

## USING ELECTRICITY

### CHARGE AND CURRENT $Q = It$

1. Complete the following table:

	CHARGE	TIME	CURRENT
a)	200 C	40 s	-----
b)	-----	15 s	4 A
c)	900 C	-----	5 A
d)	-----	3 min	7.5 mA
e)	160 mC	0.04 s	-----
f)	900 mC	-----	4.5 $\mu$ A
g)	648 kC	24 h	-----

2. How many types of charge are there?

3. State what happens when:

- two positive charges are brought close together,
- two negative charges are brought close together,
- a positive and negative charge are brought close together.

4. A lightning strike lasts for 2.8 ms and delivers 50.4 C of charge. Calculate the current during the lightning strike.

5. How much charge flows along a wire when 25  $\mu$ A passes for 2 h?

6. If a capacitor stores 20 mC of charge, how long does it take to discharge, if the average discharge current is 0.4  $\mu$ A?

7. If 72 kC of charge flows through a resistor in 4 h, calculate the current?


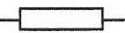

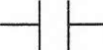
8. How much charge is transported if a current of 3 mA passes for 6 min?

9. In a television set there is a current of 2.8 A drawn from the plug and a current of 75 mA passing along the tube to the screen.

- How much charge is delivered to the set in 5 min?
- How much charge is delivered to the screen in 5 min?
- If each electron has a charge of  $1.6 \times 10^{-19}$  C, how many electrons are delivered to the screen in 5 min?

## CIRCUIT SYMBOLS

10. Complete the following table:

NAME	SYMBOL
a)	
b) Battery	-----
c)	
d)	
e) Fuse	-----
f)	
g) Diode	-----
h) Variable Resistor	-----

11. Draw the circuit diagrams for the following circuits:

- a battery connected in series to two bulbs, a resistor and a switch
- an a.c. supply connected in series to a lamp, a variable resistor and a capacitor

12. Draw the circuit diagrams for the following circuits:

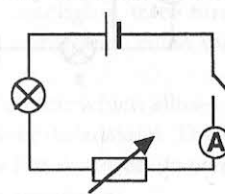
- a bulb in series with a resistor connected in parallel to a second bulb in series with a switch, both bulbs powered by a battery
- a cell connected in parallel with a capacitor in series with a resistor and a diode also in series with a resistor

13. a) Draw the circuit diagram for the circuit which has two cells in series with a switch, a variable resistor and a parallel network which consists of bulb A in series with a fuse and bulb B in series with a capacitor.

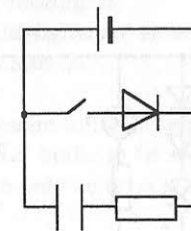
- Add an ammeter to circuit a) to measure the current through bulb A and a voltmeter to measure the voltage across the capacitor.

14. Describe in words the following circuits:

a)

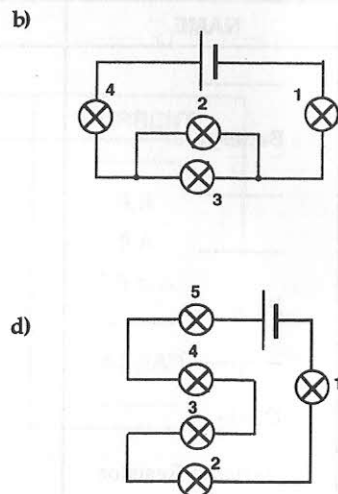
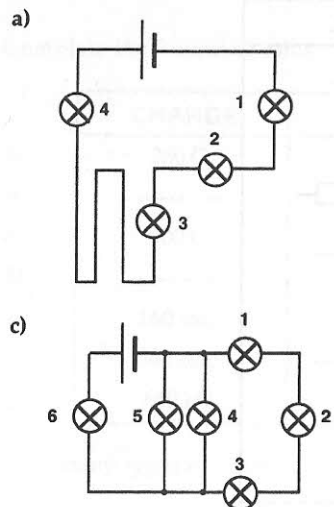


b)

