

① Graphite/Diamond Thermodynamics (easy)



So the allotrope of C called diamond is unstable

② First Law Definition (Stupidly Easy)

$$\Delta E_{\text{univ}} = \Delta S + \Delta w = 0$$

↑ "isolated system"

③ Enthalpy Definition (Easy)

$$\Delta H = \Delta E + P\Delta V$$

↑ a correct for when
constant P system
constant V is constant
if instead $\Delta H = \Delta E$

(4) Signs

(medium)

Be aware of how signs matter

q is \ominus , exothermic \oplus endothermic
 w is \ominus on surroundings ΔV is \oplus , \oplus on system, ΔV is \ominus
 ΔH at constant P, the same as q
 ΔS is \oplus favors increased disorder + spontaneity
 ΔG is \ominus favors spontaneity

(5) Signs of Phase Change (medium)

Are always $\Delta H + \Delta S$ same same

I will give a phase change, you tell me the sign



⑥ State function Definitions (medium)

Know that a state function is defined by system variable for which Δ is all you need to know $\Delta = \text{how it ended} - \text{how it started}$

reversible process

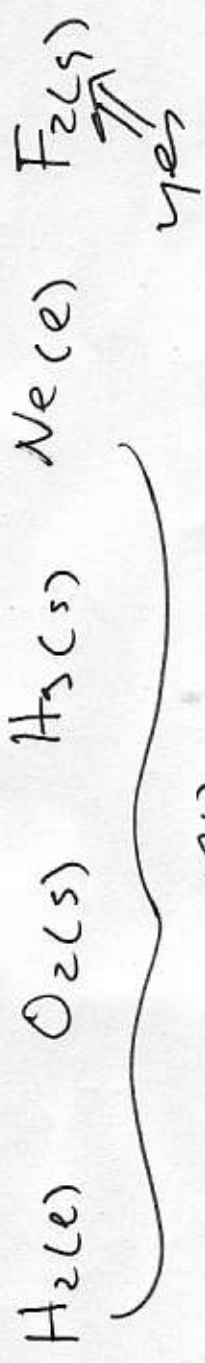
$S + w \equiv \text{path dependent (not state function)}$

E, T, V, P, H, G, S which are.

\Rightarrow H_{fus} , know which are intensive & which are extensive

⑦ Heat of Formation Definition (medium)

I will give you a bunch of compounds, you tell me which are elements in std state



⑧ Heat Capacity Definition (medium)

I will give a collection of heat capacities, you appreciate their practical application

$C_v \sim 3$ for C , which is going to burn you when $H_2O \sim 4$ same amount of heat is added

use $\Delta H = mC\Delta T$ to answer the question for all

9) Bomb calorimeter

(medium)

A classic calculation.

$$\Delta H_{\text{sys}} = -\Delta H_{\text{sur}} = -\Delta H_{\text{H}_2\text{O}} + -\Delta H_{\text{calorimeter}} - m\Delta T + -C\Delta T$$

Hint 1. uses the calorimeter matters

Hint 2. collect for the amount of the water.

use these to calculate ΔH_{sys} .

10) Calorimetry

(medium)

