"A" students work (without solutions manual)
~ 10 problems/night.

Alanah Fitch
Flanner Hall 402
508-3119
afitch@luc.edu

Office Hours W – F 2-3 pm

FITCH Rules

General

G1: Suzuki is Success
G2. Slow me down
G3. Scientific Knowledge is Referential
G4. Watch out for Red Herrings
G5. Chemists are Lazy

Chemistry

C1. It's all about charge
C2. Everybody wants to "be like Mike"
C3. Size Matters
C4. Still Waters Run Deep
C5. Alpha Dogs eat first

$$E_{el} = k\left(\frac{q_1 q_2}{r_1 + r_2}\right)$$

Properties and Measurements

Property	Unit	Reference State
Size	m	size of earth
Volume	cm^3	m
Weight	gram	mass of 1 cm^3 water at specified Temp (and Pressure)
Temperature	^oC, K	boiling, freezing of water (specified Pressure)
$1.66053873x10^{-24}g$	amu	(mass of 1C-12 atom)/12
quantity mole		atomic mass of an element in grams
Pressure	atm, mm Hg	earth's atmosphere at sea level

$$P = \frac{F}{A} = \frac{ma}{A} = \frac{\frac{kg \cdot m}{s^2}}{m^2} = \frac{kg}{ms^2}$$

Energy, General **Animal** **ft –lb of force**

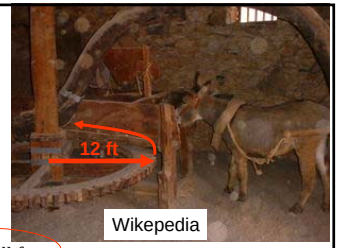
Energy: capacity to do work $w = (F)d$

Work = Force x distance

energy

$$Power = \frac{work}{time} = \frac{force\ distance}{time}$$

$$d = (2\pi 12\ ft)$$



$$1hp = (180lbs)\left(\frac{2.4}{minutes}\right)(2\pi 12\ ft) = \frac{32{,}572\ ft\ lbforce}{min}$$

$$\left[\frac{32{,}572\ ft\ lbforce}{min}\right]\left(\frac{min}{60s}\right) = \frac{542.8667\ fl\ lbf}{s}$$

$$\left[\frac{542.8667\ ft\ lbforce}{s}\right]\left(\frac{0.3048m}{1\ ft}\right)\left(\frac{4.44822\ N}{lbf}\right) = 745.699\frac{N\ m}{s} = 745.699\frac{J}{s}$$

	hp
average horse peak	14.9
average horse average	<1 hp

R.D. Stevenson and R. J. Wasserzug
Nature, 364, 195-195, Jul 1993

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Energy, General

Animal	**hp**	**horse on tread mill**
Heat	**BTU**	**lb water °F**
	Gram Calorie	**g water °C**

British Thermal Unit (>1700 AD) Energy required to raise one lb of water at it's maximum density (39.1 °F) 1 °F

Energy to raise 1 g of water by 1 °C

Unlikely you will ever need most of these,
But just in case……..

Conversion units

$$542.8667\ ft\ lbforce = 745.699\ J$$

$$1BTU = 1055.056\ J$$

$$1cal = 4.184\ J$$

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Energy, General

Animal	**hp**	**horse on tread mill**
heat	**BTU**	**1 lb water 1 oF**
	calorie	**1 g water 1 oC**
Kinetic		

Kinetic energy

Means "defined as"

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

$$1\frac{kg - m^2}{s^2} \equiv 1J_{oule}$$

2 kg mass moving at 1 m/s

$$E_k = \frac{1}{2}(2kg)\left(\frac{1m}{s}\right)^2$$

$$E_k = 1\frac{kg - m^2}{s^2}$$

James Joule (1818-1889)

English
Physicist who related
Heat energy to animal work
(to sell steam engines)

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Energy, General

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	calorie	**1 g water 1 oC**
Kinetic	**J**	**m, kg, s**
Electrostatic		

