

Solutions

2.1

$$\text{efficiency} = \frac{12\,000}{15\,000} = \mathbf{0.80} = \mathbf{80\%}$$

(decimal 1, percentage 1.)

2.2 Convert: $7.8\text{ kW} = 7800\text{ W}$ (C1). Rearrange: $\text{useful} = \text{efficiency} \times \text{total}$ (C1).

$$P_{\text{useful}} = 0.15 \times 7800\text{ W} = \mathbf{1200\text{ W}}$$
 (1.2 kW, 2 s.f.)

(answer A1.)

2.3 Useful share = $100 - 30 = 70\%$.

$$E_{\text{useful}} = 0.70 \times 8.0\text{ kJ} = \mathbf{5.6\text{ kJ}}$$

3.1 (a) Heater A:

$$\text{efficiency} = \frac{1700}{2000} = 0.85 = \mathbf{85\%}$$

(set-up 1, value 1); Heater B:

$$\text{efficiency} = \frac{1500}{2000} = 0.75 = \mathbf{75\%}$$

(set-up 1, value 1). (b) The efficiencies differ by 10 percentage points ($85 - 75$), which is one-eighth of B's efficiency ($10/75 \approx 13\%$ relative); against a saving of 200 W, that is a real efficiency gap, not "only a little" – though both heaters deliver most of their input usefully.

3.2 (a) $\text{efficiency} = \text{useful output energy transfer} \div \text{total input energy transfer}$. (b)

$$\text{efficiency} = \frac{33.9\text{ GJ}}{34.2\text{ GJ}} = \mathbf{0.991}$$
 (3 s.f.)

(fraction 1, decimal answer 1; GJ cancels – no conversion needed when top and bottom match.) (c) Some energy is dissipated – transferred to thermal stores of the cables and transformers by heating.

3.3 (a)

$$\text{efficiency}_{\text{elec}} = \frac{17}{50} = \mathbf{0.34}$$
 (34 %)

(fraction 1, value 1.) (b) Useful outputs are electrical + heating = 42 MW.

$$\text{efficiency}_{\text{total}} = \frac{42}{50} = \mathbf{0.84}$$
 (84 %)

(sum 1, value 1.) (c) A modern station turns 45 % of the fuel into electricity but rejects the rest – 55 % – as waste heat at the power station. The CHP station uses 84 % of the same fuel usefully by sending its "waste" heat to buildings instead. So for combined use the CHP station is the more efficient use of fuel, even though its electrical efficiency alone is lower – the useful output must be defined before comparing efficiencies.