5. $\underline{2}$ Na + $\underline{2}$ $H_2O \longrightarrow$ $\underline{2}$ NaOH + $\underline{\quad}$ $H_2(g)$

given: 9.2g Na   need: ? gH_2

9.2 g Na $\times \dfrac{1 \,mol \,Na}{23.00 \,g \,Na} \times \dfrac{1 \,mol \,H_2}{2 \,mol \,Na} \times \dfrac{2.02 \,g \,H_2}{1 \,mol \,H_2} = \boxed{0.40 \,g \,H_2}$

6. $\underline{\quad}$ Zn + $\underline{2}$ HCl (aq) $\longrightarrow$ $\underline{\quad}$ $ZnCl_2$ + $\underline{\quad}$ $H_2(g)$
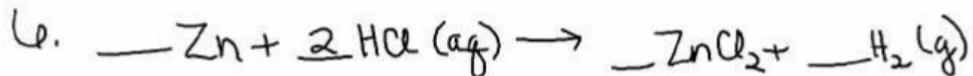
given: 15.67g Zn   need : ? Liters H_2

15.67 g Zn $\times \dfrac{1 \,mol \,Zn}{65.39 \,g \,Zn} \times \dfrac{1 \,mol \,H_2}{1 \,mol \,Zn} \times \dfrac{22.4 \,L \,H_2}{1 \,mol \,H_2} = \boxed{5.368 \,L \,H_2}$

11.

$\underline{4}$ HCl (aq) + $\underline{\quad}$ $O_2(g) \rightarrow$ $\underline{2}$ H_2O + $\underline{2}$ $Cl_2(g)$
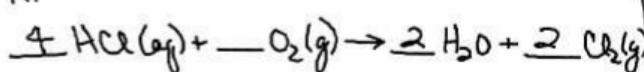
given: 750g HCl   need: ? L Cl_2
       930g O_2

Theoretical yield	230 L Cl_2
Limiting factor	750g HCl
Leftover excess	770g O_2 left
% yield	92% yield

LF

$\boxed{750 \,g \,HCl} \times \dfrac{1 \,mol \,HCl}{36.46 \,g \,HCl} \times \dfrac{2 \,mol \,Cl_2}{4 \,mol \,HCl} \times \dfrac{22.4 \,L \,Cl_2}{1 \,mol \,Cl_2} = \boxed{230 \,L \,Cl_2}$ TY

excess

930g $O_2 \times \dfrac{1 \,mol \,O_2}{32.00 \,g \,O_2} \times \dfrac{2 \,mol \,Cl_2}{1 \,mol \,O_2} \times \dfrac{22.4 \,L \,Cl_2}{1 \,mol \,Cl_2} = 1300 \,L \,Cl_2$

TY → used excess   given − used = left over
                              excess

230 L $Cl_2 \times \dfrac{1 \,mol \,Cl_2}{22.4 \,L \,Cl_2} \times \dfrac{1 \,mol \,O_2}{2 \,mol \,Cl_2} \times \dfrac{32.00 \,g \,O_2}{1 \,mol \,O_2} = \begin{matrix} 160 \\ 164 \end{matrix} \,g \,O_2$ used

930g − 160g = $\boxed{770g \,O_2 \,left \,over}$

930g − 164 = 766g → 770g O_2 left over

Per cent yield = $\dfrac{actual}{theoretical} \times 100$ $\dfrac{212 L}{230 L} \times 100 = \boxed{92\% \,yield}$

