1 relating E, ΔG and K

Plug and chug

$$-nFE = \Delta G = -RT \ln K$$

most likely E related to ΔG + K

important to notice the comparitive value of E, ΔG, K

might you need to work from ½ rxn values to get your value of G or K? yes

E	ΔG	K
−3 to +3 V	1000 kJ/mol to −1000 kJ/mol	10^{-80} to 10^{+80}

2 stoichiometry calculation from charge or current

Stoichiometry relates through a balanced chemical rxn

amounts of material in mass or charge

through

a stoichiometric relationship in a balanced eqn.

to

the amount of material in mass or charge

- remember the F!!
- Remember that $i = \frac{C}{s}$

3 calculating cell potentials – mostly certainly a Nernst Eqn calculation

$$E_{cell} = E^\circ_{cell} - \frac{.059}{n} \log Q$$

E°_{cell} comes from $E^\circ_{cath} - E^\circ_{anode}$ from ½ rxn tables

The values for n and Q come from a balanced chemical reaction. I'll likely tell you n if it isn't really obvious,

$Cu|Cu^{++}(0.2)||Ag^{+}_{(1M)}|Ag$

but

- be able to turn a shorthand cell description into a Q value
- make sure you remember those experts in Q

4 famous batteries.

It would be a good idea to have a familiarity with the following batteries including applications/advantages/reactions

non-rechargeable primary	rechargeable secondary
Alkaline	lead acid
Zn-air	NiMH

I don't expect you to memorize the cell reactions, but you should have a general idea what the major components are

5. assigning rate expressions – A classic kinetics problems problem. Neal made you do 72 of these on WS 11. I give you a chemical reaction and a rate for one of the species, you be able to explain rate for all of them.

$2A \rightarrow 3C$ and rate = 12 $\frac{\text{footballs}}{\text{hr}}$

what is the rate for A? well A is 2/3 as fast as C and is disappearing, so

rate for A is $-\frac{2}{3}(12) = -8 \frac{\text{footballs}}{\text{hr}}$.

6. relating reaction order to rate ~~constant~~.

Use the units of a given rate constant to tell me the order of a reaction

I will give you a rate law and ask you to tell me the rate after you stick all the numbers in. ~~Order, rate~~.

Example. If I tell you a rxn is first order in A and I have 2M A w/ a rate constant of $1 \times 10^{-2}\ sec^{-1}$, what is the rate? rate $= k[A] = (1 \times 10^{-2} sec^{-1})2M$

7. units of rate constants to predict order

I will give you a rate constant with units. you tell me the reaction order by canceling units. Example.

$k = 1 \times 10^{-2}$ sec.

$\text{rate} = k[A]^?$

$\frac{M}{\text{sec}} = (1 \times 10^{-2}\,\text{sec}^{-1})[A]^{?}$ ← 1 to make units cancel.

Hint, I am so tired of rxn orders = to 0, 1, 2.

Example $k = 1 \times 10^{-2}\,M^{-2}\text{sec}^{-1}$

The rate $M\,\text{sec}^{-1} = (1 \times 10^{-2}\,M^{-2}\text{sec}^{-1})[M]^3$

k so order = 3

8. method of initial rates

look for a big array filled with concentration for a particular rate. I will make this easy by holding everything constant that needs to be held constant.

A	B	C	rate
.1	.1	.1	1×10^{-2}
.1	.1	.2	2×10^{-2}
.1	.2	.1	4×10^{-2}
.2	.1	.1	8×10^{-2}

- you need to back substitute to find k.
- tricky, tricky, if a rxn is 0th order, you don't need to hold it's [ ] values constant.

C is first order B = 2nd order A = 3rd order.

9. integrated rate law calculation This is a how much kind of calculation from order 0, 1 or 2

Given

$R = R_0 - rkt$ (0th) $\quad \frac{1}{R} = \frac{1}{R_0} + rkt$ (2nd) $\quad \ln R = \ln R_0 - rkt$ (1st.)

I give you the values for all but one of

$R \equiv$ amt left
$R_0 \equiv$ starting amount
$r \equiv$ coeff of rxn
$k \equiv$ rate constant
$t \equiv$ time of reaction

} solve for one of these.

use the rate constant to tell you which reaction to use.

10. integrated rate law calculation

I feel like making this a ½ life calculation that doesn't require a calculation.