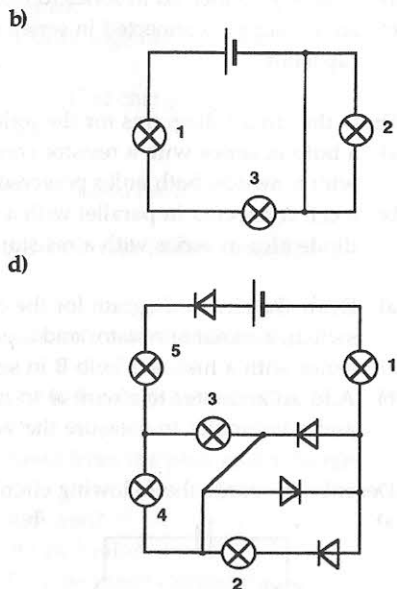
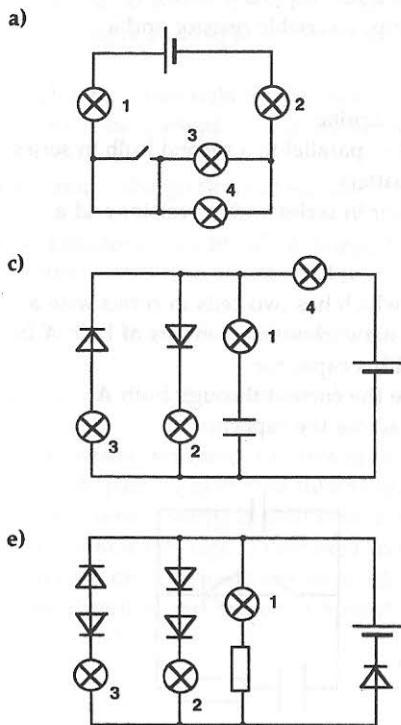


## CIRCUITS

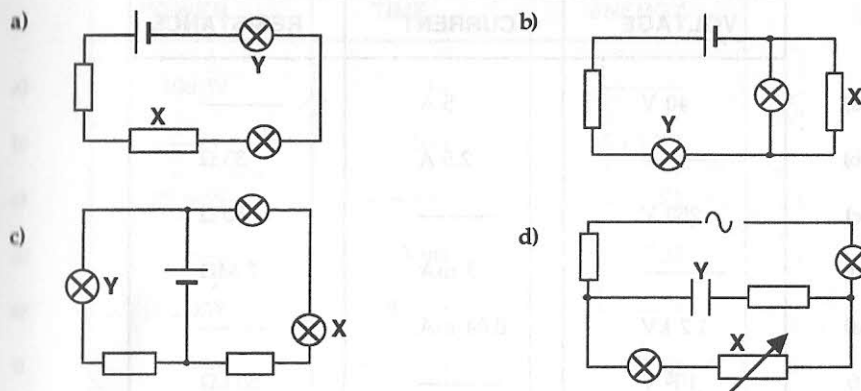
15. For the following circuits state whether the bulbs are connected in series or parallel:



16. For the following circuits state which lamps will light:

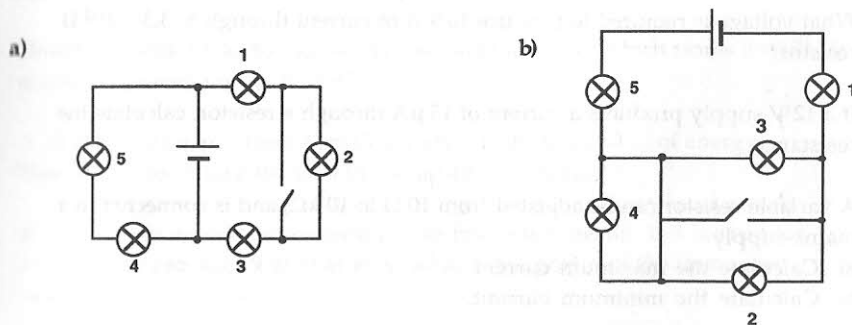


17. Copy the following circuits and add a voltmeter to measure the voltage across the component marked X and an ammeter to measure the current through the component marked Y:



e) What type of ammeter and voltmeter must be used for the measurements in circuit d)?

