on
B replace fuse, switch off, find and repair fault, switch on
C switch off, find and repair fault, replace fuse, switch on
D switch off, replace fuse, switch on, find and repair fault
N95/I/31

27 A house-owner replaced a failed fuse for the lights of the house. When the lights were switched on, the new fuse also failed. The house-owner then put in another fuse with a higher rating than the previous two.

Why was this **not** a sensible thing to do?

A Fuses allow the circuit to work only if the rating is exactly right.
B The fuse has already melted because the rating was too high.
C Using a fuse with too high a rating would cause electric shocks.
D A fuse with a higher rating might allow the circuit to work, but the fault would not be corrected.
J96/I/30

28 The kilowatt-hour is a unit of

A charge.
B energy.
C power.
D voltage. J96/I/31

29 Why should the metal casing of an electrical fire be earthed?

A to complete an electrical circuit
B to prevent the fire from overheating
C to reduce the risk of electric shocks
D to stop the casing from getting too hot to touch
N96/I/30

30 Which of the following is correct for domestic lighting circuits?

	circuits connected in	*fuse placed in*	*switch placed in*
A	parallel	live lead	live lead
B	parallel	neutral lead	neutral lead
C	series	live lead	live lead
D	series	neutral lead	neutral lead

N96/I/31

31 Which of the following can be used to calculate electrical power?

A current × resistance
B potential difference × current
C $\frac{\text{potential difference}}{\text{current}}$
D $\frac{\text{potential difference}}{\text{resistance}}$ J97/I/28

32 The extract shown is part of a Safety Officer's report on how electrical items were being used in a house.

'The hair-dryer had a plastic case with double insulation, so only the live and neutral leads were connected to the plug. When not in use, the dryer was kept in a metal cabinet but taken into the bathroom to be used.'

Which underlined comment indicates an electrical hazard?

A plastic case with double insulation
B only the live and neutral leads were connected to the plug
C kept in a metal cabinet
D taken into the bathroom to be used J97/I/29

33 The current in a power tool, working normally, is 2 A.

How much current is in each of the three wires connecting the tool to the 'mains'?

	live	*neutral*	*earth*
A	2 A	0	0
B	2 A	0	2 A
C	2 A	2 A	0
D	2 A	2 A	2 A

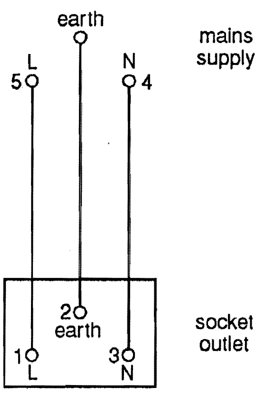
N97/I/30

34 Electrical equipment should **not** be used in damp conditions.

What is the main hazard?

A The equipment becomes too hot.
B The fuse keeps 'blowing'.
C The insulation becomes damaged.
D The risk of an electric shock. N97/I/31

35 The diagram represents the wiring from a 240 V mains supply to a socket outlet in a house.



An electrician wanted to measure the voltage at the socket outlet.

Between which numbered positions should a voltmeter be connected?

A 1 and 3 **C** 2 and 4
B 2 and 3 **D** 3 and 4 J98/I/30

36 An electric heater takes a current of 4 A from a 250 V supply when operating normally.

How long would it take the heater to convert 400 000 J of electrical energy?

A 400 s **C** 1600 s
B 1000 s **D** 100 000 s N98/I/30

37 Many houses have an electricity meter that is read so that the cost of the electricity used by the customer may be calculated.

What does the electricity meter record?

A charge **C** energy
B current **D** power J99/I/29

38 An electrician is asked to add an on/off switch and a fuse to a mains circuit.

In which wire should each of these be placed?

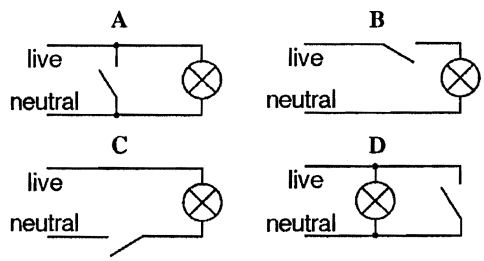
	on/off switch	fuse
A	live	earth
B	live	live
C	neutral	live
D	neutral	neutral

J99/I/30

39 What happens when a 250 V, 2500 W water heater is connected to a mains supply using a plug fitted with a 5 A fuse?

A The fuse in the plug melts.
B The heater burns out.
C The heater runs at half power.
D The heater works normally. N99/I/29

40 Which diagram shows a lamp and a switch correctly wired to the mains supply?

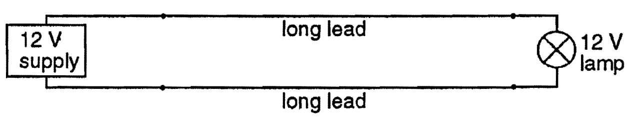


J2000/I/29

41 Which fuse should be used for a 750 W electric iron connected to a 240 V supply?

A 3 A **C** 10 A
B 5 A **D** 13 A J2000/I/30

42 A 12 V lamp is connected to a 12 V supply using very long leads.



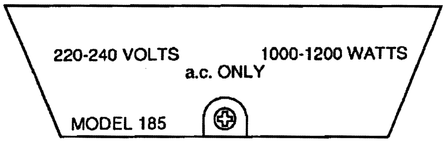
Why does the lamp glow only dimly?

A A d.c. supply is being used rather than an a.c. supply.
B Electrical energy is converted to heat in the long leads.
C The current through the lamp is less than that from the supply.
D The potential difference across each lead is half the voltage supply. J2000/I/33

43 The earth wire of an electric appliance should be connected to the

A fuse.
B metal case.
C ON/OFF switch.
D plastic handle. N2000/I/30

44 The diagram shows the information given on an electric iron.



If electricity costs 14 c per unit, what is the cost of using this iron at maximum power for 10 hours?

