

PQ 10a

Questions and Answers

Q1

- Together, two students exert a force of 825 N
- in pushing a car a distance of 35 m.
- How much work do the students do on the car?

$$\begin{aligned}W &= Fd = (825 \text{ N})(35 \text{ m}) \\ &= 2.9 \times 10^4 \text{ J}\end{aligned}$$

- If the force was doubled, how much work would they do pushing the car the same distance?

$$\begin{aligned}W &= Fd \\ &= (2)(825 \text{ N})(35 \text{ m}) \\ &= 5.8 \times 10^4 \text{ J which is twice as} \\ &\quad \text{much work}\end{aligned}$$

Q2

- A rock climber wears a 7.5-kg backpack while scaling a cliff. After 30.0 min, the climber is 8.2 m above the starting point.
- a. How much work does the climber do on the backpack?

$$\begin{aligned}W &= Fd \\ &= mgd \\ &= (7.5 \text{ kg})(9.80 \text{ m/s}^2)(8.2 \text{ m}) \\ &= 6.0 \times 10^2 \text{ J}\end{aligned}$$

- b. If the climber weighs 645 N, how much work does she do lifting herself and the backpack?

$$\begin{aligned}W &= Fd + 6.0 \times 10^2 \text{ J} \\ &= (645 \text{ N})(8.2 \text{ m}) + 6.0 \times 10^2 \text{ J} \\ &= 5.9 \times 10^3 \text{ J}\end{aligned}$$

Q2 continued

- What is the average power developed by the climber?

$$\begin{aligned} P &= \frac{W}{t} = \left(\frac{5.9 \times 10^3 \text{ J}}{30.0 \text{ min}} \right) \left(\frac{1 \text{ min}}{60 \text{ s}} \right) \\ &= 3.3 \text{ W} \end{aligned}$$

Q3

- A sailor pulls a boat into a quayside applying a force of 255N with a rope for 30m. Due to tidal and wind effects the rope is at a 50 degree angle. How much work does he do?

$$\begin{aligned}W &= Fd \cos \theta \\ &= (255 \text{ N})(30.0 \text{ m})(\cos 50.0^\circ) \\ &= 4.92 \times 10^3 \text{ J}\end{aligned}$$

Q4

- Two people lift a heavy box a distance of 15 m. They use ropes, each of which makes an angle of 15° with the vertical. Each person exerts a force of 225 N. How much work do they do?

$$\begin{aligned}W &= Fd \cos \theta \\&= (2)(225 \text{ N})(15 \text{ m})(\cos 15^\circ) \\&= 6.5 \times 10^3 \text{ J}\end{aligned}$$

Q5

- An airplane passenger carries a 215-N suitcase up the stairs, a displacement of 4.20 m vertically.
- How much work does the passenger do?

$$W = Fd = (215 \text{ N})(4.20 \text{ m}) = 903 \text{ J}$$

Q6

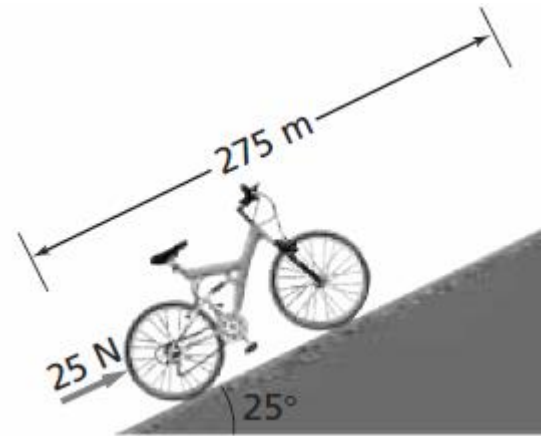
- A rope is used to pull a metal box a distance of 15.0 m across the floor. The rope is held at an angle of 46.0° with the floor, and a force of 628 N is applied to the rope. How much work does the force on the rope do?

$$\begin{aligned}W &= Fd \cos \theta \\&= (628 \text{ N})(15.0 \text{ m})(\cos 46.0^\circ) \\&= 6.54 \times 10^3 \text{ J}\end{aligned}$$

Q7

- A bicycle rider pushes a bicycle that has a mass of 13 kg up a steep hill. The incline is 25° and the road is 275 m long, as shown. The rider pushes the bike parallel to the road with a force of 25 N.
- How much work does the rider do on the bike?
- **Force and displacement are in the same direction.**

$$\begin{aligned}W &= Fd \\ &= (25 \text{ N})(275 \text{ m}) \\ &= 6.9 \times 10^3 \text{ J}\end{aligned}$$



Q8

- You push a wheelbarrow a distance of 60.0 m at a constant speed for 25.0 s, by exerting a 145-N force horizontally.
- What power do you develop?

$$P = \frac{W}{t} = \frac{Fd}{t} = \frac{(145 \text{ N})(60.0 \text{ m})}{25.0 \text{ s}} = 348 \text{ W}$$

- If you move the wheelbarrow twice as fast, how much power is developed?

***t* is halved, so *P* is doubled to 696 W.**

Q9

- An electric motor develops 65 kW of power as it lifts a loaded elevator 17.5 m in 35 s. How much force does the motor exert?

$$P = \frac{W}{t} = \frac{Fd}{t}$$

$$F = \frac{Pt}{d} = \frac{(65 \times 10^3 \text{ W})(35 \text{ s})}{17.5 \text{ m}}$$

$$= 1.3 \times 10^5 \text{ N}$$

Q10

- A winch designed to be mounted on a truck, as shown, is advertised as being able to exert a $6.8 \times 10^3 \text{ N}$ force and to develop a power of 0.30 kW. How long would it take the truck and the winch to pull an object 15 m?



$$P = \frac{W}{t} = \frac{Fd}{t}$$

$$t = \frac{Fd}{P}$$

$$= \frac{(6.8 \times 10^3 \text{ N})(15 \text{ m})}{(0.30 \times 10^3 \text{ W})} = 340 \text{ s}$$

$$= 5.7 \text{ min}$$