Mix something hot and something cold and find the equil T that is reached

$$\Delta H_{\text{hot}} = -\Delta H_{\text{cold}}$$

$$m C (T_f - T_i) = -m C (T_i - T_f)$$

↑ ↑ ↑ ↑ ↑
given given given given given

solve for T_f

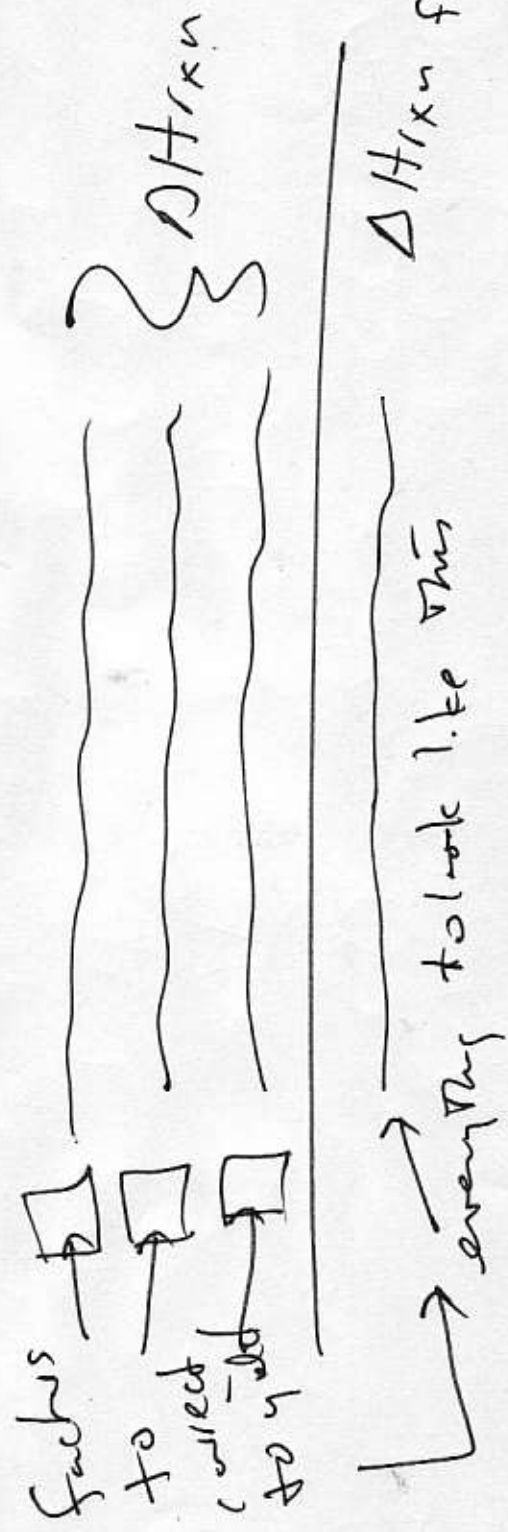
⑪ Hess's Law ΔH_f calculation (medium)

classic plus + chng

$$\Delta H_{rxn} = \sum \Delta H_{prod} - \sum \Delta H_{react}$$

using only ΔH_f values

⑫ Combined Reaction Enthalpy (Hard, changing to medium?)



Mot. and Energy calculation.

(medium)

↑ easiest I have given

every atom has 3 modes of motion

total deg of freedom = $3 \times \#$ of atoms

every modes = $\frac{1}{2} kT$

∴ in a molecule $\frac{3}{2} kT$ transl

$\frac{3}{2} kT$ rotat except linear $\frac{2}{2} kT$

all the rest vibration

Hint. There is a linear + a nonlinear calculation

Hint. one free is kT (per molecule) and other is RT (per mole)

15) Bond Energy calculation.

(medium)

$$BE = \sum BE_{\text{rea}} - \sum BE_{\text{prod}}$$

Just spread out of molecules as given given B.E.,
do the math

16) Work calculation theory

(easy)

$$W = -P\Delta V = -\Delta nRT$$

and it is embarrassingly obvious.

Hint, something is held constant (Δ) = Δ , so duh, what is it

17) work calculation from chemical reaction (medium)

$$W = -\Delta nRT$$

find $\Delta n_g = n_{\text{prod}} - n_{\text{reac}}$

and stick in equation.

$$\text{Hint } RT = 2.5 \text{ kJ}$$

when
 $T = 298$.

Not here.

(18) statistical thermo, E_k , theory (medium)

It turns out that in a system, internal energy is the consequence of the motion of the fundamental particles

$$E = \frac{1}{2} kT = \frac{1}{2} m v^2$$

(19) Bomb calorimetry theory (medium)

I will give you a bunch of statements about how a calorimeter works, you identify the really stupid one.

(20) Internal energy calculation (medium tricky)

Based on $\Delta E = q + w$. I will give $q + w$, you find ΔE . make sure about signs. Hint: There is more than one source of heat, so add the qs .