18. In the following circuits, state which lamps light when the switch is open and when the switch is closed:



19. Draw a circuit which allows a courtesy light inside a car to be turned on when either the passenger's door or the driver's door is opened.

20. All car lights have to operate at 12 V. Draw a circuit which allows: the four sidelights to be turned on without the headlights, the two headlights to be turned on only if the sidelights are already on, nothing to happen unless the ignition switch is also on.

21. Draw a circuit which allows a central heating system to be turned on from either upstairs or downstairs. The circuit also allows the boiler to be switched on to produce hot water on its own, but the pump can only be turned on when the boiler is already on.

**OHM'S LAW**  $V = IR$ 

22. Complete the following table:

	VOLTAGE	CURRENT	RESISTANCE
a)	40 V	5 A	-----
b)	-----	2.5 A	33 $\Omega$
c)	250 V	-----	50 $\Omega$
d)	-----	3 mA	7 M $\Omega$
e)	1.2 kV	0.04 mA	-----
f)	10 <sup>6</sup> V	-----	50 k $\Omega$
g)	240 V	3 x 10 <sup>-5</sup> A	-----

23. What is the current through a 5.6 k $\Omega$  resistor when it is connected to a 240 V supply?
24. What voltage is required to produce 10.9 A of current through a 3.3 x 10<sup>4</sup>  $\Omega$  resistor?
25. If a 12 V supply produces a current of 15  $\mu$ A through a resistor, calculate the resistance.
26. A variable resistor can be adjusted from 10  $\Omega$  to 10 k $\Omega$ , and is connected to a mains supply.
- Calculate the maximum current.
  - Calculate the minimum current.
27. A 9 V battery is connected to a variable resistor and an ammeter. The reading on the ammeter varies from 100  $\mu$ A to 50 mA as the resistor is adjusted. Calculate the range of the variable resistor.
28. Three resistors of 3.3  $\Omega$ , 12  $\Omega$  and 27  $\Omega$  are connected in parallel to a 9 V battery. Hence, each resistor has 9 V across it.
- Calculate the current through each resistor.
  - Calculate the total current which the battery has to provide.
29. Three resistors of 8.3  $\Omega$ , 10  $\Omega$  and 15  $\Omega$  are connected in series with a battery and a current of 150 mA passes through them.
- Calculate the voltage across each resistor.
  - What is the voltage of the battery?

**POWER AND ENERGY**  $E = Pt$ 

30. Complete the following table:

	POWER	TIME	ENERGY
a)	100 W	5 s	-----
b)	-----	750 s	5 x 10 <sup>4</sup> J
c)	25 mW	-----	5 J
d)	-----	3 ms	7 $\mu$ J
e)	1.2 kW	5 min	-----
f)	50 W	-----	10 <sup>6</sup> kJ
g)	-----	0.5 h	6.9 x 10 <sup>5</sup> J

31. A capacitor stores 40 mJ and is discharged in 0.03 s. What power does it develop?
32. How much energy, in joules, is dissipated in 1 h by a 3 kW electric fire?
33. How long does it take to completely discharge a battery which stores 2 x 10<sup>3</sup> MJ and is used to power a 6 kW heater?
34. A 20 mW LED is run from a small battery which stores 50 kJ of energy. How long does it take the LED to use up all this energy?
35. A 12 V power supply is connected to an immersion heater. If it is used for 2.5 min and provides 9 kJ of energy, what is the power of the immersion heater?
36. How much energy, in joules, is used when three 100 W bulbs, an electric fire with two bars each 2 kW and a 600 W television are used for 6 h?
37. In general, which type of devices have the highest power ratings?
38. Suggest possible power ratings for the following mains appliances:
- a colour television set
  - a light bulb
  - an electric fire
  - a kettle
  - a cooker with 4 rings, a grill and an oven
  - a hair dryer

