Question Types for Kinetics

1. assigning rate expressions

Easy: $aA \rightleftharpoons bB$

$$\frac{\pm \Delta A}{a\,\Delta t} = \frac{\pm \Delta B}{b\,\Delta t} \quad \ldots\ldots$$

conventionally,
+ ≡ products
− ≡ reactants

and a, b, c ... are the coefficients of balanced reaction.

2. relating reaction order to rate

A variation on rate law. I give you a rate law and you compare concentration changes as a function of order.

$$\text{rate} = k[A]^x[B]^y$$

really really easy — you simply need to understand how x and y impact rate.

example, if x = second order and A triples, then rate increases 9-fold.

3. units of rate constants — knowing this is essential to performing questions on integrated rate law calculations (#5 & 6 on exam).

Example for first order

rate = $k[A]^1$ since rate $\frac{M}{s}$

$[A]^1 = M$

you can cancel units

$\frac{M}{s} = k\,M$

$k = sec^{-1}$

will need to be able to perform this cancellation

sticky know your stuff

4. method of initial rates — pretty medium — straight ahead array from which rate law is determined

A	B	rate
.1	.1	1
.2	.1	4
.1	.2	1

$\therefore$ since $\left(\frac{.2}{.1}\right)^x = \frac{4}{1}$ $x = 2$ for A

$\left(\frac{.2}{.1}\right)^y = \frac{1}{1}$ $y = 0$ for B

* need to back substitute to find k.

example $1 = k(.1)^2(.1)^0$ $\therefore k = 100$

overall = rate $= 100[A]^2[B]^0$

5. integrated rate law calculation +6

medium

How much determined for

order	
∅	$A = A_0 - akt$
1	$\ln A = \ln A_0 - akt$
2	$\frac{1}{A} = \frac{1}{A_0} + akt$

* hint, you will need to know units of k to determine which eqn to use *

* hint remember a, it is slowing in the face in the balanced reaction *

~~6.~~ integrated rate law calculation

hint * there will be 2 different orders in 5+6 *

otherwise this is pretty plug + chug

hint .. reacted til 75% remained" means stick $A = .75 + A_0 = 1$ into equation

7. extracting information from straight line plots

$$A = A_0 - akt$$

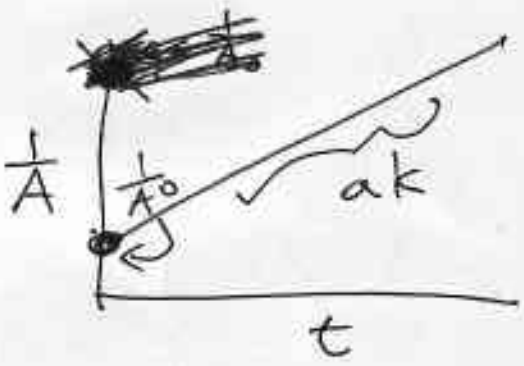
$$\ln A = \ln A_0 - akt$$

$$\frac{1}{A} = \frac{1}{A_0} + akt$$

$\frac{1}{A}$: y $\frac{1}{A_0}$: y intercept ak: slope t: x

I will want you to be able to make this into a graph and pull info out of it

example

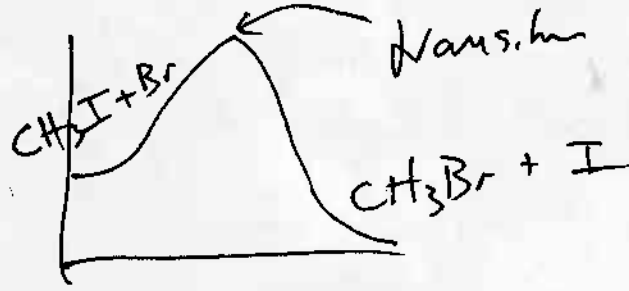


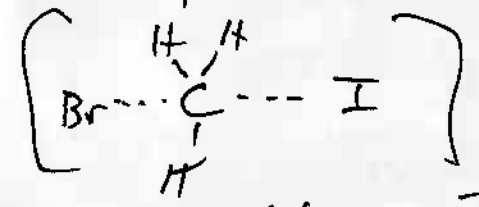
8. kinetic theory—collision

know some basic ideas

- collisions must happen
- orientation must be correct
- catalysts lower E_a by increasing orientation likelihood at collision & there are the ones with enough energy
- you need a minimum energy over activation energy

9 kinetic theory—transition state There is an instant when a transition state occurs at top of activation energy hill. This is where energy put into the system allows bond breaking + forming to make transition state





med.

you add a catalyst to lower the E_a catalyst is not consumed and has no effect on thermodynamics of rxn.

