Checkup on Previous Learning

Mon May 13th / Tues May 14rd

Thermal Energy
Intro to Nuclear Energy

Today's Plan

Complete Nuclear Energy
Start Unit Review

Coming Up

Unit Test - Wed May 15th

Unit 3: Energy Work and Power

Work

Work is transfer of energy.

$W = \Delta E = F \Delta d$ (1)

units $N \cdot m = J$

ex: $\Delta E = E_{kf} - E_{ki}$

Mechanical Energy → energy of motion or position

Kinetic energy $E_k = \frac{1}{2} m v^2$ (2)

Potential energy (gravitational) $E_p = mgh$ (3)

units J

Power

rate of energy consumption or creation.

Power $P = \frac{\Delta E}{t}$ (4)

units $J/s = Watt$

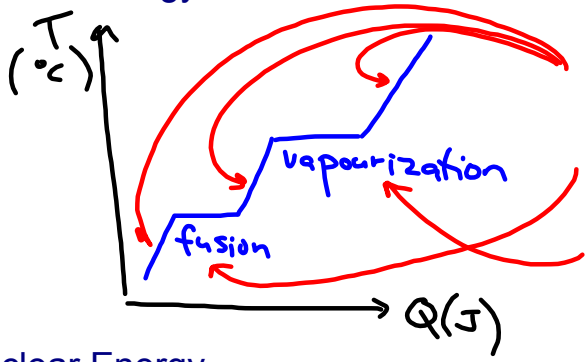
Efficiency

$Eff = \frac{E_{out}}{E_{in}} \times 100\%$ (5)

$= \frac{P_{out}}{P_{in}} \times 100\%$

units: → unitless

Thermal Energy



$Q = mc\Delta T$ (6)

$Q_f = mL_f$

$Q_v = mL_v$ (7)

Nuclear Energy

→ safety features of CANDU (heavy water, lead rods, gravity)

→ 3 types of radiation (alpha, beta, gamma)

→ pros & cons of nuclear.

Other stuff to know ☺....

Convert from kW·hr to J 1kWh = 3,600,000 J

Convert from g to kg 1000 g = 1 kg

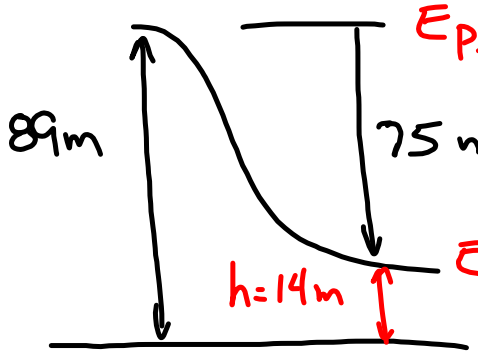
Freezing and Boiling Points of Water 0°C, 100°C ,
Density of water 1 litre/kg or 1 kg/litre

Units (MKS) metres, kg, secs (mks)

J, Cal, kWh - all units of energy !!!

Work and Mechanical Energy

Example : Calculate the energy required to lift a 505 kg roller coaster to the top of a 89m hill (assuming no friction). What would the kinetic energy be at the bottom of the first hill if the drop was 75m (again assuming no friction)?



$E_{P_{top}} = 440000J$ using $h = 89$

$E_{P_{bottom}} = 69000J$ using $h = 14m$

E_K = loss of E_P

$= 440000 - 69000J$

$= 370\,000J = E_K$

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

Power

Example : If it took 1.5 minutes to get to the top of the hill, what power was used to move the coaster to the top?

$P = \frac{\Delta E}{t} = \frac{440000J}{90s}$

$= 4900 Watts.$

$t = 1.5 mins \times 60$

$= 90s$

Efficiency

Example : If the actual energy used to get to the top of the hill was $5.0 \times 10^5 J$ (due to losses due to friction), calculate the efficiency of the coaster lift mechanism.

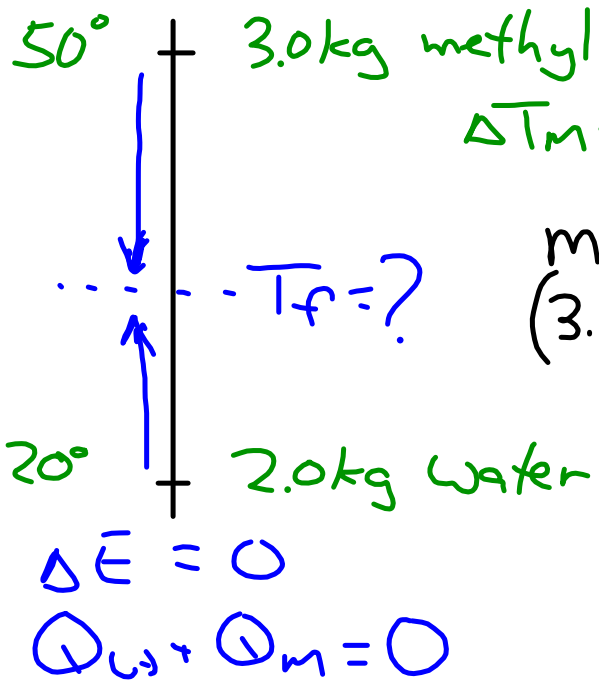
$Eff = \frac{E_{out}}{E_{in}} \times 100$

$= \frac{440000}{500000} \times 100$

$= 88\%$

Thermal Energy

Example : If 3.0 kg of methyl alcohol at 50°C is added to 2.0 kg of water at 20°C, what is the equilibrium temperature (methyl alcohol c=2,460 J/kg°C, water c=4,180 J/kg°C)? Which substance gained or lost the most energy?



