Year 11 Science: Electrical energy, power and circuits

Name: _____ Date: _____

Try these without your notes first, then check the answer key.

Practice

1. What current flows through a 12 Ω resistor with 6.0 V across it?

2. A toaster draws 4.0 A from the 230 V supply. What is its power?

3. How much energy, in joules, does that toaster use in 3.0 minutes?

4. What does it cost to run a 2.0 kW heater for 3 hours at 42.1 c/kWh?

5. A 9 W LED gives the same light as a 60 W incandescent bulb. By what percentage is its power lower?

Exam-style question: the hair dryer

Ari's hair dryer is rated at 1800 W on the 230 V mains supply. She uses it on high for 10 minutes every day. Electricity costs 42.1 cents per kWh.

6. Describe the energy changes in the hair dryer.

7. Calculate the current in the hair dryer on high, with a unit.

8. Calculate how much it costs Ari to use the hair dryer for a year.

9. On the low setting, the heating element has a higher resistance. Discuss how this changes the current, the power and how long Ari takes to dry her hair.

Fix the mistake

10. Correct this statement: "A 2 kW heater for 3 hours: E = 2 × 3 = 6 J."

11. Correct this statement: "Current gets used up by the heater, so less comes out than goes in."

12. Correct this statement: "A bigger resistance means a bigger current, because the resistor works harder."

13. Correct this statement: "Power and energy are the same thing, both in watts."

Answer key (for parents and tutors)

1. What current flows through a 12 Ω resistor with 6.0 V across it?
   I = V ÷ R = 6.0 ÷ 12 = 0.5 A.
2. A toaster draws 4.0 A from the 230 V supply. What is its power?
   P = VI = 230 × 4.0 = 920 W.
3. How much energy, in joules, does that toaster use in 3.0 minutes?
   E = Pt = 920 × 180 = 165 600 J (3.0 minutes = 180 s).
4. What does it cost to run a 2.0 kW heater for 3 hours at 42.1 c/kWh?
   E = 2.0 kW × 3 h = 6 kWh; cost = 6 × 42.1 = 252.6 c, about $2.53.
5. A 9 W LED gives the same light as a 60 W incandescent bulb. By what percentage is its power lower?
   (60 − 9) ÷ 60 × 100% = 85% lower.
6. Describe the energy changes in the hair dryer.
   Electrical energy becomes thermal energy in the heating element, kinetic energy of the fan and the moving air, and some sound (Achieved).
7. Calculate the current in the hair dryer on high, with a unit.
   I = P ÷ V = 1800 ÷ 230 = 7.8 A (Merit needs the working and the unit).
8. Calculate how much it costs Ari to use the hair dryer for a year.
   E = 1.8 kW × (10 ÷ 60) h = 0.3 kWh a day; 0.3 × 365 = 109.5 kWh a year; cost = 109.5 × 42.1 = 4610 c, about $46.10 (Excellence for the full chain with units).
9. On the low setting, the heating element has a higher resistance. Discuss how this changes the current, the power and how long Ari takes to dry her hair.
   Achieved: the current is lower, so it is less hot. Merit: the voltage stays at 230 V, so a higher resistance gives a smaller current (I = V ÷ R), and P = VI is smaller. Excellence: with V constant and I smaller, P = VI is lower, so fewer joules of electrical energy become thermal energy each second; by E = Pt she needs roughly the same total energy to evaporate the water, so she must use it for longer to dry her hair.
10. Correct this statement: "A 2 kW heater for 3 hours: E = 2 × 3 = 6 J."
    kW × hours gives kWh, so it is 6 kWh; for joules use watts and seconds: 2000 × 10 800 = 21 600 000 J.
11. Correct this statement: "Current gets used up by the heater, so less comes out than goes in."
    Current is the same all round a series circuit; it is energy that the heater transfers to the room.
12. Correct this statement: "A bigger resistance means a bigger current, because the resistor works harder."
    At the same voltage, I = V ÷ R, so a bigger resistance gives a smaller current.
13. Correct this statement: "Power and energy are the same thing, both in watts."
    Power is the rate of energy transfer in watts (J/s); energy is the total amount, in joules or kWh, and E = Pt links them.