10. factors effecting rate really easy in rate law

$$\text{rate} = k[B]^x = \overbrace{A \exp^{-E_a/RT}}^{k} [B]^x$$

Factors effecting rate:
1. concentration ← function of reaction order
2. A preexponential factor ← linear
3. T
4. activation energy } vary exponentially

11 combined Arrhenius calculation classic plug + chug

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

medium. make you with cancel, T → Kelvin
Ea + R as Joules

This is like all the examples. Know your calculator + it is easy

12. reaction mechanisms I will give a multi. step medium reaction mechanism. you will need to relate it to a rate law. Requires you know the rate determining step.

$NO_2 + NO_2 \rightleftharpoons NO_3 + NO$ slow

$NO_3 + CO \rightleftharpoons NO_2 + CO_2$ fast

$NO_2 + CO \rightleftharpoons NO + CO_2$ overall

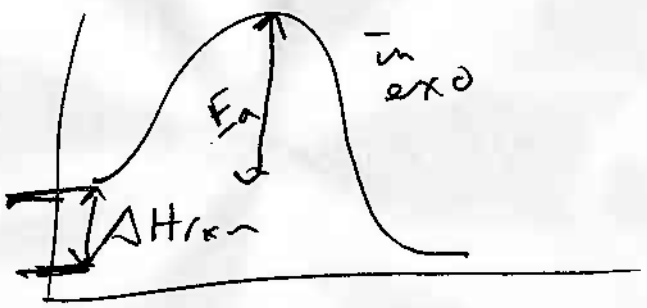
remember to only use the compds before the slow step.

rate $= k[NO_2]^2$

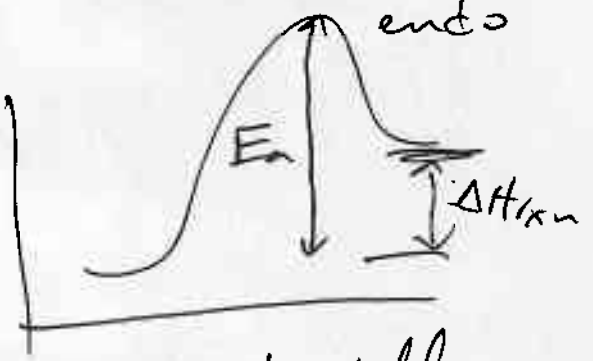
note that NO_3 is an intermediate

13. E_a and potential energy surfaces simple math problem.

easy if you keep your signs collect



or



hint. I won't give you a picture, I will tell you words. (sigh)

"If ΔH for exo is -100 kJ and Ea is 200 for the endo rxn, what is Ea for Exothermic?" Answer +100 kJ

14. famous catalysts

easy Ozone recall that $O\cdot$ is catalyst in overall reaction

$$O_3 + O\cdot \rightarrow 2O_2$$

catalytic converter recall that bad things are eliminated

nitrogen oxides reduced $\rightarrow NO_x \rightarrow N_2$

CO oxidized $\rightarrow CO \rightarrow CO_2$

incomplete combustion oxidize $\rightarrow CH \rightarrow CO_2$

} using metals like Pd, Pt

Survey of Chapters 14-16 and 18, 19

15. properties and reactivity of hydrogen

H_2 is the fuel of the future

- Its ΔH is really large per mole mass
- really efficient storage (density as a liquid)
- $H_2 \rightarrow H_2O$
- cool demos

Hint
tell me everything you can about H_2 gas
its reactivity,
its properties
its structure

16. properties and reactivity of alkali metals

all alk metals — explosive

- are explosive in H_2O //

$$Na + H_2O \rightarrow Na^+ + H_2 + OH^-$$

- form +1 oxidation states
- metals
- form basic hydrides + basic oxides

17. properties and reactivity of alkali earths

Be is only covalent one (emerald)
Mg is in chlorophyll
Ca is structural backbone (a pun) cement, teeth, bones

properties
- explosive (actually they fizz) in hot water
- +2 ions (higher charge density and ∴ stronger building blocks)
- basic hydrides + oxides ($CaO \rightarrow Ca(OH)_2$ soited CCC)

18. properties and reactivity of the B family

B makes cool compounds like borax (soap) and boric acid (kills things)

Al is a metal (lightest and less resistant to oxidation)
↳ know the Hall process for making Al electrochemically.