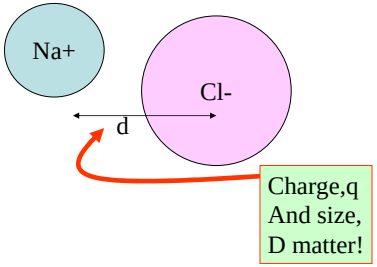
Chemistry Rule #1 = it's all about Charge and How To Balance Positive and Negative Charge

J =Work required to move one electric charge of one coulomb through an Electric potential difference of 1 V

$$J = VC$$

$$E_{el} = \left(\frac{kQ_1}{d}\right)Q_2$$

Electric potential, V, Exerted by Q_1 over distance d on the charge Q_2 of object 2



$$k = \frac{8.99x10^9\ J - m}{\left(C_{oulomb}\right)^2}$$

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Kinetic	**J**	**m, kg, s**
Electrostatic		**1 electrical charge against 1 V**

Energy of electronic states in atom

Reference state?

Some constant, k*

$$E_{el} = \left(\frac{k * Q_{proton}}{d}\right)Q_{electron}$$

Electric field Generated by nucleus (+ coulombs)

Electron (-coulombs)

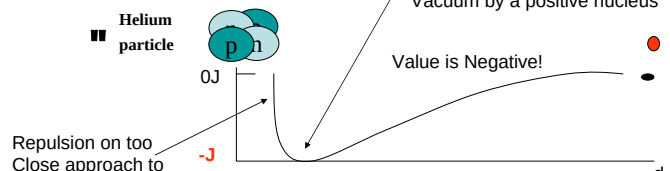
Reference State?

Electron in a vacuum
Experiences no force and hence
No energy = E = 0

$$E_{el} = (+)(-) = -$$

Energy will be negative value.

Energy state of electron
At "rest" captured from
Vacuum by a positive nucleus



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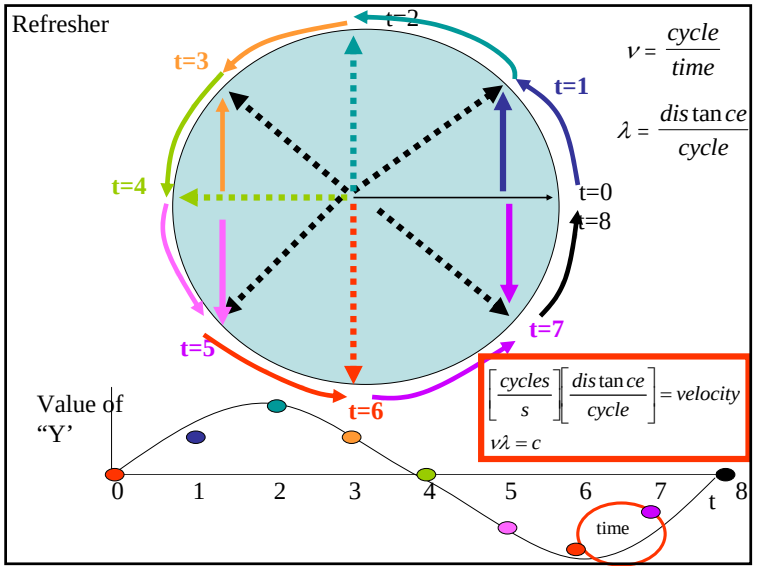
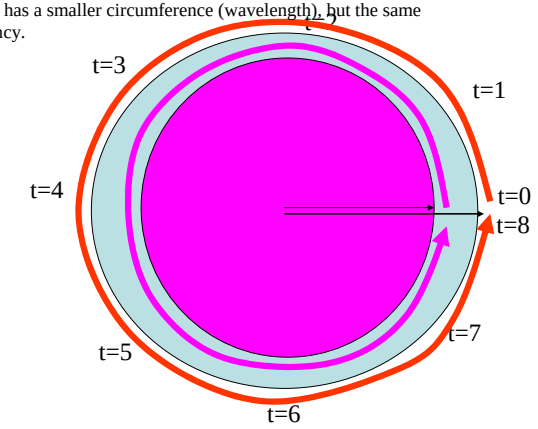
Energy, General

