Work is defined as the product of the applied force and the distance the object moves (after the applied force has been applied)

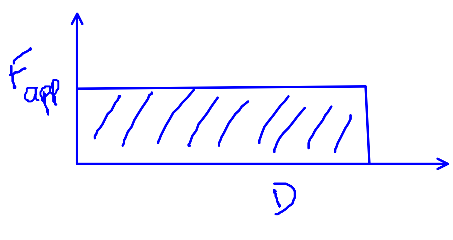
if the distance travelled by the object is "0", then by def^N of work, work done = "0"

Formula for work

$W = F \cos\theta \cdot d$ where θ is the angle of applied force, work is a scalar and work can be negative.

The units for work are N·m or J (Joules)

Graphically work is described as the area under the Force displacement curve



ex

if 15.0N is applied on this object and it moves parallel to the direction of applied force then $\theta = 0$. Assume the object moves 3.0m

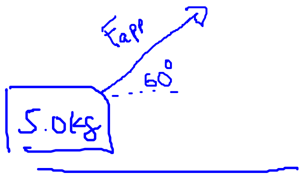
$\therefore W = F_{app} \cos\theta \cdot d$

$= 15.0N \cos(0°) \cdot 3.0m$

$= (15.0)(1)(3.0\,m)$

$= 45.0\ N\cdot m$ or 45.0 Joules (J)

ex using that same problem but this time the applied force is on an angle of 60°



in order to solve we use the component of the Force vector that is parallel to the direction of motion

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

$= (15.0N)(\cos 60°)(3.0m)$

$= 22.5\ Nm$ or $23\ Nm$ or $23J$

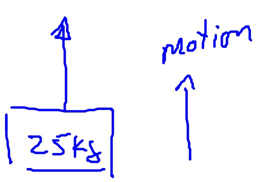
ex 2) lifting a 25.0kg mass at constant velocity for a distance of 1.50m. How much work is done lifting the object.

$W = F_{app}\cos\theta \cdot d$

$d = 1.50m$

$\theta = 0°$

$F_{app} = ?$



$F_{app} = -F_g$ because $F_{NET} = 0$ since $a = 0$

$F_{NET} = F_{app} + F_g \Rightarrow 0 = F_{app} = -F_g = -(25.0kg)(-9.8)$

$= 245N$

$\therefore W = (245)(\cos(0))(1.50m)$

$= 368\ J$

ex How much work is done if we are going to lower this object at constant velocity a distance of 1.50 m?

In this problem, we are still required to have an upward force of 245 N but now the distance travelled is opposite the direction of the applied force

Note: when the direction of motion is opposite the direction of applied force, work is always ⊖'ve, negative

$W = +F\cos\theta \cdot d$

$= +245\cos(180°) \cdot 1.5$

$= -368\ J$

ex) A 1385 kg car travelling @ 61 km/h is brought to a stop after skidding 42.0 m. Determine the work done by the frictional forces

$W = ?$ Need $F \cdot d$

$d = 42\ m$, $m = 1385\ kg$

$F = ?$, Need $a = ?$

We have $V_i = \left(61\frac{km}{hr} \cdot \frac{1000\ m}{1\ km} \cdot \frac{1\ hr}{3600\ s}\right)$

$V_f = 0$

$d = 42.0\ m$

$a = -3.42\ m/s^2$

use $V_f^2 = V_i^2 + 2ad$

Assume car is moving to the right. In order for the car to slow down due to friction, the applied Force must be opposing the direction of motion.

$W = F\cos(\theta) \cdot d$

$W = F\cos(\theta) \cdot d$

$= (385kg)(3.42 \frac{m}{s^2}) \cos(180^\circ) \cdot 42m$

$= -2.0 \times 10^5$ J

HW W/B pg 150-151 # 1-11 odd, 13, 14

T/B pg 174- #1,3,4,7 (slightly hard)

Power is defined as the amount of work done in a given period of time. It is a scalar and

the units for power $= \frac{N \cdot m}{t}$ or $\frac{J}{t}$ or W (watts)

$$P = \frac{W}{t} = \frac{F \cdot d}{t} = \frac{N \cdot m}{s} = \frac{J}{t} = \text{Watts}$$

ex) a 1.10×10^3 kg car starting @ rest accelerates for 5.00 s. The magnitude of "a" is $4.60 \frac{m}{s^2}$. Calculate the power of the engine that accelerates this vehicle

we know $a = 4.60 \frac{m}{s^2}$, $m = 1.10 \times 10^3$ kg, $V_i = 0$ m/s, $t = 5.00$ s

$$P = \frac{W}{t} = \frac{F \cdot d}{t} = \frac{\overset{\checkmark}{m} \cdot \overset{\checkmark}{a} \cdot \overset{?}{d}}{\checkmark t}$$

need to calc d

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

$= (0)(5) + \frac{1}{2}(4.60 \frac{m}{s^2})(5.0 s)^2$

$= 57.5$ m

$$P = \frac{(1.1\times10^3\ kg)(4.60\ \frac{m}{s^2})(57.5m)}{5.0\ s}$$

=

$= 5.82\times10^4\ W$

Another way of calculating this problem is $P = \frac{W}{t} = F\frac{d}{t} = F \cdot v_{avg}$

if you can calc the average velocity

$P = \underbrace{m \cdot a}_{F} \cdot v_{avg}$

$$\text{Efficiency} = \frac{\text{work out}}{\text{work in}} \times 100\%$$ } memorize

$$\text{or} = \frac{\text{Power out}}{\text{Power in}} \times 100\%$$

ex) pg 156 # 4

An 8.5×10^2 kg elevator is pulled up at a constant velocity of 1.00 m/s by a 10.0 kW motor. Calculate efficiency.

ANS The amount of Power being put into the system = 10,000 W for every 1 second

How much Power are we getting by lifting 850 kg up @ 1 m/s for 1 sec?

$P_{out} = \frac{F \cdot d}{t}$ or $m \cdot g \bar{v} = (850)(9.8)(1)$
$= 8330 \text{ W}$

Efficiency $= \frac{P_{out}}{P_{in}} = \frac{8330\text{W}}{10{,}000\text{W}} \times 100\%$
$= 83.3\%$ efficient.

#1 pg 184 (W/B)

A 3.00×10^2 W electric motor lifts a 25.0kg object a height of 10.0m in 11.5s. Determine efficiency of the motor

$P_{in} = 300 \text{ W}$ $\quad P_{out}$ = Power gained by lifting the 25.0kg object

$P_{out} = \frac{W}{t} = \frac{F \cdot d}{t} = F \cdot \bar{v}_{avg} = mg\bar{v}_{avg}$
$= (25)(9.8)\left(\frac{10}{11.5}\right)$
$= 213 \text{ W}$

Efficiency $= \frac{P_{out}}{P_{in}} = \frac{213\text{ W}}{300\text{W}} = .71 \times 100 = 71\%$

W/B Pg 156 - 157 # 1-7 all (except 4 I've done it in an ex)

T/B pg 177 55, 57, 59