$\Delta T_M = T_f - 50$, $\Delta T_w = T_f - 20$

$mc\Delta T + mc\Delta T = 0$

$(3.0)(2460)(T_f - 50) + (2.0)(4180)(T_f - 20) = 0$

$T_f = 34\,°C$

$\Delta E = 0$

$Q_w + Q_m = 0$

The amount of energy lost by the methyl alcohol equals the amount of energy gained by the water (120,000J).

Test Prep

handout #'s 1-13
text book pg 186 #4,8,9,11,12,18,25,27,28,29
plus review mechanical energy quiz, personal power project

1. You have a 0.500kg sample of Ice and Ethyl Alcohol, both at-10°C and you want to warm each of them up to 70°C. Determine which one takes more energy and by how much.

	H_20	Ethyl alcohol
Freezing Point (°C)	0	-114
Boiling Point (°C)	100	78.3
L_f - Latent Heat of Fusion (J/kg)	$3.34x10^5$	$1.04x10^5$
L_v - Latent Heat of Vaporization (J/kg)	$2.26x10^6$	$8.54x10^5$
c - Specific Heat Capacity (as a solid) (J/kg·°C)	2100	na
c - Specific Heat Capacity (as a liquid) (J/kg·°C)	4180	2,460
c - Specific Heat Capacity (as a gas) (J/kg·°C)	2100	na

2. A roller coaster is at the top of a 73m ramp when it starts to roll down the track (you can assume the initial velocity is zero). When it gets to the bottom, it is travelling at 35m/s.

a. Determine what speed it should have been travelling at if there were no losses due to friction.

b. What is the efficiency of the roller coaster in converting potential energy into useful kinetic energy?

c. Describe where the “lost” potential energy went and why this example does not violate the Law of Conservation of Energy.

#1.

	H_2O	Ethyl alcohol
Freezing Point (°C)	0	-114
Boiling Point (°C)	100	78.3
L_f - Latent Heat of Fusion (J/kg)	3.34×10^5	1.04×10^5
L_v - Latent Heat of Vaporization (J/kg)	2.26×10^6	8.54×10^5
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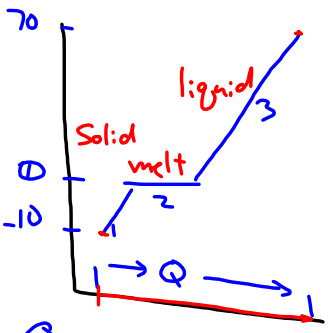
1. You have a 0.500kg sample of Ice and Ethyl Alcohol, both at -10°C and you want to warm each of them up to 70°C. Determine which one takes more energy and by how much.

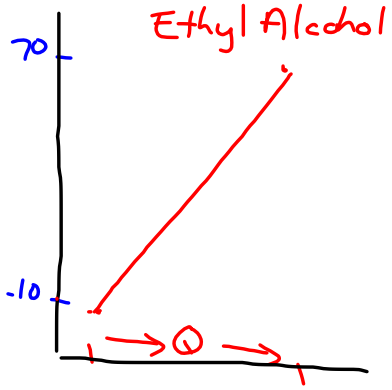
ICE → WATER



$Q = mc\Delta T + mL_f + mc\Delta T$

$= (0.5)(2100)(10) + (0.5)(3.34 \times 10^5) + (0.5)(4180)(70)$

$= 324000\,J$



$Q = mc\Delta T$

$= (0.5)(2460)(80)$

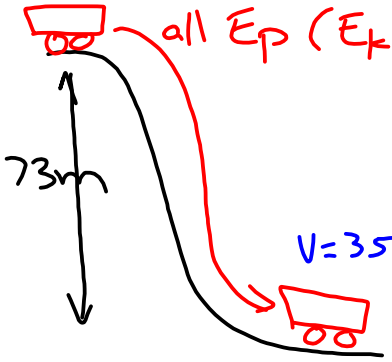
$= 98400\,J$

2. A roller coaster is at the top of a 73m ramp when it starts to roll down the track (you can assume the initial velocity is zero). When it gets to the bottom, it is travelling at 35m/s.

a. Determine what speed it should have been travelling at if there were no losses due to friction.

b. What is the efficiency of the roller coaster in converting potential energy into useful kinetic energy?

c. Describe where the "lost" potential energy went and why this example does not violate the Law of Conservation of Energy.



no losses $E_{p\,top} = E_{k\,bot}$

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

max velocity formula

$V = \sqrt{2gh}$

a. $V = \sqrt{2 \times 9.8 \times 73}$

$= 37.8$ m/s.

b. $eff = \frac{E_{out}}{E_{in}} \times 100$ $E_{in} = E_p$ $E_{out} = E_k$

$= \frac{E_{k\,bot}}{E_{p\,top}} \times 100$

$= \frac{\frac{1}{2}mv^2}{mgh} \times 100$

$= \frac{\frac{1}{2}(35)^2}{9.8 \times 73} \times 100$ 0.86

$= 86\%$

c. lost to heat, sound etc.