**POWER, CURRENT AND VOLTAGE**  $P = IV$ 

39. Complete the following table:

	CURRENT	VOLTAGE	POWER
a)	2 A	-----	12 W
b)	-----	240 V	$3 \times 10^3$ W
c)	25 mA	250 mV	-----
d)	-----	800 V	$4 \times 10^2$ W
e)	7 $\mu$ A	-----	0.00021 W
f)	3.2 mA	5 kV	-----
g)	-----	240 V	$6.9 \times 10^3$ W

40. Calculate the power consumption of the following devices:

- a 2 V LED drawing 10 mA
- a mains lamp drawing 250 mA
- an electric kettle working from the mains taking 12.5 A
- a mains television set which takes 2.75 A

41. Calculate the current through the following devices:

- a mains heater rated at 2 kW
- a 250 W hair dryer which works from a 36 V battery
- an electric train with a power of 6 W running from a 12 V battery
- a transistor requiring 5 V and dissipating a power of 0.2 mW

42. Calculate the voltage required to run the following at their rated power level:

- a 1500 kW generator carrying 30 A
- a 5 mW diode carrying 0.00125 A
- a hair-dryer rated at 550 W carrying 4.6 A
- an immersion heater rated at 2.4 kW carrying 10 A

 43. A 100  $\Omega$  resistor carries a current of 2 A.

- Calculate the voltage across the resistor.
- Calculate the power dissipated in the resistor.

 44. 400 kV is applied to a 50 M $\Omega$  resistor.

- Calculate the current in the resistor.
- Calculate the power dissipated in the resistor.

 45. Show that  $P = IV$  and  $P = I^2R$  are equivalent.

**POWER, CURRENT AND RESISTANCE**  $P = I^2R$ 

46. Complete the following table:

	POWER	CURRENT	RESISTANCE
a)	40 W	-----	10 $\Omega$
b)	-----	0.03 A	$2 \times 10^3 \Omega$
c)	100 W	5 A	-----
d)	-----	8 mA	$4 \times 10^5 \Omega$
e)	5760 W	-----	$10^3 \Omega$
f)	6 mW	5 $\mu$ A	-----
g)	-----	7 mA	1 M $\Omega$

47. Calculate the power which is dissipated in the following resistors:

- a 1 k $\Omega$  resistor carrying 50 mA
- a 5 M $\Omega$  resistor carrying 2.5 mA
- a 680  $\Omega$  resistor carrying  $3 \times 10^{-2}$  A
- a 390  $\Omega$  resistor carrying 27 mA

48. Calculate the resistance of the resistor when:

- a rated power of 500 W requires a current of 0.05 A,
- a rated power of 4.5 kW requires a current of 300 mA,
- a rated power of 10 mW requires a current of 250  $\mu$ A,
- a rated power of 5 MW requires a current of  $2 \times 10^2$  A.

49. Calculate the current in the following resistors when used at their maximum power rating:

- a 0.5  $\Omega$  resistor, rated at 4.5 W
- a 1 k $\Omega$  resistor, rated at 640 W
- a 75  $\Omega$  resistor, rated at 3 kW
- a  $3 \times 10^4 \Omega$  resistor, rated at 7200 W

50. In 1 min a charge of 120 C flows through a resistor which dissipates 25 W.

- Calculate the current which passes.
- Calculate the resistance of the resistor.

 51. There is a voltage of 12 V across a 3 k $\Omega$  resistor.

- Calculate the current in the resistor.
- What power must the resistor dissipate?

