Work + Energy

$W = F_{\parallel} \Delta d$ (use if F is in the same direction as Δd)

$W = F \Delta d \cos\theta$ (for any angle)

PP|235

14. $m = 180\,kg$

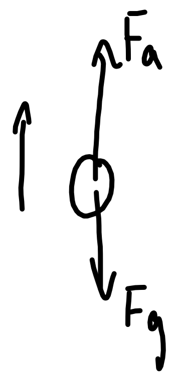
$\Delta d = 2.33\,m$

a) $W = ?$ (lifting)

b) $W = ?$ (lowering)

c) forces doing work?

a)



$(180\,kg)(9.81\,m/s^2)$

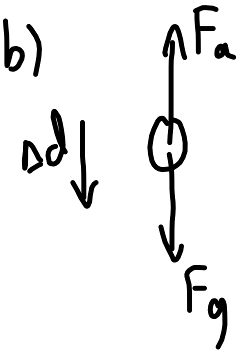
$1765.8\,N$

$W = F_{\parallel} \Delta d$

$W = (1765.8\,N)(2.33\,m)$

$\boxed{W = 4.11 \times 10^3\,J}$

b)



$W = F \Delta d \cos\theta$

$W = (1765.8\,N)(2.33\,m) \cos 180^\circ$

$\boxed{W = -4.11 \times 10^3\,J}$

§6-2 Kinetic Energy and the Work-Energy Theorem

Kinetic energy is directly related to the mass of an object and directly related to the square of its velocity.
Any moving object has kinetic energy.

$$E_k = \frac{1}{2}mv^2$$

Scalar!

Where E_k is the kinetic energy (J)
m is the mass (kg)
v is the velocity (m/s)

$1\,kg\cdot\frac{m^2}{s^2} = 1\,J$

mp|237

$m = 0.200\,kg$
$v_1 = 0$
$v_2 = 27.0\,m/s$

a) $E_{k_1} = ?$
b) $E_{k_2} = ?$

a) If the puck is not moving $(v=0)$ then the kinetic energy is zero!

b) $E_k = \frac{1}{2}mv^2$

$E_k = \frac{1}{2}(0.200\,kg)(27.0\,m/s)^2$

$E_k = 72.9\,J$

Consider an object that is being accelerated from v_1 to v_2:

$W = F_{\parallel}\Delta d$ but $F_{\parallel} = ma$

$W = ma\Delta d$ but $a = \frac{\Delta v}{\Delta t}$

and $\Delta d = v_{ave}\Delta t$

$$W = m\left(\frac{\Delta v}{\cancel{\Delta t}}\right)\left(v_{ave}\cancel{\Delta t}\right)$$

$$W = m(\Delta v)(v_{ave})$$

$$W = m(v_2 - v_1)\left(\frac{v_1 + v_2}{2}\right)$$

$$W = \frac{1}{2}m(v_2 - v_1)(v_1 + v_2)$$

$$W = \frac{1}{2}m(\cancel{v_1v_2} + v_2^2 - v_1^2 - \cancel{v_1v_2})$$

$$W = \frac{1}{2}m(v_2^2 - v_1^2)$$

$$W = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2$$

$$W = E_{k_2} - E_{k_1}$$

$$W = \Delta E_k$$

Work-Energy Theorem

Work is equal to the change in kinetic energy

+ work ⇒ increase in KE

− work ⇒ decrease in KE

MP|242

$m = 2.5\,kg$

$F_a = 4.0 \times 10^1\,N$

$\Delta d = 1.5\,m$

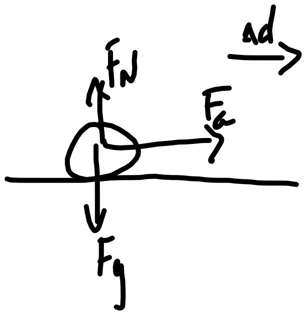
a) $W = ?$

b) If $v_1 = 0$, $v_2 = ?$

a) $W = F_{\parallel} \Delta d$

$W = (40\,N)(1.5\,m)$

$\boxed{W = 6.0 \times 10^1\,J}$



b) $W = \Delta E_k$

$W = E_{k2} - \cancel{E_{k1}}^{\,0}$

$W = \frac{1}{2} m v^2$

$2W = m v^2$

$v^2 = \frac{2W}{m}$

$v^2 = \frac{2(60\,J)}{2.5\,kg}$

$\boxed{v \doteq 6.9\,m/s}$

MP|244

$m = 75\,kg$

$\Delta d = 5.0\,m$

$F = 2.0 \times 10^2\,N$

$v_1 = 8.0\,m/s$

$E_{k_2} = ?$

$W = \Delta E_k$ (work energy theorem)

$F_{\parallel}\Delta d = E_{k_2} - E_{k_1}$

$$E_{k_2} = \underbrace{E_{k_1}}_{\text{energy at start}} + \underbrace{F_{\parallel}\Delta d}_{\text{work done}}$$

$E_{k_2} = \frac{1}{2}mv^2 + F_{\parallel}\Delta d$

$E_{k_2} = \frac{1}{2}(75\,kg)(8.0\,\frac{m}{s})^2 + (200\,N)(5.0\,m)$

$E_{k_2} = 2400\,J + 1000\,J$

$E_{k_2} = 3400\,J$

$v_2 = ?$

$E_k = \frac{1}{2}mv^2$

$3400\,J = \frac{1}{2}(75\,kg)v^2$

$v = ?$

$v^2 = \frac{2(3400\,J)}{75\,kg}$

$v = 9.5\,m/s$

TODO

① PP|238

② PP|245-246