Phases of Matter
  Solid, Liquid, Gas

Joules = mass · H_f

Changes in Phase
Solid → Liquid   Melting   (measured by the Heat of fusion)
Solid → gas   Sublimation

liquid → solid   freezing   (measured by (-) Heat of fusion.)
liquid → gas   evaporation (No HEAT Added)
                  * Vaporization (Heat added) (measured by the Heat of Vaporization) H_v

gas → liquid   condensation (measured by (-) Heat of Vaporization)

gas → Solid   deposition

Intermolecular Forces : connection between molecules

1. London Dispersion or Van der Waals Forces: Temporary attractions
   based on movement of e^-

   ⊕ Ⓝ ·· ⊖ ⊕ Ⓝ · ⊖

2. Dipole - Dipole : attraction based on charged ends of a
                      molecules.

   ⊖N—H
   H H H
   ⊕ ⊖N—H ⊕
        H
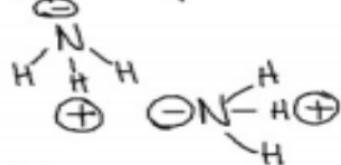
3. Hydrogen bond: F, O, N, + H   very strong attraction
   ⊖ H   H
     O ·· O
   H   H
     ⊕
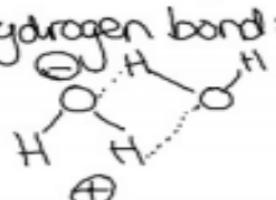
Boiling — the process of vaporizing a liquid

STP = Standard Temperature & Pressure
0°C/273K

1 ATM   1013 kPa   760 mmHg
atmosphere   Kilopascal   milimeters
                          of Mercury

Standard or "normal" boiling point — measured at Stand. pressure

↑ pressure ↑ BP.   ↓ pressure ↓ BP.

Vapor-pressure curve   illustrates   pressure vs temp   to indicate
                                          boiling pt.

any where on
the line a substance
is boiling

? standard B.P. = 21-22°C

stronger
attraction
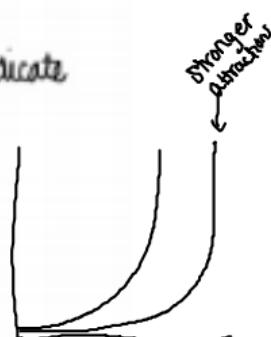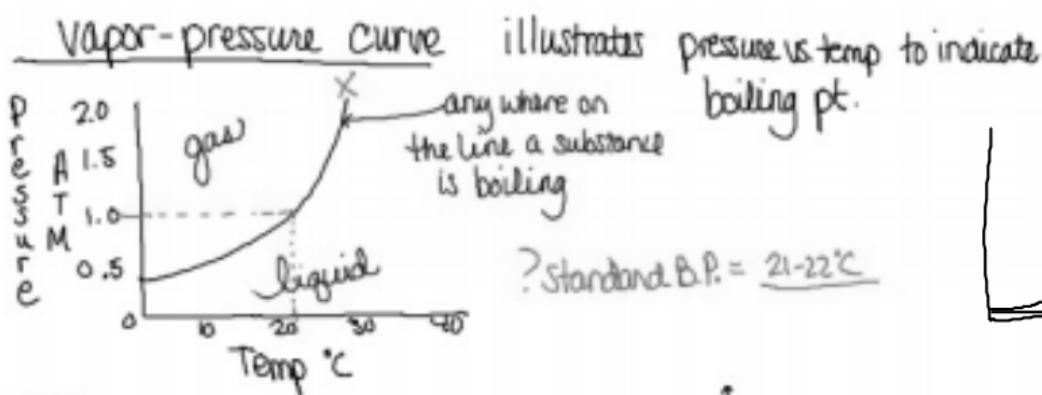
Practice
1. A ~ 34.0 kPa   B ~ 7 kPa
2. 70°C
3. ~ 20 kPa
4. A 73-75°C   B 112-116°C

low of. tension

low

high
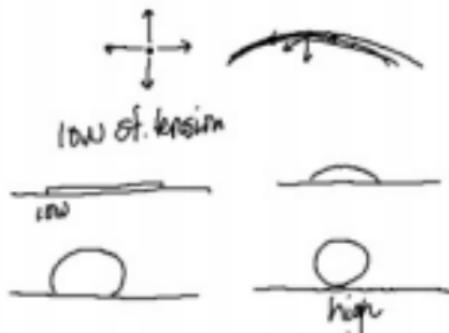
Prop & Changes Hmwk

1. b a → 7. intermolecular (Vander Waals, Dipole-Dipole, Hydrogen bonds)

