

Solutions

2.1 $\Delta E_{\text{grav}} = mg\Delta h = 250 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 12 \text{ m} = 2.9 \times 10^4 \text{ J}.$

2.2 $E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 0.40 \text{ kg} \times (15 \text{ m s}^{-1})^2 = 45 \text{ J}.$

2.3 $P = \frac{E}{t} = \frac{800 \text{ J}}{4.0 \text{ s}} = 200 \text{ W}.$

2.4 $W = \Delta E_k$: E_k change $= \frac{1}{2}m(v^2 - u^2) = \frac{1}{2} \times 60 \text{ kg} \times (36 - 9.0) \text{ m}^2\text{s}^{-2} = 810 \text{ J}.$

3.1 B. Work dissipated = power $\times$ time, and force = work $\div$ distance. A multiplies by the distance; C and D invert the ratio.

3.2 B. At terminal velocity the kinetic energy is constant, so the whole gravitational loss does work against air resistance. A forgets the drag; C violates conservation; D reverses the fall.

3.3 (a) $\Delta E_{\text{grav}} = mg\Delta h = 200 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 4.5 \text{ m} = 8.8 \times 10^3 \text{ J}$ per minute;
 $P = \frac{E}{t} = \frac{8.8 \times 10^3 \text{ J}}{60 \text{ s}} = 147 \text{ W} \approx 150 \text{ W}.$ (b) efficiency $= \frac{\text{useful power output}}{\text{total power input}} = \frac{147 \text{ W}}{550 \text{ W}} = 0.27.$

3.4 (a) $\Delta E_{\text{grav}} = mg\Delta h = 85 \text{ kg} \times 9.81 \text{ N kg}^{-1} \times 25 \text{ m} = 2.1 \times 10^4 \text{ J}.$ (b) $\Delta E_k = \frac{1}{2}m(v^2 - u^2) = \frac{1}{2} \times 85 \text{ kg} \times (18^2 - 4.0^2) \text{ m}^2\text{s}^{-2} = 1.3 \times 10^4 \text{ J}.$ (c) The remaining $8 \times 10^3 \text{ J}$ is work done against air resistance and friction – energy is conserved once every transfer is counted.