For example. I have a 1000 baseballs. The first order ½ life for these puppies is 2 years. How many baseballs do I have after 8 years?

1000 balls $\xrightarrow[1\text{ ½ life}]{2\text{ years}}$ 500 balls $\xrightarrow[2\text{ ½ lives}]{2\text{ years}}$ 250 balls $\xrightarrow{2\text{ years}}$ 125 balls $\xrightarrow{2\text{ years}}$ 62.5 balls

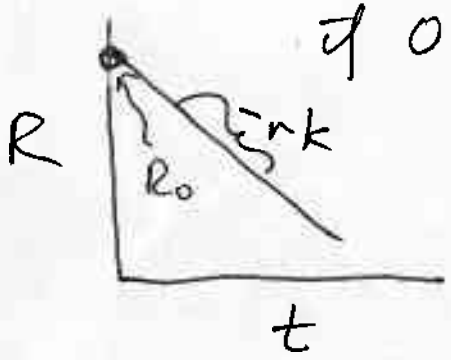
Hint: Common sense.

Hint: It will be a first order process

11. extracting information from straight line plots

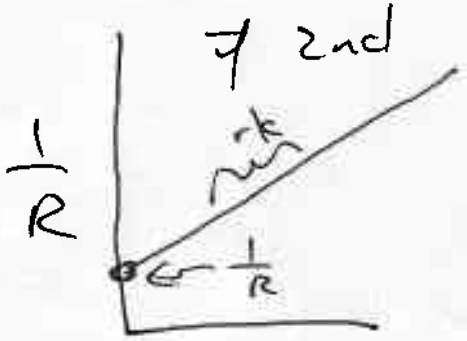
note that each integrated rate law was of the form of a straight line

$R = R_0 - rkt$ if 0th



$\ln R = \ln R_0 - rkt$ if 1st

$\frac{1}{R} = \frac{1}{R_0} + rkt$ if 2nd



H.W. I will give you a straight line plot and tell you the order. you extract the R_0 and k from it.

12. kinetic theory—collision

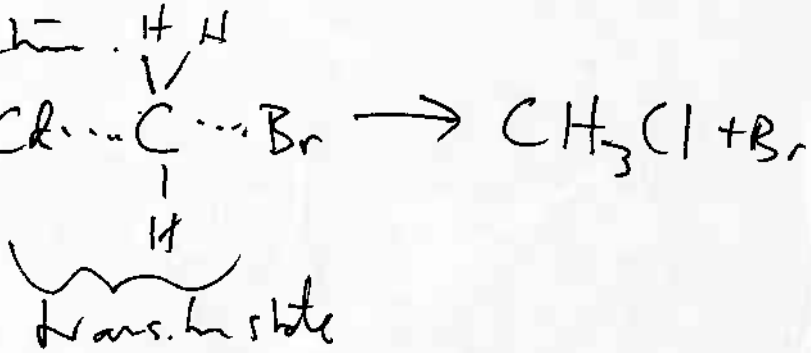
This is pretty simple because otherwise it is really hard if I add math.

- rxns occur because things bump into each other. no collision no rxn. So the higher the concentration, the faster the reaction.
- Even if a collision happens, if the orientation isn't good, the collision is ineffective. You need to add energy to make it effective.

13 kinetic theory—transition state

This theory says that when a collision happens there is an instant where a transition state exists

Consider an organic addition reaction.



the transition state is at the top of an activation energy hill and you need to either lower Ea or increase T to get to the transition state.

14. combined Arrhenius calculation

Plug + chug that lets you determine either Ea or A from two k, T data points.

$$\ln \frac{k_2}{k_1} = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

I will give a k_1 and T_1 and a k_2 and T_2 and you give me E_a

Hint. This is easy. Just make your units cancel and practice doing the algebra correctly.

15. reaction mechanisms I will ask you to find the rate law from a simple series of multistep reactions. To do this this, identify the r.d.s. and combine all the cmpds produced before the r.d.s. to obtain the rate law.