Animal heat	**hp**	**horse on tread mill**
	BTU	**1 lb water 1 oF**
	calorie	**1 g water 1 oC**
Kinetic	**J**	**m, kg, s**
Electrostatic		**1 electrical charge against 1 V**
electronic states in atom		**Energy of electron in vacuum**

What tool will we use to **measure** the energy of the electron? Light



A particle traveling the circumference of the smaller purple circle in Sync with one traveling the circumference of the red circle moves Slower, has a smaller circumference (wavelength), but the same Frequency.



The frequency is the "constant" associated with the photon because The wavelength changes with the medium (water, air).

Max Planck
1858-1947
German physicist

Measurement Tool – wavelength of light (light emitted, absorbed)

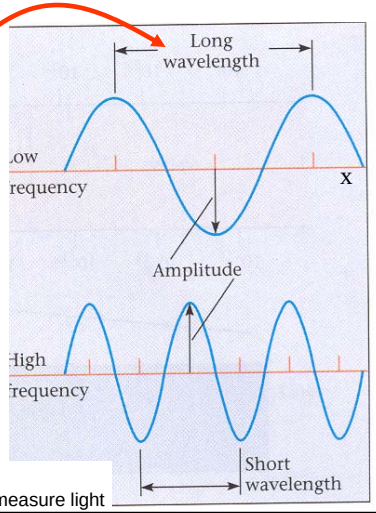
$$E = h\nu = \frac{hc}{\lambda}$$

frequency

$$h = 6.626x10^{-34}\ J \cdot s$$

Planck's constant

$$c = 2.998x10^{8}\ \frac{m}{s}$$



Energy ~ **color of light**
~ wavelength of light

Our predecessors
Could only describe not measure light

The g[illegible]t associated with the aur[illegible]realis is emitted by excited (high energy) oxy[illegible]ms at a wavelength of 557.7 nm.

What is the frequency of this light?
What is the energy, in joules, of a single photon emitted by an excited oxygen atom?
What is the energy, in kilojoules, of a mole of such photons.

$E = h\nu$

$h = 6.626x10^{-34}\ J \cdot s$

$c = 2.998x10^{8}\ \frac{m}{s}$

$\left[units\right]\left[\frac{1mole}{6.022x10^{23}\ units}\right] = moles$

557.7 nm wavelength

Frequency =?
Energy/photon
Energy/mole

$\nu\lambda = c$

$\nu = \left(\frac{\left[2.998x10^{8}\ \frac{m}{s}\right]}{557.7nm}\right)\left[10^{9}\ \frac{nm}{m}\right] = \frac{5.376x10^{14}}{s} = 5.376x10^{14}\ Hz$

$Hz = 1 cycle\ per\ second$

Heinrich R. Hertz, 1857-1894
German physicist

The g[illegible]t associated with the aur[illegible]realis is emitted by excited (high energy) oxy[illegible]m at a wavelength of 557.7 nm.

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$\lambda = 557.7nm$

$\nu = 5.376x10^{14}\ Hz$

$E = 3.55617x10^{-19}\ J$

$h = 6.626x10^{-34}\ J \cdot s$

$\left[units\right]\left[\frac{1mole}{6.022x10^{23}\ units}\right] = moles$

$E = h\nu$

$E = \left[6.626x10^{-34}\ J \cdot s\right]\left[5.376x10^{14}\ \frac{1}{s}\right]$

$\frac{3.55617x10^{-19}\ J}{Photon}\left[\frac{kJ}{10^{3}\ J}\right]\left[\frac{6.022x10^{23}\ photons}{mol}\right] = 2.1415x10^{2}\ \frac{kJ}{mol}$

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