## POWER, VOLTAGE AND RESISTANCE

$$P = \frac{V^2}{R}$$

52. Complete the following table:

	POWER	VOLTAGE	RESISTANCE
a)	40 W	-----	10 $\Omega$
b)	-----	500 V	$2 \times 10^3 \Omega$
c)	25 000 W	5 kV	-----
d)	-----	50 mV	2.5 $\Omega$
e)	16 kW	-----	$10^5 \Omega$
f)	640 mW	-----	1 M $\Omega$
g)	-----	19 mV	100 m $\Omega$

53. Calculate the power which is dissipated in the following devices:

- a mains heater with 2 k $\Omega$  resistance
- a 2 V LED with a resistance of 300  $\Omega$
- a resistor of 10 k $\Omega$  connected to a 36 V battery
- a 25  $\Omega$  toy car motor connected to a 1.5 V cell

54. Calculate the resistance of the following devices:

- a mains heater rated at 5 kW
- a 2.4 kW heater running from a 120 volt supply
- a 56 W toy train operating on a 12 volt supply
- a 3 mW component running off a 1.5 V cell

55. Calculate the voltage which is required to operate the following devices at their full power rating:

- a 25  $\Omega$ , 6 W lamp
- a 5 k $\Omega$ , 450 mW model car
- a 250  $\Omega$ , 5 mW diode
- a 0.35 M $\Omega$ ,  $4 \times 10^4$  W generator

56. A bulb is rated at 20 V, 80 W.

- Calculate the resistance of the bulb.
- Calculate the current when the bulb works at its rated value.

57. A 2 kW heater has a resistance of 26.45  $\Omega$ . Calculate the voltage and the current required to operate the heater at its standard rating.

58. Show that  $P = IV$  and  $P = \frac{V^2}{R}$  are equivalent.

## MIXED PROBLEMS ON POWER $E = Pt, P = IV, P = I^2R, P = \frac{V^2}{R}$

59. Complete the following table (in each case assume that the time is 10 s):

	POWER	VOLTAGE	CURRENT	RESISTANCE	ENERGY
a)	1000 W	---i)---	---ii)---	10 $\Omega$	---iii)---
b)	---i)---	50 V	---ii)---	$4 \times 10^3 \Omega$	---iii)---
c)	---i)---	---ii)---	5 mA	---iii)---	250 J
d)	---i)---	50 mV	---ii)---	2.5 $\Omega$	---iii)---
e)	---i)---	---ii)---	0.24 A	$10^3 \Omega$	---iii)---
f)	40 kW	---i)---	30 A	---ii)---	---iii)---
g)	---i)---	$10^2$ V	---ii)---	---iii)---	12 kJ

60. Three resistors of 500  $\Omega$ , 1 k $\Omega$  and 5 k $\Omega$  are connected in parallel so that each has 42 V across it from a power supply.

- Calculate the current through each resistor.
- Calculate the power dissipated in each resistor.
- Calculate the total power dissipated.
- Calculate the total energy used in 5 min.

61. The same three resistors as in Q. 60 are connected in series with a power supply to give a current of 5.6 mA through each.

- Calculate the voltage across each resistor.
- What is the total voltage supplied by the power supply?
- Calculate the power dissipated in each resistor.
- Calculate the total power dissipated.
- Calculate the total energy used in 5 min.

62. A toy train running off a 12 V battery uses  $1.5 \times 10^5$  J of energy in 1 h 30 min.

- Calculate the power of the train.
- Calculate the resistance of the train.
- Calculate the current through the train.
- How much charge is transferred in the time the train is running?

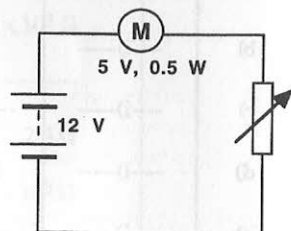
63. A heater is rated at 3 kW and has a resistance of 20  $\Omega$ . Calculate the current and voltage required to operate the heater at its stated rating.