19. properties and reactivity of the C family

C makes bio stuff but also

- C allotropes
  - graphite sp^2
  - diamond sp^3
  - fullerenes C_{60} balls + tubes
- carbonates which love to create the world's cement

Si most common element that doesn't fly around
present in sand → glass and lots of cheap knock off gems
oh, and semiconductors.

20. properties and reactivity of the N family on Tuesday

N + P are the sources of plant food

N $\quad N^{-3}H_3 \rightarrow N^{+5}O_3^-$

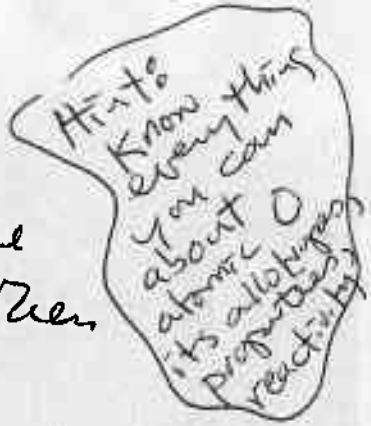
8 e^- change in species

most important is NH_3 so I will teach

- Haber process
- N_2 fixation
- HNO_3 as an oxidizing agent

P → phosphates which are good for plants
Also are found in detergents, fertilizers, matches, pesticides.

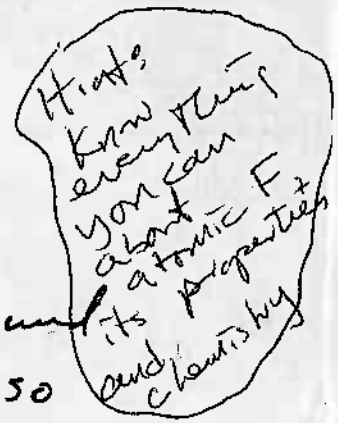
21. properties and reactivity of the O family



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.

22. 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 compounds 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.

23. famous manufacturing processes

Be able to identify the name of a manufacturing process and what is produced

Hall → Al metal
Haber → NH_3
Claus → elemental S
Ostwald → $NH_3 \rightarrow HNO_3$
Bayer → alumina (Al_2O_3)
contact → H_2SO_4

24. famous gems

Be able to relate famous gems to their oxides

emerald → beryllium oxide
ruby → aluminum oxide
sapphire → aluminum oxide
topaz → aluminum oxide
agate → silicon oxide
amethyst → silicon oxide
onyx → silicon oxide
asbestos → silicon oxide

25. hydrocarbon nomenclature you will need to be able to name a compound containing only C + H
If could include $-$ $=$ $\equiv$ 

Example 

2-methyl pentane

1, 3 pentadiene

26. organic functional group nomenclature

know your functional groups

$-OH$ alcohol

$C=O$ (H) aldehyde

$C-\overset{O}{\overset{\|}{C}}-C$ ketone

$C-\overset{O}{\overset{\|}{C}}-OH$ acid

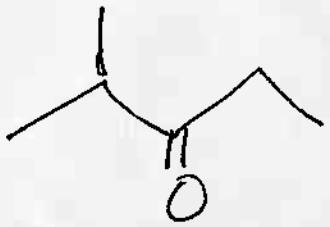
$C-\overset{O}{\overset{\|}{C}}-O-C$ ester*