21 Predicting Sign of ΔS_{rxn} (medium)

of particles increases $\Delta S +$

$S \rightarrow l \rightarrow g$ $\Delta S +$ ~~$\Delta S +$~~

pure \rightarrow mixtures $\Delta S +$

~~llllllll~~

I will give a set of reactions, you find the one that is not like the others

H.t. gases rule. \leftarrow

23 predicting absolute molar entropies, S (medium)

I will give a series of irregularities

again size, $T \rightarrow H_2O(l) < H_2O(s)$ } use same which is correct

mix-
state determine S } $F \rightarrow H_2(g) < H_2(e)$

(24) Calculating ΔS for a phase change (medium tricky)
There are 5 problems where "phase change"

Think this $\Delta G = 0 = \Delta H - T\Delta S$

$$\text{have } T\Delta S = \Delta H \quad \therefore \Delta S = \frac{\Delta H}{T}$$

So simply plug + chng.

you know
it from
The phase
change

WARNING WARNING, get your sign right!!

(25) Second law theory (easy)

ΔS_{univ} must be $(+)$ for a spontaneous process

Hint write down

$$\Delta S_{\text{univ}} = \Delta S_{\text{sys}} + \Delta S_{\text{sur.}}$$

Stick in assigned
values and
predict sign

(26) Third Law theory

"perfect crystal"

If a compound has one C_{center}

$$\text{N}_2, \text{O}_2, \text{CO}_2 \quad \therefore S = k \ln W = k \ln(1)^{\#} = 0$$

(28) Statistical Thermo Theory (S) (medium)

here is a chance to use IMF concepts rank a series of compounds based on IMF.

The larger the IMF, the less the absolute entropy

most dense
most ordered
highest S

dipole-dipole
less S

if bond
least ideal
lowest S

(29) positional entropy calculation

(medium)

(30)

Two simple $S = k \ln W$ calculation.

In one, I give a molecule, you determine # of orientations, then calculate S

$$S = k \ln (\text{orientations})^{\# \text{ of molecules}}$$

In a second example, I give multiple

of diff molecules, you say which is largest S

10 molecules H_2 , 5 molecules CH_3Cl , 7 molecules CO

$$k \ln 1^{10}$$

$$k \ln 4^5$$

$$k \ln 2^7$$

calculating $\Delta S_{sys} + \Delta S_{sur}$
Easy calculation

(medium)

$$\Delta S = \frac{q}{T}$$

no time

$$\Delta S_{sys} = \frac{q_{sys}}{T}$$

$$\Delta S_{sur} = - \frac{q_{sys}}{T}$$

33 T at phase change

(medium)

$$\Delta G = 0 = \Delta H - T \Delta S$$

$$T = \frac{\Delta H}{\Delta S} \leftarrow \begin{matrix} \text{kJ} \times 1000 \\ \text{J} \end{matrix}$$

↑ gives result in Kelvin

(34) 2nd Law calculation

(medium)

Travis' favor problem except I
didn't tell you Travis favors

$$\Delta S_{\text{univ}} = \Delta S_{\text{sys}} + \Delta S_{\text{sur}} - \frac{\Delta H_{\text{sys}}}{T}$$

(35) predicting spontaneity from $\Delta G = \Delta H - T\Delta S$ (medium)

$$\Delta G = \Delta H - T\Delta S$$

+	+	+	happens at h.T
+	-	-	never
-	+	+	always
-	-	-	happens at l.T

(37) calculating T at which ΔG_{rxn} spontaneous (medium)

$$\Delta G = 0 = \Delta H - T \Delta S$$

$$T = \frac{\Delta H}{\Delta S}$$

Then this is just like the phase change problem but it is at a phase change (like (33))

(38) compound stability (easy)

Ignore all the words and excess numbers
look at ΔG° when at stable systems
look at \ominus \oplus

(39)
(40)

ΔG_r from $\Delta H_f^\circ + \Delta S_m^\circ$

(medium)

$$\Delta G = \Delta H - T\Delta S$$

$$T\Delta S \leftarrow J$$



arising
K

like problem # 11 order for

like problem # 11

ΔS
 $\Delta S_{sp} - \Delta S_r$

$\Delta H_p - \Delta H_r$

Do it twice