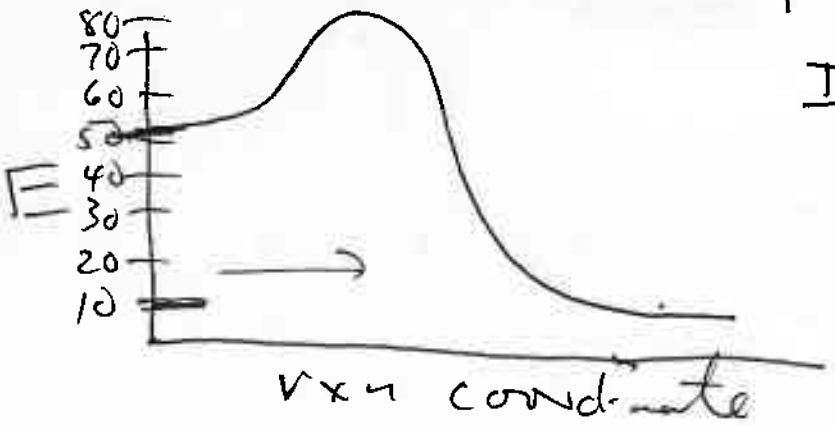
$NO_2 + CO_2 \rightleftharpoons NO_3 + CO$ thermodynamic result

comes from

$NO_2 + NO_2 \rightarrow NO_3 + NO$ ← slow so rate = $k[NO_2]^2$

$NO + CO_2 \rightarrow NO_2 + CO$ ← fast

16. E_a and potential energy ~~surfaces~~ plot



I can ask what is

ΔH for exothermic −40kJ

ΔH for endothermic +40kJ

E_a for exothermic 30kJ

E_a for endothermic 70kJ

17. famous catalysts I will discuss this on Tuesday.
But for sure understand the catalytic converter found in automobiles and the catalytic process involving the Haber cycle. Also be familiar with the famous enzymatic processes used industrially. There isn't a lot of detail to memorize for the enzymes. Just associate an enzymatic process with a product like

papain ≡ meat tenderizer
trypsin ≡ baby food digestion

18. properties and reactivity of alkali metals

Know the general characteristics of the metals including strong reducing capability, activity in water, general reactivity with everything except noble gases, and basicity of hydrides and oxides.

Also know their utility:
as food additives
role in neurological + metabolic processes

} don't need to know anything beyond these statements.

19. properties and reactivity of alkali earths

Know the general reactivity of the metals, the basicity of the oxides, displacement in hot water.

Important applications include presence in minerals, the use of Ca^{++} in structural materials, the fascinating story of tooth decay + fluorine, and the fact that Austin is built on $CaCO_3$. Also Mg is important because it is found in chlorophyll.

20. properties and reactivity of the B family

Know the B and Al cannot form more than 3 bonds, that B is nonmetal that does strange things to satisfy octet, the Al is abundant as earth as metal and oxide.

Applications: We start seeing a lot of gemstones made with alumina. The use of Hall process to produce Al from cryolite is important. Al is important as a light, nonreactive metal. Alumina is used in papermaking as the sulfate.

BN is a hexagonal material like graphite with many possible applications

21. properties and reactivity of the N family

Know N and P. Understand N_2 fixing. Know the Haber process and its starting materials well. Know where phosphates come from and how H_2SO_4 is used with them. Understand how NH_3 is converted to HNO_3. Know the coal stories of NO_x and also bomb making.

Know why phosphates matter.

22. properties and reactivity of the C family

C forms 3 allotropes - diamond, graphite and C_{60}. Know them, their structures, and applications. Know a bit of the history and potential of C_{60}.

Understand Si as second most prevalent of elements in earth crust. Know the famous materials: the gems, the silicates and aluminosilicates, the formation of glass and ceramics. Know the silicone story, and use with alkyl groups to make waterproofing.

23. properties and reactivity of the O family

Know why O_2 is so important. Understand where S comes from and how S is made and then goes on to form H_2SO_4.

Know the important reactions of H_2SO_4 as an oxidizer, acid and dehydrator. This means knowing the important industrial reactions that make it the #1 chemical produced.

24. properties and reactivity of the halogen family

Know the general reactivity of the halogens and the periodic trends that drive this reactivity.

Understand why F makes fundamentally different compound than the other halogens and why its reactivity is so special.