$C-O-C$ ether*

$C-NH_2$ amine

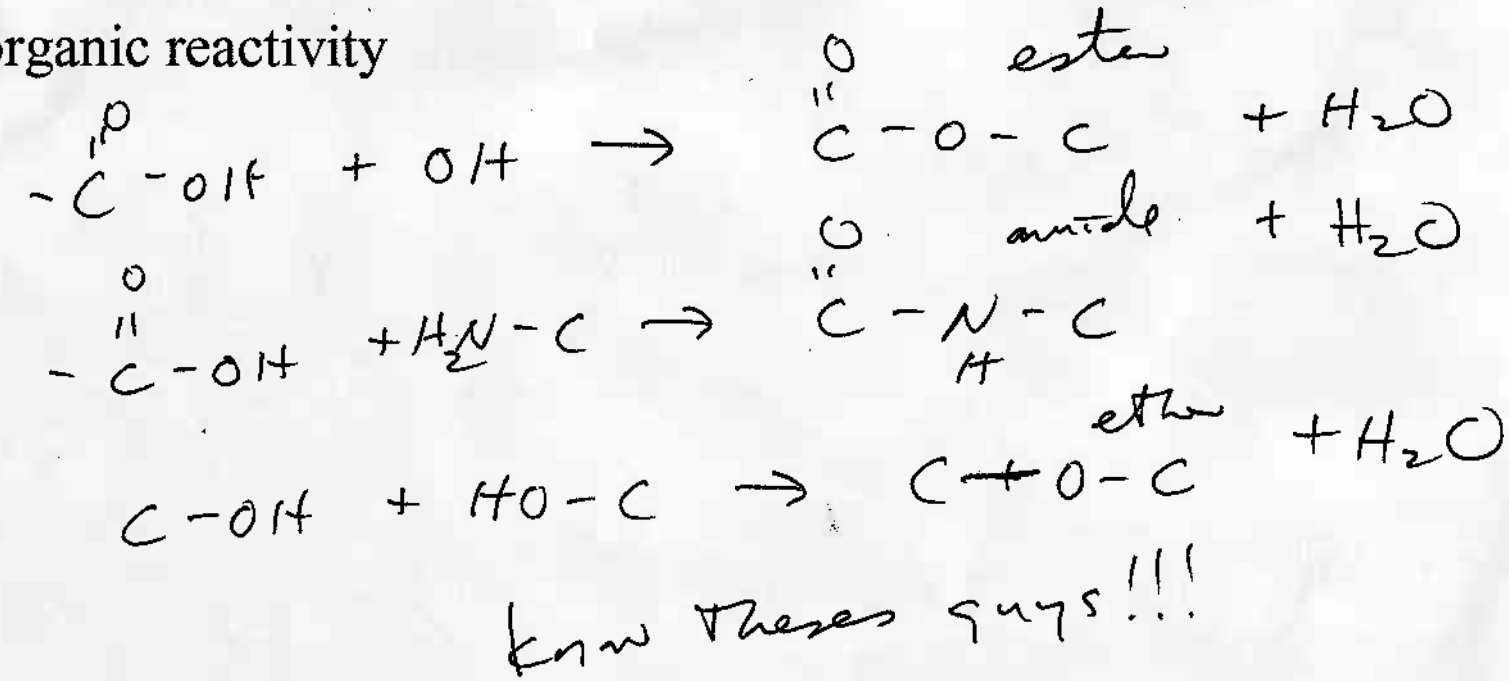
$C-\overset{O}{\overset{\|}{C}}-N-C$ amide*

* for sure in biopolymers reactions

Example 

2-methyl-3 pentanone

27. organic reactivity

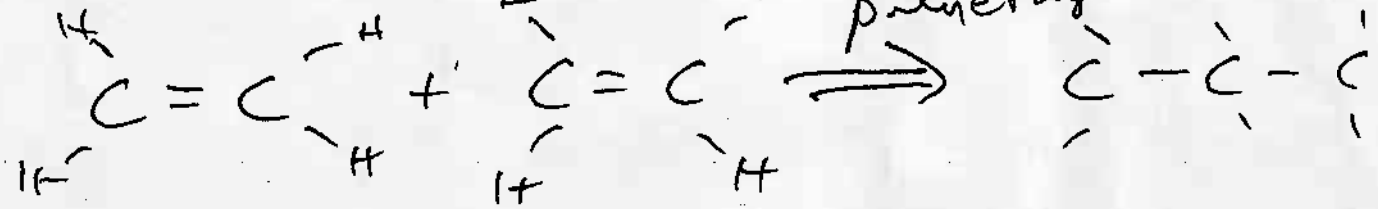


know these guys!!!