A 34 c
B 140 c
C 168 c
D 440 c

N2000/I/31

45 A 12 V electric motor is used to lift a load of 60 N through a height of 2 m in 4 seconds.

Assuming the motor to be 100% efficient, what is the average current in the motor?

A $\frac{4}{60 \times 2 \times 12}$ A

B $\frac{12 \times 4}{60 \times 2}$ A

C $\frac{60 \times 2}{12 \times 4}$ A

D $\frac{60 \times 2 \times 4}{12}$ A

N2000/I/40

46 *(a)* A 12 V 36 W heater is connected across a 12 V d.c. supply of negligible internal resistance. Calculate

(i) the current through the heater,

(ii) the resistance of the heater.

J79/II/6*(a)*

47 A room is heated by a thermostatically controlled heater rated 3 kW, which, it is estimated, is switched on for 40% of an eight-hour period. The lighting is provided by two 150 W bulbs which are in use continuously. Calculate the cost of heating and lighting the room during the eight hours, the cost of electrical energy being 2.5 p per kWh.

J79/II/10 (part)

48 An electric motor takes a current of 5.0 A from a 4.0 V supply.

Calculate the power input to the motor.

The motor lifts a weight of 50 N through a vertical height of 3.0 m in 10 s. Calculate the average useful work done per second by the motor in lifting this weight.

Suggest a reason for the difference between this quantity and the power input to the motor.

J80/I/14

49 Heating coils, each with a different resistance, are connected one at a time in series with a 12 V supply. In each case the rate of production of heat is measured and the results are shown below.

Resistance of coil (in Ω)	1.5	2.0	3.0	4.0	5.0	6.0
Rate of heat produced (in J/min)	640	690	720	708	675	642

Plot a graph showing how the rate of heat produced, *H*, varies with the resistance of the coil. Begin your scale on the *H* axis at 60 J/min.

From your graph deduce

(i) the resistances of coils which would produce heat at a rate of 670 J/min,

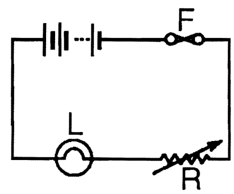
(ii) the resistance of the coil in which the rate of production of heat from the given 12 V supply is a maximum.

Draw a labelled diagram of the arrangement you would use to measure *H*, the rate at which heat is *produced*, directly (i.e. without the use of meters).

State **two** precautions you would take in order to obtain a more accurate result. In each case explain clearly what is achieved by taking the precaution stated.

J80/I/II/1

50 The diagram shows a circuit in which a lamp L, a variable resistor R, a fuse F and a d.c. supply are connected in series.



(a) What is the purpose of the fuse in such a circuit?

How does it achieve this purpose?

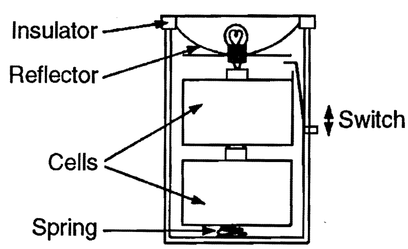
(b) The lamp has a resistance of 4.0 Ω when a current of 3.0 A passes through it. Calculate the power of the lamp under these conditions.

(c) The d.c. supply has an e.m.f. of 25 V and an internal resistance 1.0 Ω.

Calculate the resistance of the variable resistor when the current of 3.0 A flows through the lamp. (The resistance of the fuse is to be neglected.)

J80/II/4

51 The diagram shows the arrangement of a battery-operated torch; in this design the metal casing of the torch is used as part of the circuit.



(a) (i) What part does the spring play in the action of the torch?

(ii) State an advantage of using the casing of the torch as a part of the circuit.

(iii) What is the purpose of the reflector behind the bulb?

(*b*) The bulb is labelled "2.5 V, 0.3 A". What is the power of this bulb when in normal use?

(*c*) What is the combined e.m.f. of the two cells when connected as shown in the diagram, the e.m.f. of each cell being 1.5 V?

(*d*) Explain why the bulb labelled "2.5 V, 0.3 A" is suitable for this torch. N80/II/5

52 Describe briefly **three** features of a domestic electric wiring system which help to make the system safe, making clear the advantage of each feature.

A 100 W lamp bulb and a 4 kW water heater are connected in turn to a suitable 250 V supply. Calculate *(a)* the current which flows in each appliance and *(b)* the resistance of each appliance when in use.

Explain the difference you would expect to find between the wiring used to connect the bulb and the water heater respectively to the mains supply.

Calculate the time taken for the temperature of an electric iron to rise by 150 K, when connected to a suitable electrical supply. The iron is rated at 1200 W and its heat capacity is 600 J/K. Why, in practice, would the time be greater than you have calculated? N80/II/10

53 A small heating coil is rated 12 V 24 W and is connected directly across a 12 V accumulator which has negligible internal resistance.

(*a*) (i) Calculate the current through the coil,

Calculate the resistance of the coil,

Calculate the energy dissipated by the coil in 300 s.

(ii) Draw a labelled diagram in the space of a circuit which would enable you to check the calculated value of the resistance of the coil, when it is in use. How would the value of the resistance be obtained?

(*b*)

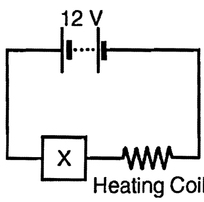


Fig. 1

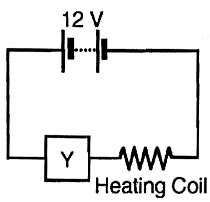
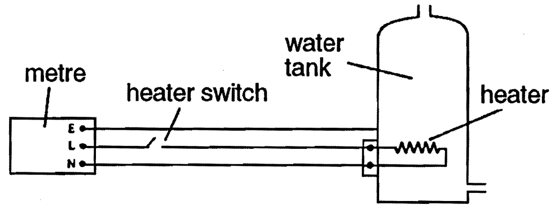


Fig. 2

In Fig. 1 a heating coil and a component X are connected in series across a 12 V accumulator. In Fig. 2 the component X has been replaced by a different component Y. With X in the circuit the coil does not heat up, but on reversing the connections to X the coil heats up. With Y in the circuit the heat produced per second by the coil can be varied, and reversing the connections to Y makes no difference to the heat produced per second. Identify X and Y and explain the effect in each case. J81/II/5

54 A domestic electric immersion heater circuit, from which the fuse has been omitted, is illustrated in the diagram. Show on the diagram where the fuse should be placed.



What is the purpose of the fuse?

Suggest a suitable rating for the fuse to be used with this heater if, in normal use, the current through it is 10.0 A.

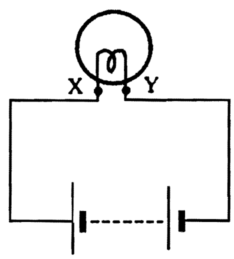
What is the purpose of the wire connecting the tank to the terminal marked E? N81/I/11

55 An electric hot plate contains two identical heating elements, each rated 250V, 2.5 kW.

Calculate the current flowing through one element when connected to the 250 V supply, and the resistance of the element when in use.

Calculate also the power consumption of the hot plate when the two elements are connected *(a)* in parallel and *(b)* in series. Assume that the resistance of each element remains constant. N81/I/11 (part)

56



The lamp shown in the diagram dissipates 36 W when the p.d. across it is 12 V.

Calculate

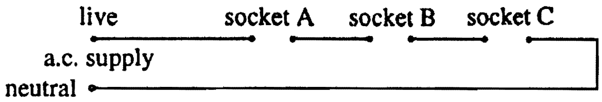
(i) the current through the lamp,

(ii) the resistance of the lamp filament under these conditions.

Would the current through the lamp be different if a 4 Ω resistor were connected across the lamp, i.e. joining the points XY, assuming that the internal resistance of the supply is negligible?

Give a reason for your answer. J82/I/12

57 The diagram shows an **incorrect** attempt to wire three sockets A, B and C to the mains supply. When a mains electric heater is plugged into any one of the three sockets, no current flows in the circuit. When similar mains heaters are plugged into each of the sockets simultaneously, a current flows in the circuit but the heaters give out much less heat than they were designed to do.



Explain these observations.

Draw a circuit diagram to show the three sockets correctly wired to the main supply so that the three heaters can operate normally. Include *(a)* a fuse, *(b)* an earth wire, in your circuit diagram.

Explain clearly why a fuse and an earth wire are used in a main wiring circuit.

Draw a labelled diagram of the structure of one type of fuse.

A 3 kw heater is fitted with a 35 W indicator lamp and a 15 W fan.

These three components of the appliance are connected directly to the 250 V mains and switch on and off together.

When the appliance is operating, calculate

(i) the total power,

(ii) the total current,

(iii) the energy used in 4 hours.

J82/II/10

58 A resistor of resistance 5.6 Ω is connected across a battery of e.m.f. 3.0 V by means of wires of negligible resistance. A current of 0.5 A passes through the resistor. Calculate

(a) the power dissipated in the resistor,

(b) the total power produced by the battery.

Account for the difference between these two quantities.

N82/I/11

59 An electric heating element is used for toasting slices of bread. At its operating temperature, the resistance of the element is 120 Ω: the supply voltage is 240 V.

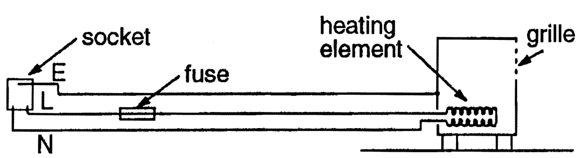
(a) Calculate

(i) the current flowing in the element under these conditions,

(ii) the power dissipated in the element.

N82/II/5*(a)*

60 The diagram illustrates the essential components of the circuit connecting an electrical convector heater to a 250 V mains socket. The heating element has a resistance of 65.2 Ω when in use. The connecting wires to the heating element have a total resistance of 0.01 Ω and the resistance of the fuse may be neglected.



(a) Calculate the steady current flowing in the circuit. (Ignore the resistance of the connecting wires.)

(b) What power is dissipated in the heating element?

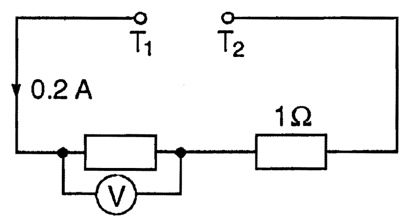
(c) Account for the fact that the heating element becomes much hotter than the wires connecting it to the mains supply.

(d) Explain why the temperature of the heating element becomes steady soon after the heater is switched on.

(e) When a connection in a circuit of this kind becomes loose without breaking the circuit, the connection becomes hot. Why is this?

J83/II/6

61 *(c)* In the circuit shown, T_1 and T_2 are the terminals of a battery. The voltmeter reads 1.5 V.



[In this diagram,
• represents wires connected at a junction.]

Calculate the potential difference across the terminals of the battery.

(d) (i) When tested, a battery supplied an average current of 2.0 A for 12 hours. The cost of the battery was 20 pence. Find the cost, in pence, of one ampere-hour of charge.

(ii) How long would a similar battery last when supplying an average current of 0.05 A?

N83/II/5*(c, d)*

62 *(a)* Describe, with the aid of labelled diagrams, an experiment to determine the relationship between the heat produced in a given resistor and the current flowing through it.

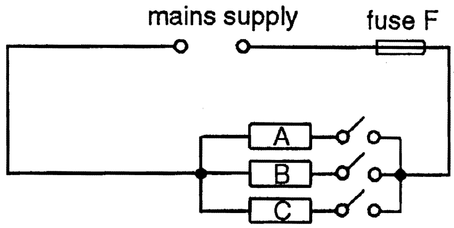
(b) A heater consisting of 100 turns of wire is connected to a power supply unit of fixed voltage and of negligible internal resistance.

What is the effect on the heat dissipated in the heater of

(i) connecting in series in the circuit a second similar power supply unit,

(ii) reducing the number of turns of wire to 50 and using only one of the power supply units?

(c) The diagram illustrates the circuit of a 3-element electric cooker connected to a 240 V supply. When switched on separately, the currents in the elements are as follows: element A, 4 A; element B, 4 A; element C, 8 A.



[In this diagram,
• represents wires connected at a junction.]

Calculate

(i) the power dissipated by element B,

(ii) the energy dissipated by element C in 5 hours.

By finding the total current in the circuit when all three elements are switched on, suggest a suitable value for the rating of fuse F.

N83/II/10

63 *(d)* When operating normally, the filament of the bulb has a resistance of 3.5 Ω and carries a current of 2.0 A. Calculate

(i) the power dissipated by the bulb,

(ii) the energy dissipated by it in 300 s.

N84/II/5*(d)*

64 *(a)* The current through the filament of the bulb in a car headlamp in normal use is 3.0 A. The potential difference across the lamp is 12.0 V. Calculate the power dissipated by the lamp.

(b) What is the resistance of the filament under these conditions?

(c) Car headlamps are connected in parallel across the battery. State the advantage of connecting them in this way rather than in series.

J85/I/15

65 Draw a labelled diagram to show how three power sockets should be connected to a 240 V a.c. supply.

Describe, with the aid of sketches where necessary, how the total current is limited to 30 A and how the output from each socket is limited to 13 A.

An electric immersion heater, correctly wired, develops a fault whilst in use. The heating element breaks in the centre so that each of the broken ends of its wire touches the earthed, metal cover of the heater. Describe and explain what happens.

An immersion heater has a rating of 3.0 kW. What would it cost to use for 5 hours at a price of 6p per kWh?

N85/II/11

66 An electric iron reaches its steady working temperature 300 s after being switched on. The average current flowing through the heating element during this time is 1.3 A.

Calculate the energy drawn from the 240 V mains supply whilst the iron is heating up.

Explain why this quantity of energy is *greater* than the heat retained by the iron.

J86/I/9

67 Figure (i) and (ii) show two possible lighting circuits, containing switches S_1, S_2 and two identical lamps L_1, L_2 to enable two rooms in a house to be lit.

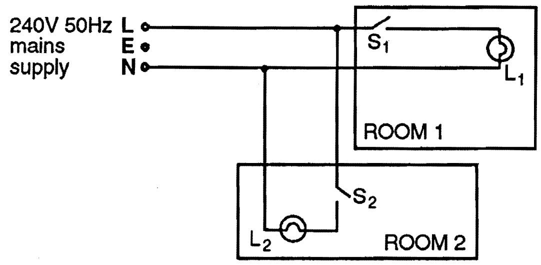


Fig. (i)

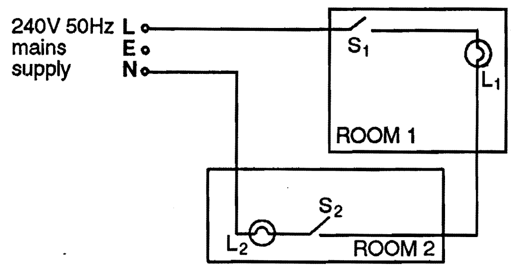


Fig. (ii)

(a) Explain carefully the effect of closing

switch S_1 in Fig. (i)

switch S_1 in Fig. (ii), with S_2 open

switch S_1 in Fig. (ii), with S_2 closed

State *one* reason why the circuit in Fig. (i) is used in practice.

(b) Assuming the resistance of each lamp to be 1 000 Ω, find the current drawn from the 240 V mains supply in each circuit when both S_1 and S_2 are closed.

Calculation for circuit Fig. (i).

Calculation for circuit Fig. (ii).

(c) Show, on Fig. (i), where the lighting circuit fuse should be placed in the circuit; briefly explain your choice of position.

J86/II/4

68 A battery of e.m.f. 9.0 V and internal resistance 1.5 Ω is connected in series with a resistor and a current 0.50 A passes through the resistor.

Calculate

(a) the resistance of the resistor in the circuit,

(b) the total rate at which chemical energy is transformed by the battery.

N86/II/11

69 *(a)* With the aid of a labelled diagram, describe an experiment to show that a heating coil of fixed resistance produces four times the power when the current through it is doubled.

(b) A mains heater carries a current of 8.0 A and has a power rating of 2 kW.

Calculate

(i) the voltage of the supply,

(ii) the resistance of the heater element,

(iii) the cost of the energy used by the heater in 5 hours if electrical energy costs 6 p per kWh.

(iv) Suggest a suitable rating for a fuse to be used in the plug connecting this heater to the mains supply.

(c) Describe how you would use a low voltage test circuit to check the rating marked on a 2 A fuse.

N86/II/11

70 An electric heater is connected, through a correctly wired 3-pin plug, to a mains supply socket. Explain briefly

(a) the function of the earth wire,

(b) why the fuse is connected in the *live* wire rather than the neutral wire.

J87/I/19

71 An electric fire operating from 250 V mains is connected to a 3-pin socket by a 3-pin plug containing a fuse. The fire (which has a metal case and reflector) has two heating elements, one rated at 1.0 kW and the other at 1.5 kW, and also a 25 W lamp. The lamp is connected so that it lights when the appliance is plugged in.

There are two switches A and B on the fire. Neither element heats up unless switch A is *on*. When switch B is *off*; only the 1.0 kW element heats up; when switch B is *on*, both elements heat up.

Draw a labelled diagram showing the connections in the fused plug, and to the heating elements and lamp. Mark clearly the positions of the two switches A and B. [7]

Calculate

(i) the current when only the lamp is on,

(ii) the maximum power of the appliance,

(iii) the energy (in kW h) consumed when the 1.0 kW element and lamp are in use for 8.0 hours. [5]

Draw a labelled diagram to show the structure of a fuse suitable for use in the plug connecting this electric fire to the mains socket.

Describe how a short circuit' may arise in the electric fire. Explain how, if a 'short circuit occurs, the fuse in the plug prevents the continued flow of current. [5]

N87/II/11

72 The element of an electrical heater has a power rating of 1150 W when used on a 230 V supply. Calculate the cost of operating the heater for 3.0 hours if the cost of 1 kWh of energy is 6.0 p. [2]

Measurements indicated that 92 000 J of energy were given out by the heater element in a particular period of time. What quantity of charge passed through the element during that time? [2]

J88/I/10

73 The heater of an electric kettle is rated at 2.0 kW.

(a) (i) Calculate how long it would take to raise the temperature of 1.5 kg of water in the kettle from 15 °C to 100 °C. The specific heat capacity of water is 4200 J/(kg K). Ignore heat losses and the heat needed to raise the temperature of the material of the kettle.

(ii) Calculate the cost of heating the water assuming that 1 kWh of energy costs 6.0 p. [5]

(b) The heating element works from a 250 V a.c. supply

Calculate

(i) the current through the heating element,

(ii) the resistance of the heating element. [4]

(c) The kettle is connected to a switched socket by a 3-core cable with a fused plug at the socket end.

(i) State the purpose of the fuse and explain how it works. [4]

(ii) Draw a labelled wiring diagram showing the connections within the plug and to the kettle. [4]

N88/II/9

74 An electric lamp is marked "250 V 100 W" and an immersion heater is marked "250 V 2 kW".

(a) Calculate the current in each device when operating normally. [3]

(b) (i) Explain why the filament of the lamp is made to have a larger resistance than the heating element of the immersion heater.

(ii) Suggest a reason why the filament is made of a metal with a much higher melting point than that of the element. [3]

(c) (i) The heat capacity of the filament of the lamp is very small. State one reason why this is an advantage.

(ii) Explain why the wire connecting the immersion heater to the supply remains cool even when the heater has been in use for some time. [4]

J89/II/5

75 The filament of a table lamp is connected to a 250 V 50 Hz mains supply by two wires. One wire is the *live* wire and the other is the *neutral*.

(a) Use the axes in Fig. 3.1 to sketch a graph which shows the variation with time of the voltage of the live wire during one cycle. The zero of the voltage scale is earth voltage. [2]

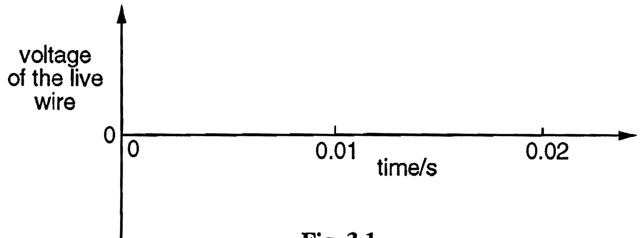


Fig. 3.1

(b) On the axes in Fig. 3.2, show the corresponding variation of voltage of the neutral wire. [2]

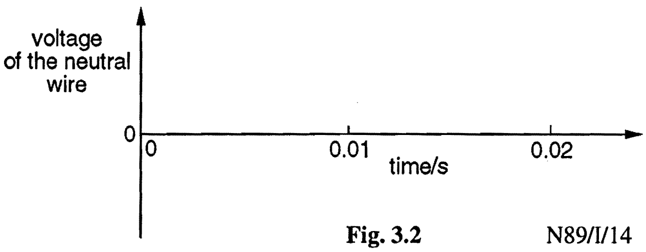


Fig. 3.2 N89/I/14

76 *(c)* An uncharged 12 V battery can be completely charge by passing a steady current of 0.40 A through the battery for 90 minutes.

(i) Calculate the total charge passing through the battery during charging.

(ii) Suggest one way in which you could confirm that the battery is completely charged.

(iii) The battery is to be used as the power source for a video camera which requires a power input of 15 W. Calculate the current supplied by the battery. Suggest a value for the length of time the camera could be used before the battery would need recharging. [7]

N89/II/11*(c)*

77 An isolated farmhouse has its own electrical generator which supplies an output voltage of 250 V to each of the following circuits.

Circuit **A**: a lighting circuit containing 8 lamps each rated at 250 V, 150 W.

Circuit **B**: a circuit for an electric cooker rated at 250 V, 6.0 kW.

For each circuit,

(a) determine the maximum current,

(b) Suggest a suitable fuse rating. [5]

J90/II/7

78 Fig. 4 shows a battery connected in series with a lamp and a switch **S**.

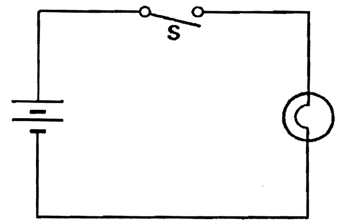


Fig. 4

(a) Assume that you have a voltmeter with a very high resistance and an ammeter with a very low resistance. Redraw the circuit diagram in the space alongside Fig. 4, showing how you would connect the voltmeter and the ammeter in order to measure the voltage across the battery and the current in the lamp when **S** is closed. [2]

(b) The voltage across the battery is found to be 2.70 V when the current in the lamp is 0.60 A.

(i) Calculate the resistance of the lamp.

(ii) Calculate the energy dissipated in the lamp in 30 minutes. [3] N90/II/7

79 *(a)* In an electrical wiring system in the home, there are three leads or conductors, the *earth*, the *live* and the *neutral*. A 110 V mains system is commonly used in houses. Write down, for such a system, the voltage between

(i) the *earth* and *neutral* conductors

(ii) the *live* and *neutral* conductors

(iii) the *earth* and the *live* conductors [2]

(b) State why the metal casings of electrical equipment are often connected to the *earth* lead. [2]

(c) State why the fuse protecting a circuit is connected into the *live* lead of that circuit. [2]

J92/II/7

80 A village is 5.00 km from the nearest electricity substation. Two conductors are used to connect the village to the substation. Each metre length of each conductor has a resistance of 0.00120 Ω.

(a) Calculate

(i) the combined resistance of the two conductors from the substation to the village,

Combined resistance = ...

(ii) the power loss in the conductors when the current through them is 40.0 A.

Power loss = ... [3]

(b) The voltage between the two conductors is 6000 V and the voltage to each house in the village is 240 V.

(i) Name the device that is used to change the 6000 V supply to a 240 V supply.

(ii) Explain why such a high voltage is used for transmitting the electricity. [4]

J92/II/8

81 Students investigating the variation of current through a filament lamp, also have available

a 6.0 V d.c. supply,
an ammeter which reads up to 100 mA,
a voltmeter which reads up to 6.0 V,
a variable resistor of maximum resistance 24 Ω,
a switch and suitable connecting leads.

The lamp has printed on it "4.5 V, 0.36 W".

(a) (i) What does the "4.5V 0.36 W" printed on the lamp mean?

(ii) What is the current through the lamp when the voltage across it is 4.5 V?

(iii) What is the resistance of the lamp when the voltage across it is 4.5 V? [4]

(b) (i) Draw a diagram of a circuit containing the d.c. supply, the lamp, the ammeter, the switch and the variable resistor all connected in series.

(ii) Add the voltmeter to your circuit diagram, connected to enable you to measure the potential difference across the lamp.

(iii) Assuming that the resistance of the lamp is constant, calculate the smallest possible current through the lamp, and the smallest possible voltage across the lamp, using this circuit. [6]

(c) This part of the question is about using the variable resistor as a potentiometer.

(i) Draw a diagram of a circuit, using the components listed above, in which the variable resistor is used as a potentiometer. The circuit should enable you to vary and measure the current through the lamp and the voltage across the lamp.

(ii) What is now the smallest possible voltage across the lamp?

(iii) How would you modify your circuit to make sure that the maximum possible voltage across the lamp would be 4.5 V? [5]

J92/II/11

82 *(a)* How much electric charge passes through a 12 V battery in 1.0 s when the current is 1.0 A? [1]

(b) How much energy is transferred by a 12 V battery in 1.0 s when the current is 1.0 A? [1]

(c) Fig. 5 shows a battery of e.m.f. 12 V connected in series with a 0.50 Ω resistor and lamps of resistance 2.5 Ω and 3.0 Ω.

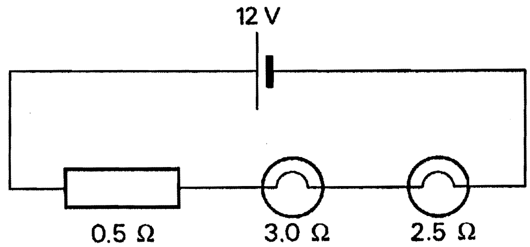


Fig. 5

(i) Calculate the current in the circuit.

(ii) Calculate the voltage across the 3.0 Ω lamp.

(iii) Calculate the power developed in the 3.0 Ω lamp. [5]

N92/II/5

83 Figure 6 shows the three conductors of a 240V a.c. supply cable, a fuse, a switch and a lamp.

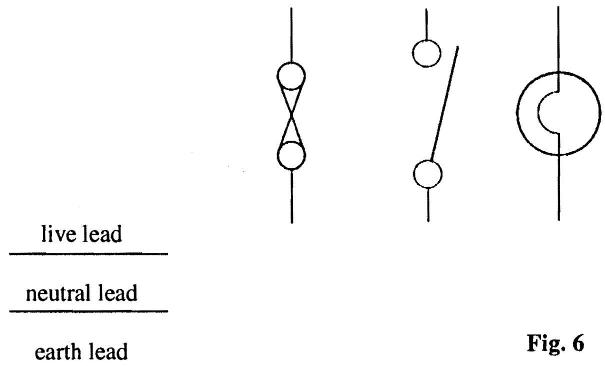


Fig. 6

The cable is rated at 240 V, 5 A continuous working.

The lamp is rated at 240 V, 500 W.

(a) Complete Fig. 6 to show how the fuse, switch and lamp should be connected to the supply. [3]

(b) What fuse rating should be used?