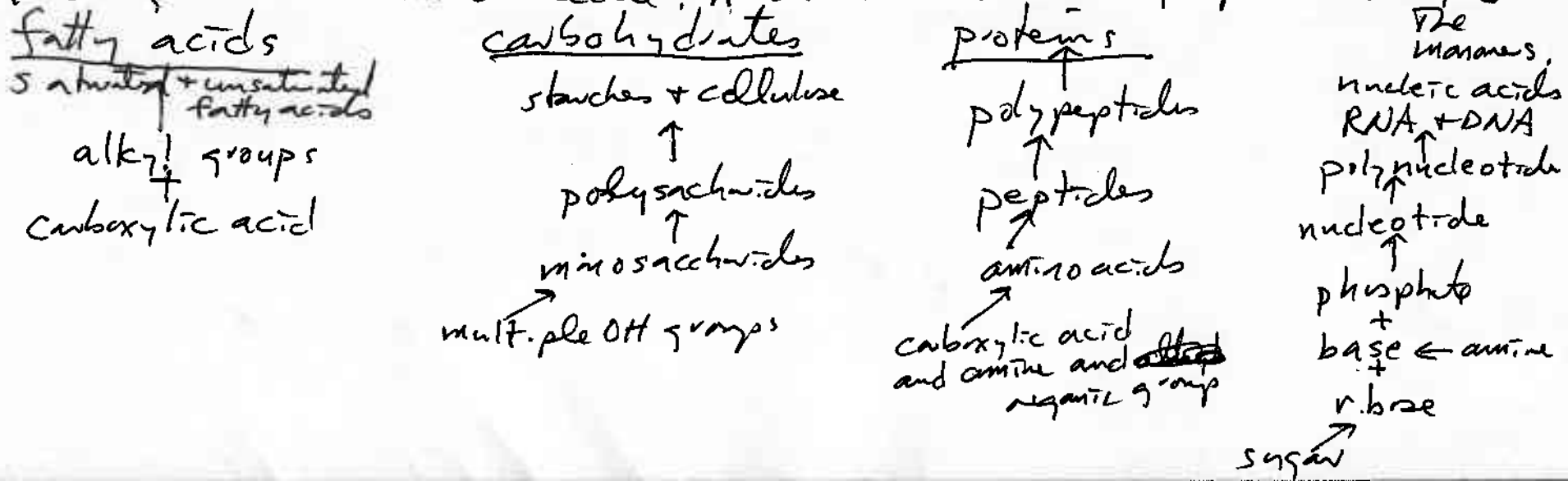
Be able to explain why Cl_2 is used as a precursor in so many chemical reactions to produce products we use in our daily lives.

25. famous polymers

From the lecture notes on organic polymers, be able to identify the monomer and understand the polymer that it produces. Be able to do this for nylon, polyethylene, polystyrene and teflon as representative examples. Also know how these specific polymers are used in our daily lives.

26. how to build a biomolecule

For the four classes of biopolymers, know the building blocks leading to the macromolecule. Also know the functional groups that define the monomers.



27. hydrocarbon nomenclature

Understand the general structure of organic compound naming

substituent root functional group

for each of these, be able to identify the ● phrase that defines it. Like

5 C ●root means penta

3 C substituent means propyl

28. hydrocarbon reactivity

Be able to identify addition, substitution + elimination reactions

$AB\,C \longrightarrow AB + C$ elimination

$AB + C \longrightarrow AC + B$ substitution

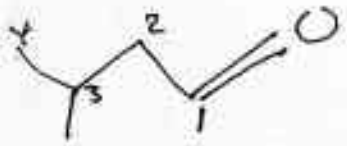
$AB + C \longrightarrow ABC$ addition

when looking at any organic reaction.

29. organic functional group nomenclature

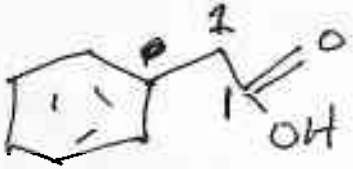
Be able to tell me the name of an organic molecule from its structure

Example



≡ 3-methyl-1-butanal

or



given this

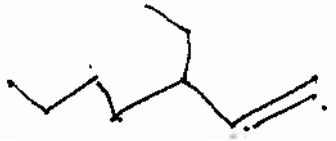
≡ phenylethanoic acid

tell me this

30. organic functional group nomenclature

Be able to tell me the structure of an organic molecule

methyl propyl ether ≡ 

3-ethyl-1-heptene ≡ 

given this

tell me this