2021 Sec 4 Physics Chapter 16

Practical Electricity - ANSWERS

16.2 Electric power and energy consumption

Example 1
1 kW → 1000 J / s
1 kWh → Using 1 kW for an hour

1 kWh = 1000 W x 60 x 60 s
= 3 600 000 J

Example 2
Electrical energy E = P x t
E(in kWh) = P (in kW) x t (h)
t= 0.36 / (60/1000) = 6 h

Example 3
Electrical energy E = P x t = 2.50 x 6 x 7 = 105 kWh
Cost = 105 x 30.0 cents = $31.50

Exercises

16.1 Electric Power and Energy

1 (a) $P = IV = 12 \times 1.5 = 18$ W (b) $P = V^2/R = 8^2/10 = 6.4$ W
(c) $P = I^2R = 2^2(15) = 60$ W
(d) $P = V^2/R = 3^2/35 = 0.26$ W (2sf) [Total power in circuit]
$P = I^2R = (3/35)^2(5) = 0.0367 =$ <u>0.037 W (2sf)</u> [resistor]
$P = I^2R = (3/35)^2(30) = 0.22$ W (2sf) [lamp]

Try working Q1 with the 3 different versions of power formula. They should all give you the same answer. If you do not get the same answer, some of your understanding of the quantities are not correct.

2 (a) The lamp will operate at normal brightness and convert 100 J of electrical energy to light and thermal energy every second when the p.d. across the lamp is 240 V.
(b) (i) E = Pt = 100 x 2 x 60 x 60 = 720 kJ
(ii) Resistance of lamp = $V^2/P = 240^2/100 = 576\ \Omega$
Therefore the power when p.d. is 110 V = V^2 / R
$= 110^2 / 576 = 21.0$ W
E = Pt = 21.0 x 2 x 60 x 60 = 151 kJ

3 (ai) $P = V^2/R = 12^2/12 = 12$ W
(aii) $V = 12/18 \times 12.0 = 8.0$ V; $P = V^2/R = 8^2/12 = 5.3$ W
(bi) $P = V^2/R = 12^2/6 = 24$ W
(bii) $V = 12.0 - 8.0 = 4.0$ V; $P = V^2/R = 4^2/6 = 2.7$ W

(ci) P = 12 + 24 = 36 W
(cii) P = 5.3 + 2.7 = 8.0 W

(d) Circuit 2, as the resistors will only convert a total of 8.0 J of electrical energy into heat energy in one second.

(e) The 6 Ω resistor in circuit 1 as it has the largest power of 24 W. That means it converts 24 J of electrical energy into heat in 1 second.

4 (ai) $I = P/V = 60/110 = 0.55$ A
(aii) $I = P/V = 60/240 = 0.25$ A

(bi) $R = V^2/P = 110^2/60 = 200\ \Omega$
(bii) $R = V^2/P = 240^2/60 = 960\ \Omega$

(ci) I = V/ R = 240/ 200 = 1.2 A Since the current through it is now 1.2 A instead of 0.25 A The lamp will be very bright and might blow .
(cii) I = V/R = 110/ 960 = 0.11 A. Since the current through it is now 0.11A instead of 0.55 A, the lamp will be very dim and might not light up.

16.3 Dangers of Electricity

Exercises

1 Overloading: Too high a current is taken from a socket due to multiple appliances connected. Overheating of the socket cables may cause insulation wires to melt or even result in a fire.

Damp conditions: Due to the lower electrical resistance, touching damp electrical items or using wet hands to touch the items may increase the risk of an electric shock to the user.

Damaged insulation: This may result in exposed electrical cables which may increase the risk of an electric shock to the user.

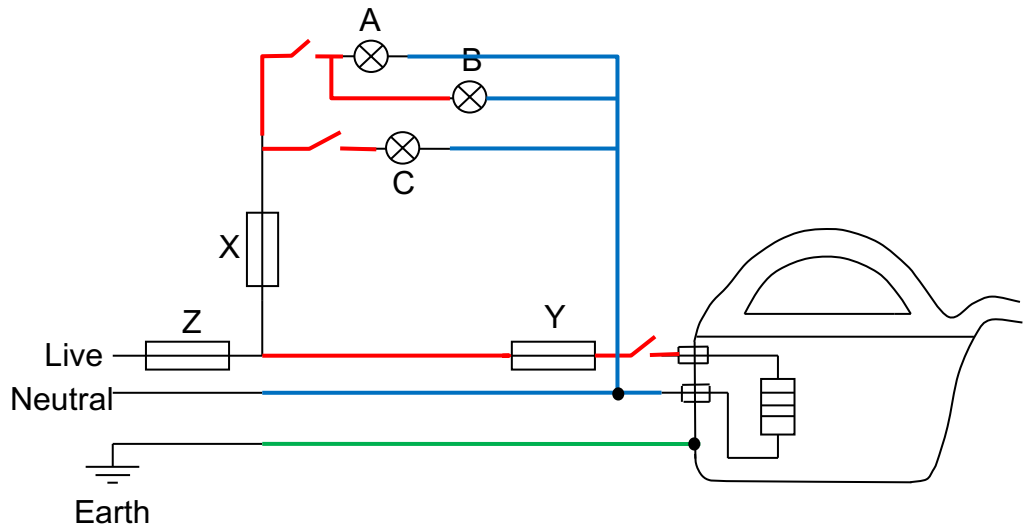
16.4 Safe Use of Electricity in the Home

Example 1

Type of wire	colour	potential	current (during normal usage)	connection (during normal usage)
live	brown	high (240 V)	yes	connected to one end of the appliance
earth	yellow and green	zero	no	connected to metal casing
neutral	blue	zero	yes, same as live wire	connected to other end of the appliance

Exercises

1 (a)



Note:

- Fuse is on live wire before the switch so that the switch will be at low potential when the fuse melts.
- Earth wire should be connected to the metal casing of the kettle.
- Lamps A and B should be connected in parallel, each with 240 V applied across it (its rating for normal brightness).

(b) $P = VI \rightarrow I = P/V$: $I_X = 0.75$ A (2 sf) $I_Y = 3.125 \approx 3.1$ A (2 sf)
$I_Z = I_X + I_Y = 3.88 \approx 3.9$ A (1 d.p.)

(c) The current flowing through fuse Y is 10 A which exceeds its fuse rating of 5 A, fuse Y will melt and break, and the kettle will be cut off from the mains.
The current flowing through fuse X is unchanged at 0.75 A. Hence, fuse X remains undamaged and the 3 lamps will continue to operate at normal brightness.
The current flowing through fuse Z has increased to 10.75A but it is still lower than its fuse rating of 15 A. Hence fuse Z remains undamaged.

(d) Switches and fuses must be on the live wire so that they can effectively isolate the kettle and the lamps from the high voltage mains when the switches are off and the fuses are damaged.

(e) electricial energy $E = P \times t$ $= (750/1000) \times (15/60) \times 14 = 2.625$ kWh
(P in kW, t in hours)
Cost of electricity = E x unit cost $= 2.625 \times 0.35 = 0.919$
$\approx$ \$0.92 (rounded off to the nearest cent)

2. total current drawn from socket($I = P/V$)

= current in electric kettle and current in oven

= 2000/220 + 2500/220 = 9.091 + 11.36

= 20.45 = 20 A

The individual 3-pin plug fuse rating is usually 13 A, so current will still flow in both appliances. However, the overall current drawn from the socket is 20 A which may cause excessive heating in the cables of the socket and result in a fire.