Chapter 6 material

1. Theory: First Law of Thermodynamic

Type: I will list 3 statements and you decide which are true/false.

First law is built around conservation of energy in isolated systems (universe.)

2. Definition: Enthalpy

Type: I will list 4 definition as T/F statements and you distinguish them.

Hint. Look at all the ways H is written

$\Delta H = mC\Delta T = q_P$

or $H = U + PV$ etc.

Know how to turn the equations I provide into words on a page.

3. Signs for thermodynamic quantities

for every state function and for $q + w$, know the + and - definitions.

Hint. I will tell you a phase change. You tell me the signs of w, q, ΔH, ΔS, ΔG, etc

4. Definition: state functions easy problem.

state functions don't care about path ≡ S, T, V, P, U, G, H
and other functions like q, w do care about path.

5. Definition: Heats of formation

I will list some chemical reactions. you tell me which are written as heats of formation.

elements in their std. state

$H_{2(g)}$, $O_{2(g)}$, $Hg(l)$ C(graphite) $\longrightarrow$ 1 [redacted] mole of something

$N_{2(g)}$ etc

6. Definition: Heat capacity

I will list some examples of chemical systems and a basis of definition

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

you tell me which has highest or low heat capacities.

know water vs metals

7. Calculation: Bomb calorimeter

I will write down a combustion reaction for a certain amount of material. You tell me answer to one of the parameters in

$$\Delta H_{sys} = -\Delta H_{surr} = -\underbrace{mC\Delta T}_{water} - \underbrace{C\Delta T}_{calorimeter}.$$

simple plug + chug. Make your units cancel.

8. Calculation: Hess' Law and heats of formation

Tragically simple calculation

$$\Delta H_{rxn} = \sum \Delta H^{\circ}_{f\,prod} \quad \sum \Delta H^{\circ}_{f\,reac}$$

make sure you include coeff. provided in balanced rxn.

very easy plug + chug.

9. Calculation: Hess's Law and combined reaction enthalpies

Another ΔH_{rxn} solution.

I will give you three ΔH_{rxn} w/ balanced eqns. you mix and match to produce the final ΔH_{rxn} requested.

This is similar to a bunch you have seen.

10. Calculation: Statistical mechanics determination of internal energy

Much easier than quiz question but same type. I give you a certain # of molecules. you tell me total motional energy in translational, rotational + vibrational modes.

Ex. In a mole of H_2O, how much energy in a [illegible] rotations

Answer 3 rotations per molecule, $\frac{3}{2}kT$ rotation per molecule

$\therefore \frac{3}{2}RT$ in a mole of H_2O

11. Calculation: Bond energies

Straight ahead plug & chug.

Write out the Lewis formula. Count up the bonds in each molecule, and multiply by the given B.E. value. Then add them up according to

$$BE = \Delta H_{rxn} = \sum BE_r - \sum BE_p$$

12. Calculation: Work calculation

I will give you a balanced reaction. You determine Δn_{gas} and stick into the expression

$$W = -P\Delta V = -\Delta n RT$$

(Δn from reaction; T → give; R → 8.3)

and solve now W (kJ.)

make sure your signs are correct

w → ⊖   w ← +

13. Definition: Internal Energy

I'll give you a bunch of T/F statements you sort them out.

Hint. Once again, take equations that define internal energy and be able to put them into words.

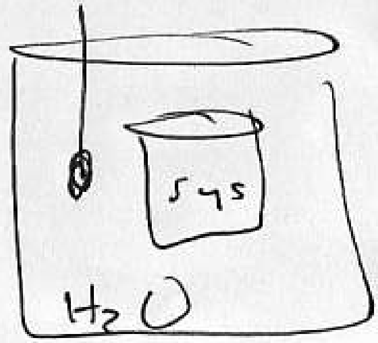
$\Delta U = q + w$ $\quad \Delta U = q_v$

14. Theory: Calorimetry

I will provide a series of T/F statements. sort them out.

Be able to distinguish $\Delta H = q_p$ from $\Delta U = q_v$

Also be able to describe the physical apparatus



← B.C.

15. Calculation: Internal Energy calculation (q and w)

A rediculously easy question because $\Delta U = q + w$. I'll give you $q + w$, you give me ΔU. But make your units ("be the system") correct.

Chapter 7 Material

16. Ranking: Predicting entropy change in a chemical reaction

I'll give you a collection of chemical reactions. you be able to rank (most neg to most positive) the predicted ΔS

Example

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$ ← ΔS ⊖

$H_2O_{(s)} \rightarrow H_2O_{(l)}$ ← ΔS ⊕

$H_2O_{(l)} \rightarrow H_2O_{(g)}$ ← ΔS really ⊕

17. Calculation: Entropy change at a phase transition

$$\Delta G = \Delta H - T\Delta S = \emptyset \therefore \Delta S = \frac{\Delta H}{T}$$

this is problem #26

This becomes a simple plug and chg.

Make sure you units are right.

Hint. ΔS is almost always in J and ΔH is almost always in kJ. so match them up!!

I lied. this is the problem

$\Delta S_{\text{phase transition}} = S_l - S_g$ or $S_s - S_g$ or $S_l - S_s$

18. Theory: Second and Third Laws of Thermodynamic

I'll make some obvious statements about 2nd + 3rd law

$$-T\Delta G = \Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr} > 0$$

as $T \to \emptyset$ $S \to \emptyset$ in a perfect crystal

19. Theory: Statistical thermodynamics and entropy

I'll make a collection of statements about

$$S = k \ln W.$$

make sure you know what each of these symbols means and how the math works.

20. Calculation: Statistical thermodynamics and entropy

Use $S = k \ln W$ to find the specific value of S in a plug & chug. Example, what is S for 2 moles of CH_3Cl?

21. Ranking: Statistical thermodynamics, ranking molar entropy in a compound

Same as on the quiz, I'll give you a collection of molecules that vary by state (l, s, g), amount (1 or 2 or 3), T, or complexity. There is an easy ranking to make.

$H_2O(g)$, $H_2O(l)$, $H_2O_2(l)$

$$H_2O(l) < H_2O_2(l) < H_2O(g)$$

22. Problem: Non-ideality and absolute entropy

$S = k \ln W$ ← W assumes an ideal in which molecules are free to randomly assume any allowed orientation equally.

In practice, non-ideality arises from IMF.

If you can rank IMF for non-ideal gas law, you can rank here. (use the buckets)

23. Calculation of ΔS from heat transfer

By definition $\Delta S = \frac{q}{T}$. Just plug and chug. It is easy.

Hint sys ↔ sys, no sign change

24. Calculation involving the second law equation Twist these. Easy & hard

$$\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr} > 0$$

Travis embarrassed me by giving you a problem in which you tell me the answer once I give two of the values.

25. Calculation involving the second law equation

hard hard hard

$$\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr}$$

ΔS_{sys}: calc. this using 17 problems

ΔS_{surr}: $\Delta S = -\frac{\Delta H_{sys}}{T}$

26. Calculation of phase transition temperature using the Gibbs equation at equilibrium

This is what I'm talking about

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

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

simple plug & chug

I give you ΔH, ΔS, you give me a T_b or T_f

Lecture in class Tuesday.

27. Theory: The temperature dependence of ΔGro

First thing I taught you.

$\Delta G = \Delta H - T\Delta S$				type
ΔH	ΔS			
+	+	← T dep	T ↑	I
+	−	← never		II
−	+	← always		III
−	−	← T dep	T ↓	IV

28. Problem: temperature dependence of reaction spontaneity for a chemical reaction

Apply # 27. I will give you a list of chem. reactions. you assign them to the four types above.

Example $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$

is Type III

29. Problem: predicting compound stability from ΔGro

very easy.

This will be covered in class on Tuesday.

30. Calculation: ΔGro from table values of ΔHfo and Sfo

messy plug + chug from first day of class.

For a given balanced reaction

$$2H_2O \rightleftharpoons 2H_2 + O_2$$

	$2H_2O$	$2H_2$	O_2	
ΔH_f	given	given	given	⇒ calc. ΔH_r
S_f	given	given	given	⇒ calc ΔS_r

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