Fuse rating = ... [1]

J95/II/6

84 The useful power output of a small d.c. motor is used to raise a load of 0.75 kg through a vertical distance of 1.2 m. The time taken is 18.0 s. The voltage across the motor and the current through it are constant at 6.0 V and 0.30 A respectively. Assuming that the gravitational force on a mass of 1.0 kg is 10 N, calculate

(a) the power input to the motor,

(b) the work done in raising the load,

(c) the useful power output developed by the motor,

(d) the efficiency of this operation. [7]

N95/II/3

85 The table gives details of the use of electricity in one household in one three-month period.

kind of use	power in kW	time of use in h	energy consumption in kW h
lighting	0.8	270	
heating	12.0	150	
other	2.0	400	
		TOTAL	

(a) Complete the last column of the table. [2]

(b) Given that there is a fixed cost of 480 p and that energy is charged for at the rate of 6.4 p per kW h, calculate the total cost for the three-month period. [4] N95/II/5

86 Students investigating the heating effect of an electric current passed a constant current through a coil of wire immersed in water in a boiling tube. They measured the temperature of the water and used their measurements to determine the temperature rise of the water at 5.00 minute intervals after switching on.

The resistance of the coil was 12.0 Ω.

In one experiment, the current was kept at a constant value of 1.50 A.

In a second experiment, using a fresh amount of water of the same mass, the current was kept at a constant value of 1.20 A.

(a) Calculate the power input to the water when the current was

(i) 1.50 A,

(ii) 1.20 A. [3]

(b) Curve **P** in Fig. 7 gives the variation of temperature rise θ with time t when the current was 1.50 A.

Curve **Q** in Fig. 7 gives the variation of temperature rise θ with time t when the current was 1.20 A.

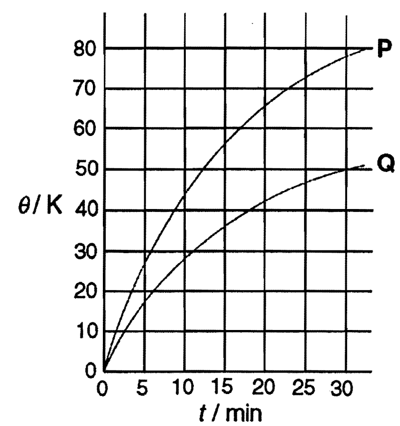


Fig. 7

(i) Explain briefly why the temperature rose at a smaller rate in the second experiment (curve **Q**).

(ii) Explain why the rate of temperature rise decreased with time in each case.

(iii) Determine the temperature rise after 10 min for each curve.

(iv) State, with reasons, whether your answers to *(b)* (iii) suggest that the temperature rise in a given time is directly proportional to the square of the current. [9]

(c) In the first experiment (curve **P**), the initial rate of rise of temperature was 0.100 K/s (°C/s). Using this value and your answer to *(a)* (i), obtain a value for the mass of water used in the experiment. The specific heat capacity of water is 4200 J/(kg K). [3] N95/II/10

87 Figure 8 shows a lamp connected in series with an ammeter of negligible resistance. A second identical lamp is connected in parallel across this series arrangement. The lamp circuit is connected in series with a 12 V battery, a switch and a variable resistor.

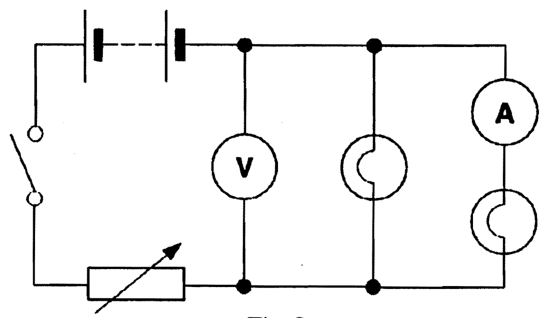


Fig. 8

(a) In the circuit shown in Fig. 8, the ammeter reading is 2.0A when the voltmeter reading is 6.0 V. Determine

(i) the resistance of each lamp,

(ii) the power developed in each lamp,

(iii) the current through the battery. [5] N95/II/11*(a)*

88 Fig. 9 shows part of the mains electrical circuit in a house. Two lamps A and B, each rated at 60 W 230 V, are connected to the live wire through fuse X. An electric kettle, rated at 750 W 230 V, is connected to the live wire through fuse Y. Fuse Z protects the whole circuit. The electric kettle has a metal case which is connected to Earth. The mains supply voltage is 230 V.

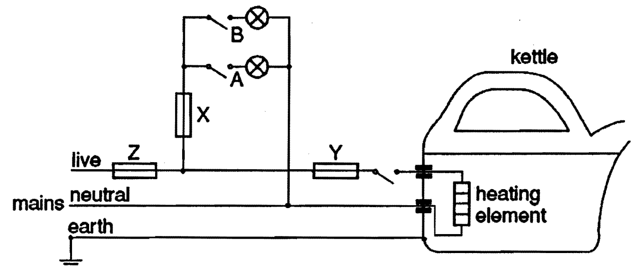


Fig. 9

(a) Calculate the current in each of the three fuses when the electric kettle and both of the lamps are **all** switched on. [4]

(b) A fault develops in the electric kettle, causing a current of 10 A in fuse Y. The lamps A and B remain switched on.

The maximum current ratings of the fuses are shown in the table.

	fuse X	fuse Y	fuse Z
current rating/A	3	5	15

Describe and explain what happens to each of the fuses X, Y and Z when the fault develops. [4]

(c) The switches and fuses to the lamps and the kettle are all in the live wire. Explain why this is necessary. [2]

(d) With the electric kettle working normally, it is switched on for 15 minutes per day.

(i) Calculate how many kW h are used by the electric kettle in one week.

(ii) Given that 1 kW h costs $ 0.15 in the country of use, calculate the cost of using the kettle for one week. [5]

J98/II/9

89 (b) Solar cells can be used to provide energy to run a refrigerator in a place where there is no mains electricity supply. Several solar cells are connected in series and used to charge up a storage battery as well as to run the refrigerator, as shown in Fig. 10.

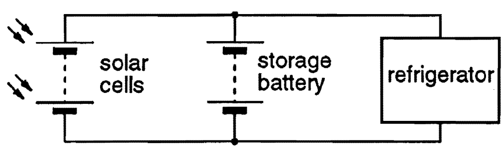


Fig. 10

(i) State the useful energy transformation that occurs within a solar cell.

(ii) Suggest why a storage battery is needed as well as the solar cells.

(iii) The tables below provide information about a **single** solar cell and a refrigerator, in a certain country.

SINGLE SOLAR CELL	REFRIGERATOR
Maximum output power in bright light 5.0 W. Effective number of hours of bright light in an average day 4.0	Input power required 125 W. When in use, refrigerator requires power for 20% of the time it is switched on.

1. Calculate how many kW h of energy are provided by a single solar cell in an average day.

2. Calculate how many kW h of energy are used by the refrigerator in an average day.

3. Using your answers to (iii) 1. and 2., calculate the minimum number of single solar cells that are needed to run the refrigerator. [8]

N98/II/10(b)

90 Fig. 11 shows part of the lighting circuit of a house.

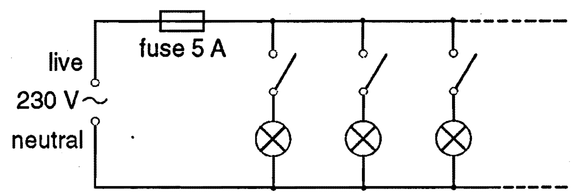


Fig. 11

(a) (i) Explain why a fuse is included in the circuit.

(ii) Explain why the fuse is placed in the live wire rather than in the neutral wire. [3]

(b) Each lamp has a power of 60 W. Calculate the current through one lamp when it is switched on. [2]

(c) The fuse has a rating of 5 A. Calculate the maximum number of lamps that can be connected and switched on without the fuse blowing. Each lamp is in parallel with the power supply. [2]

N99/II/6

ANSWERS

1. **D**	2. **B**	3. **E**	4. **E**	5. **D**
6. **C**	7. **B**	8. **D**	9. **C**	10. **B**
11. **C**	12. **D**	13. **B**	14. **A**	15. **D**
16. **C**	17. **E**	18. **D**	19. **C**	20. **B**
21. **B**	22. **A**	23. **C**	24. **D**	25. **C**
26. **C**	27. **D**	28. **B**	29. **C**	30. **A**
31. **B**	32. **D**	33. **C**	34. **D**	35. **A**
36. **A**	37. **C**	38. **B**	39. **A**	40. **B**
41. **B**	42. **B**	43. **B**	44. **C**	45. **C**

46. *(a)* (i) 3.0 A (ii) 4.0 Ω
47. 30 *p*
48. 20 W; 15 J/s
49. (i) 1.8 Ω , 5.2 Ω (ii) 3.15 Ω
50. *(b)* 36 W *(c)* 3.3 Ω
51. *(c)* 0.75 W *(c)* 3 V
52. *(a)* 0.4 A , 16 A *(b)* 625 Ω , 15.6 Ω
53. *(a)* (i) 2 A , 6 Ω , 7 200 J
55. 10 A ; 25 Ω
    (a) 5.00 kW *(b)* 1.25 kW
56. (i) 3 A (ii) 4 Ω
57. (i) 3.05 kW (ii) 12.2 A
    (iii) 12.2 kW
58. *(a)* 1.4 W *(b)* 1.5 W
59. *(a)* (i) 2 A (ii) 480 W
60. *(a)* 4 A *(b)* 1 000 W
61. *(c)* 1.7 V
    (d) (i) 8.3 *p* (ii) 48 h
62. *(c)* (i) 960 W (ii) 9.6 kW ; 16 A
63. *(d)* (i) 14 W (ii) 4 200 J
64. *(a)* 36 W (b) 4.0 Ω
65. 90 *p*
66. 93 600 J
67. *(b)* 0.48 A; 0.12 A
68. *(a)* 16.5 Ω *(b)* 4.5 W
69. *(b)* (i) 250 V (ii) 31.3 Ω
    (iii) 60 *p* (iv) 10 A
71. (i) 0.1 A (ii) 2 525 W
    (iii) 8.2 kWh
72. 20.7 *p* ; 400 C
73. *(a)* (i) 267.8 s (ii) 0.89 p
    (b) (i) 8 A (ii) 31.25 Ω
74. *(a)* 8 A
76. *(c)* (i) 2 160 C (iii) 28.8 s
77. Circuit A *(a)* $^{24}/_5$ A *(b)* 5A
    Circuit B *(a)* 24 A *(b)* 30 A
78. *(b)* (i) 4.5 Ω (ii) 2 916 J
79. *(a)* 0 V *(b)* 110 V *(c)* 110 V
80. *(a)* (i) 12 Ω (ii) 19 200 W
81. *(a)* (ii) 0.08 A (iii) 56.25 Ω
    (b) (iii) 80.25 Ω , 0.075 A , 4.22 V *(c)* 8 Ω
82. *(a)* 1 C *(b)* 12 J
    (c) (i) 2 A (ii) 6 V (iii) 12 W
83. *(b)* 5 A
84. *(a)* 1.80 W *(b)* 9 J
    (c) 0.50 W *(d)* 28 %
85. *(a)*

kind of use	power in kW	time of use in h	energy consumption in kW h
lighting	0.8	270	216
heating	12.0	150	1800
other	2.0	400	800
		TOTAL	2816

86. *(a)* (i) 27 W (ii) 17.3 W
87. *(a)* (i) 3.0 Ω (ii) 12 W (iii) 4.0 A
88. *(a)* 3.78 A
    (d) (i) 1.31 kWh (ii) 20 cents
90. *(b)* 0.261 A *(c)* 19