64. Twenty Christmas lamps are connected in series across the mains supply. Each lamp has a resistance of  $80 \Omega$ .

- If the lights have an equal share of the voltage, what is the voltage across one lamp?
- What is the current in each lamp?
- What is the power dissipated in one lamp?
- How much energy is transformed by the set of lamps in 1 h?

65. The resistance of a variable resistor can vary from  $0 - 100 \Omega$  and has to be set at the right value for the motor to work at its correct rating.

- What is the resistance of the motor?
- Calculate the current required by the motor.
- What is the voltage across the variable resistor?
- What resistance setting is required by the variable resistor?



66. A fluorescent tube is rated at  $240 \text{ V}$ ,  $40 \text{ W}$ .

- How much energy is transformed in 1 min?
- What forms of energy are produced?
- What is the advantage of a fluorescent tube over a filament lamp?

67. An electrical generator provides  $9 \times 10^7 \text{ J}$  of energy every minute to the mains supply. It works at a voltage of  $40 \text{ kV}$ .

- Calculate the power of the generator.
- Calculate the resistance of the generator.
- Calculate the current through the generator.

68. A kettle has a resistance of  $20 \Omega$  and a current passing through it of  $12 \text{ A}$ .

- Calculate the power of the kettle.
- What voltage does it require?
- How long will it take to produce  $3 \text{ MJ}$  of energy?

69. The energy used by a mains heater in 5 min is  $9 \times 10^5 \text{ J}$ .

- Calculate the power of the heater.
- Calculate the resistance of the heater.
- How much current does it draw from the mains?

70. A  $75 \text{ W}$  car vacuum cleaner runs off the  $12 \text{ V}$  car battery.

- What is the resistance of the vacuum cleaner?
- How much energy is transformed in 3.5 min?
- What types of energy are produced?
- How much charge flows through the vacuum cleaner in this time?

71. How much charge will pass through a  $60 \text{ W}$ ,  $960 \Omega$  lamp in 1 min?

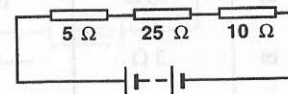
## SERIES AND PARALLEL CIRCUITS

72. a) What can you say about the current in a series circuit?  
b) What can you say about the voltages in a series circuit?

73. a) What can you say about the current in a parallel circuit?  
b) What can you say about the voltages in a parallel circuit?

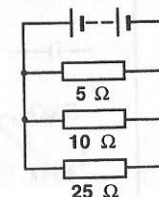
74. There is a current of  $250 \text{ mA}$  through the circuit shown.

- Calculate the voltage across each resistor.
- What is the supply voltage?
- Calculate the total power dissipated in the circuit.

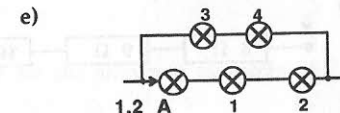
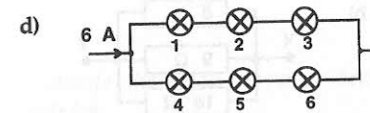
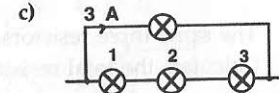
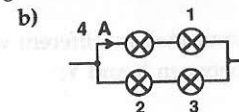
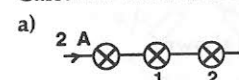


75. In the circuit shown the supply voltage is  $12 \text{ V}$ .

- Calculate the current in each resistor.
- What is the total current drawn from the battery?
- Calculate the total power dissipated in the circuit.



76. In the following circuits the bulbs are identical. Calculate the current through each numbered bulb:



77. In the following circuits an external voltage is applied between A and B and the bulbs are identical.

From the voltages indicated, calculate the voltage across each numbered bulb:

