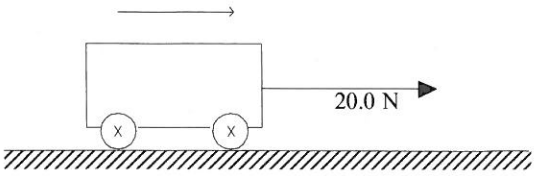
Physics 504

Name: Answers

Quiz: Work, Power and Energy

1. A 10.0 kg cart is initially moving at a speed of 1.0 m/s.

A boy applies a horizontal force of 20.0 N on the cart for 2.0 seconds in the direction of its motion.



Disregard the effects of friction.

How much power is generated by the boy?

① $a = \frac{F_{net}}{m}$

$= \frac{20.0\,N}{10\,kg}$

$= 2\,m/s^2$

② $v_i = 1.0\,m/s$

$a = 2.0\,m/s$

$\Delta t = 2.0\,s$

$\Delta d = ?$

$\Delta d = v_i \Delta t + \frac{1}{2} a (\Delta t)^2$

$= (1.0\,\frac{m}{s})(2.0\,s) + \frac{1}{2}(2.0\,m/s^2)(2.0\,s)^2$

$= 6.0\,m$

③ $W = F \Delta d$

$= (20\,N)(6.0\,m)$

$= 120\,J$

④ $P = \frac{W}{\Delta t}$

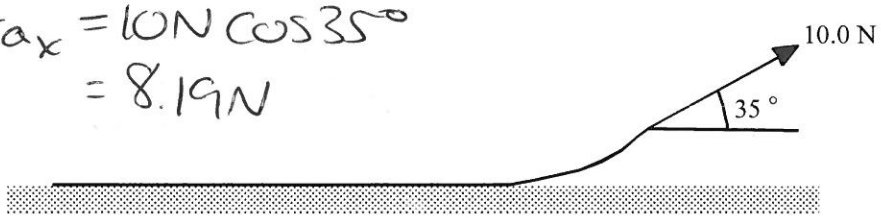
$= \frac{120\,J}{2.0\,s}$

$\boxed{P = 60\,W}$

2. A sled has a mass of 10.0 kg. A child pulls the sled a distance of 20.0 metres with a force of 10.0 N at an angle of 35° with respect to the horizontal. During this motion, a force of friction of 4.0 N acts in the opposite direction of the motion. The child generates 27.3 W of power in this process.

① $F_{a_x} = 10\,N \cos 35°$

$= 8.19\,N$



How long does it take the child to pull the sled over the 20.0 m?

② $W = F_x \Delta d$

$= (8.19\,N)(20.0\,m)$

$= 164\,J$

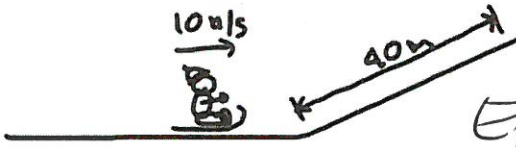
③ $P = \frac{W}{\Delta t}$

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

$= \frac{164\,J}{27.3\,W}$

$\boxed{\Delta t = 6.0\,s}$

3. A boy coasting on a sled comes to a hill with a speed of 10 m/s. The combined mass of the boy and the sled is 30 kg, and friction exerts a force of 20.0 N. The boy and the sled slide 40 m along the surface of the hill. When the boy and the sled come to a stop, how much higher than the bottom of the hill are they?



① $E_{ki} - W_f = E_{pf}$

$E_{pf} = E_{ki} - W_f$

$= \frac{1}{2}mv^2 - F \cdot \Delta d$

$= \frac{1}{2}(3\text{kg})(10\text{m/s})^2 - (20\text{N})(40\text{m})$

$= 1500\text{J} - 800\text{J}$

$= 700\text{J}$

② $E_p = mgh$

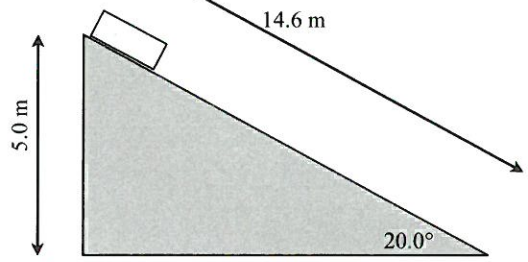
$h = \frac{E_p}{mg}$

$= \frac{700\text{J}}{(3\text{kg})(9.8\text{m/s}^2)}$

$\boxed{h = 2.38\text{ m}}$

4. A ~~50.0~~ kg box starts from rest at the top of a ramp, as illustrated below. A worker pushes the box over the first 2.2 m so that the box will reach the bottom of the ramp with a speed of 1.0 m/s. Friction between the box and the ramp is 92 N. What is the magnitude of the force the worker applied to the box?

20kg



② $W_a = F \cdot \Delta d$

$F = \frac{W_a}{\Delta d}$

$= \frac{373.2\text{J}}{2.2\text{m}}$

$\boxed{F_a = 170\text{N}}$

① $E_{pi} + W_a - W_f = E_{kf}$

$W_a = E_{kf} + W_f - E_{pi}$

$= \frac{1}{2}mv^2 + F_f \cdot \Delta d - mgh$

$= \frac{1}{2}(20\text{kg})(1.0\text{m/s})^2 + (92\text{N})(14.6\text{m}) - (20\text{kg})(9.8\text{m/s}^2)(5.0\text{m})$

$= 10\text{J} + 1343.2\text{J} - 980\text{J}$

$W_a = 373.2\text{J}$