28. organic polymer nomenclature and function

2 kinds of reaction

addition



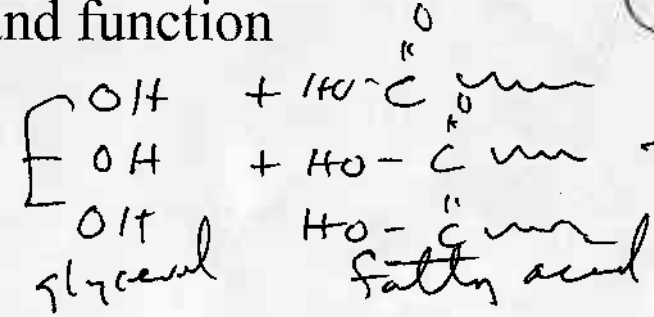
polymers will be from these types

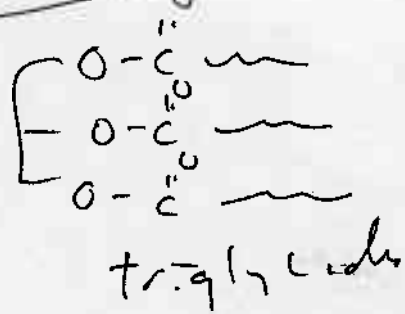
condensation reaction like 27 above to form nylon + biopolymers

29. biopolymer nomenclature and function

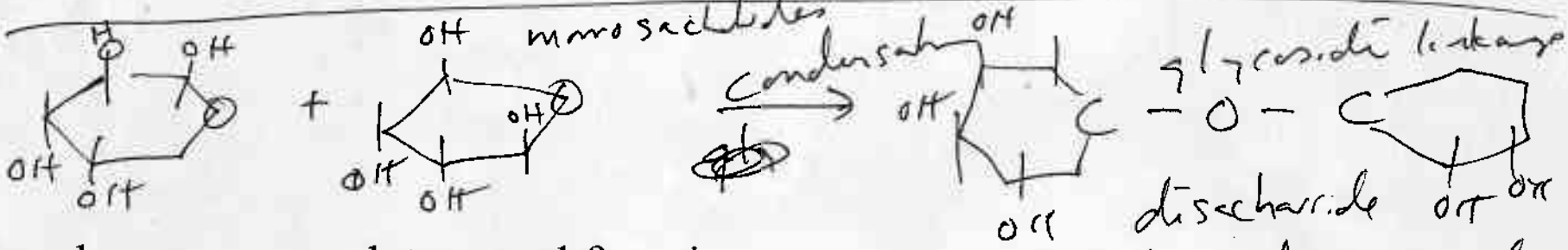
(satd vs unsatd)

fatty acids
know the nomenclature





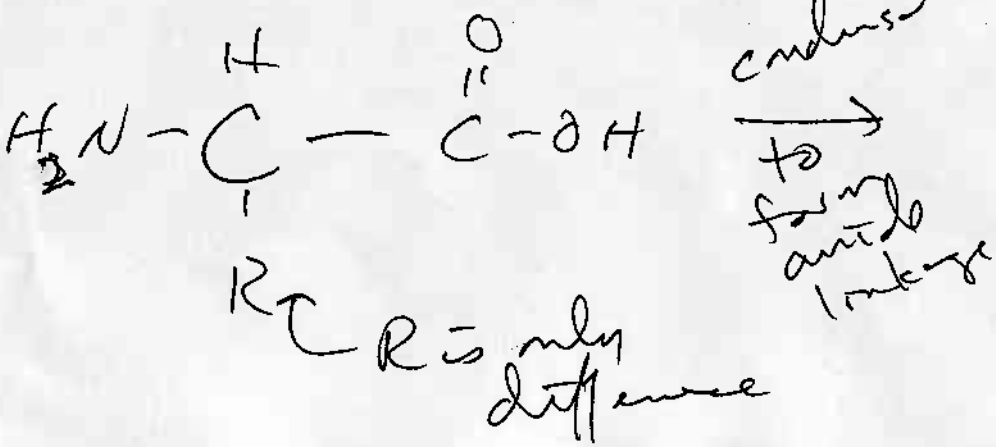
triglyceride

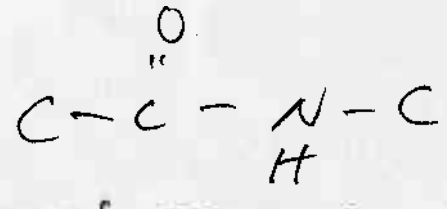


30. biopolymer nomenclature and function

↳ polysaccharide
starches (eat)
cellulose (wear)

amino acids (20)





amide linkage

↳ peptide proteins