

1. Jennifer pushes a sofa 3 meters across the floor by applying a force of 200N. If it takes her 6 seconds to push the sofa, what amount of power did she supply?

$$P = \frac{W}{t} = \frac{Fdcos\theta}{t} = \frac{200\text{ N}(3\text{ m})}{6\text{ s}} = 100\text{ W}$$

2. Kevin pushes the same sofa 3 meters across the floor by applying a force of 200N. Kevin, however, takes 12 seconds to push the sofa. What amount of power did Kevin supply?

$$P = \frac{W}{t} = \frac{Fdcos\theta}{t} = \frac{(200\text{ N})(3)}{12} = 50\text{ W}$$

3. Motor A lifts a 5000N steel crossbar upward at a constant 2 m/s. Motor B lifts a 4000N steel support upward at a constant 3 m/s. Which motor is supplying more power?

$$P_A = Fv = (5000\text{ N})(2\text{ m/s}) = 10000\text{ W}$$

$$P_B = Fv = (4000\text{ N})(3\text{ m/s}) = 12000\text{ W}$$

4. A 70kg cyclist develops 210 watts of power while pedaling at a constant velocity of 7m/s east. What average force is exerted eastward on the bicycle to maintain this constant speed?

A) 490N B) 30N C) 3.0N D) 0N

$$P = Fv \Rightarrow F = \frac{P}{v} = \frac{210}{7} = 30\text{ N}$$

5. Alien A lifts a 500-newton child from the floor to a height of 0.40 meters in 2 seconds. Alien B lifts a 400-newton student from the floor to a height of 0.50 meters in 1 second. Compared to Alien A, Alien B does
- (A) the same work but develops more power (B) the same work but develops less power
(C) more work but develops less power (D) less work but develops more power

6. A 110-kilogram bodybuilder and his 55-kilogram friend run up identical flights of stairs. The bodybuilder reaches the top in 4.0 seconds while his friend takes 2.0 seconds. Compared to the power developed by the bodybuilder while running up the stairs, the power developed by his friend is

(A) the same (B) twice as much (C) half as much (D) four times as much

7. Mary holds a 5-kg mirror against the wall 1.5 meters above the ground for 20 seconds while Bob nails it in place. What is Mary's power output during that time period?

(A) 2.45 Watts (B) 3.68 Watts (C) 66.7 Watts (D) None of the above

NO POWER OUTPUT - NO WORK. DISPLACEMENT = 0

8. Which of the following are appropriate units for power? Choose all that apply.

(A) $\frac{\text{J}}{\text{s}}$

(C) $\frac{\text{kg} \cdot \text{m}^2}{\text{s}^2}$

(B) $\frac{\text{N} \cdot \text{m}^2}{\text{s}}$

(D) $\frac{\text{kg} \cdot \text{m}^2}{\text{s}^3}$

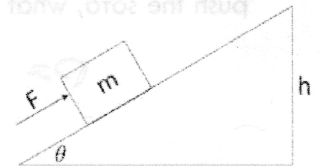
9. A box of mass m is pushed up a ramp at constant velocity v to a maximum height h in time t by force F . The ramp makes an angle of θ with the horizontal as shown in the diagram below. What is the power supplied by the force? Choose all that apply.

(A) $\frac{mgh}{t}$

(C) $\frac{Fh}{t \sin \theta}$

(B) $\frac{mgh}{t \sin \theta}$

(D) Fv



10. A person in good physical condition can put out 100 W of useful power for several hours at a stretch, perhaps by pedaling a mechanism that drives an electric generator. Neglecting any problems of generator efficiency and practical considerations such as resting time: (a) How many people would it take to run a 4.00-kW electric clothes dryer? (b) How many people would it take to replace a large electric power plant that generates 800 MW? (Answer: (a) 40 (b) 8 million)

$$N = \frac{P_{\text{req}}}{P_{\text{per person}}} = \frac{4000 \text{ W}}{100 \text{ W}} = 40 \text{ PEOPLE}$$

$$N = \frac{P_{\text{req}}}{P_{\text{per person}}} = \frac{800 \times 10^6 \text{ W}}{100 \text{ W}} = 8 \times 10^6 \text{ PEOPLE}$$

11. A large household air conditioner may consume 15.0 kW of power. What is the cost of operating this air conditioner 3.00 h per day for 30.0 d if the cost of electricity is \$0.110 per kW·h? (Answer: \$149)

$$E = P_e t$$

$$t = (30)(3) = 90 \text{ h}$$

$$E = (15 \text{ kW})(90 \text{ h}) = 1350 \text{ kWh}$$

$$\text{COST} = 1350 \text{ kWh} \times \$0.110/\text{kWh} = \$148.5$$

12. (a) What is the average useful power output of a person who does $6.00 \times 10^6 \text{ J}$ of useful work in 8.00 h? (b) Working at this rate, how long will it take this person to lift 2000 kg of bricks 1.50 m to a platform? (Work done to lift his body can be omitted because it is not considered useful output here.) (Answer: (a) 208 W (b) 141 s)

$$P = \frac{W}{t} = \frac{6.00 \times 10^6 \text{ J}}{8 \text{ h} \times 3600 \text{ s/h}} = 208.33 \text{ W} = 208.3 \text{ W}$$

$$W = mgh \rightarrow W = P_e t \rightarrow P_e = mgh \rightarrow t = \frac{mgh}{P} = \frac{(2000)(9.8)(1.5)}{208.3} = 141.15 \text{ s}$$

13. (a) How long will it take an 850-kg car with a useful power output of 40.0 hp (1 hp = 746 W) to reach a speed of 15.0 m/s, neglecting friction? (b) How long will this acceleration take if the car also climbs a 3.00-m-high hill in the process? (Answer: (a) 3.2 s (b) 4.04 s)

$$W = \Delta KE \rightarrow P_e t = \frac{1}{2} m v^2 - \frac{1}{2} m v_0^2 \rightarrow t = \frac{m v^2 - m v_0^2}{2 P} = \frac{(850)(15)^2}{2(29,840)} = 3.25$$

$$P = (40 \text{ hp}) \left(\frac{746 \text{ W}}{1 \text{ hp}} \right)$$

$$P = 29,840 \text{ W}$$

$$b) W = \Delta KE + \Delta PE = \frac{1}{2} m v^2 - \frac{1}{2} m v_0^2 + mgh - mgh_0$$

$$P = \frac{W}{t} \rightarrow t = \frac{\frac{1}{2} m v^2 - \frac{1}{2} m v_0^2 + mgh}{P} = \frac{(0.5)(850)(15)^2 - 0 + (850)(9.8)(3)}{29,840} = 4.04 \text{ s}$$

14. (a) What is the available energy content, in joules, of a battery that operates a 2.00-W electric clock for 18 months? (b) How long can a battery that can supply $8.00 \times 10^4 \text{ J}$ run a pocket calculator that consumes energy at the rate of $1.00 \times 10^{-3} \text{ W}$? (Answer: (a) $9.46 \times 10^7 \text{ J}$ (b) 2.54 y)