2. b   8. intramolecular (covalent/ionic)

3. c

4. b   9. Dispersion or Vander Waals

5. a

6. c   10. boiling

11. amorphous

12. higher

13. dipole-dipole

14. freezing

15. hydrogen bond

16. (1 ATM) 30°C

17. 1 ATM

18. 40°C

19. 46-49°C

20. 0.3 - 0.4 ATM
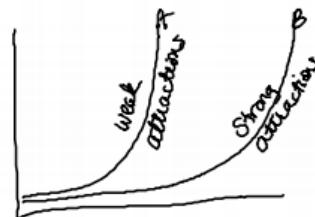
21. ↑ Temp ↑ molecule activity (movement)   ↓ viscosity

22. Hg - strongest H_2O - medium   Alcohol - lowest
   If strong   med.   weak

23. Metallic, molecular, ionic + covalent network

good conductors, some are ductile, repetitive pattern,

definite shape, organized, sharp melting point

unit cell = repetitive pattern.

24. KMT = kinetic Molecular Theory = all particles are in constant motion

- motion stops at absolute zero
         0 K (zero K)
        -273°C

Properties of Water

H_2O or $H(OH)$

Hydrogen ion + hydroxide ion
H^+ OH^{1-}
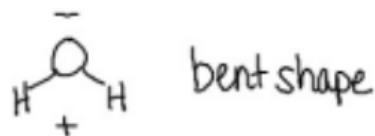
$\overset{-}{\underset{+}{O}}$ with H and H bent shape

if a molecule dissociates in H_2O the solution is called an
(becomes ions)   electrolyte

H_2O is the universal solvent

ex) $1cm \times 1cm \times 1cm = 1cm^3$
hold $1 mL$ = mass $1g$

Liquid at RT, $1 \, g/cm^3$ or g/mL

Solid H_2O (ice) is less dense than liquid water

Intermolecular Force = Hydrogen Bond
  ↑ Boiling Pt   ↑ heat of fusion   ↑ surface tension
  ↑ Specific Heat   ↑ heat of vaporization   ↑ viscosity

H_2O requires a large amount of energy to change temperature
 or change phases — great climate moderator

Calorie = the energy required to raise the temp. of 1 gram of H_2O
   by $1°C$.
1 Calorie = 1,000 calories   1 calorie = 4.184 joules

Heating/Cooling Curve
illustrates the time required to absorb energy + change temperature + phase

Heating of H_2O
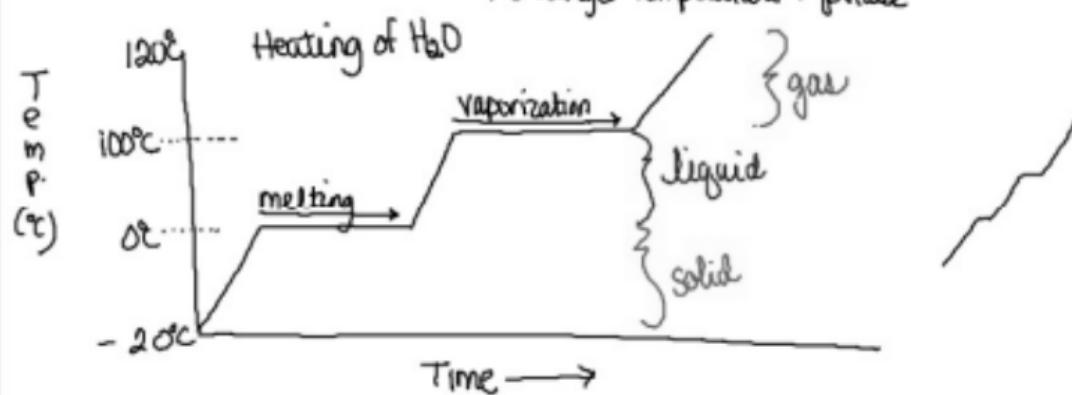
plateau — area when substance is changing phase.

Cooling Curve

condensation

freezing
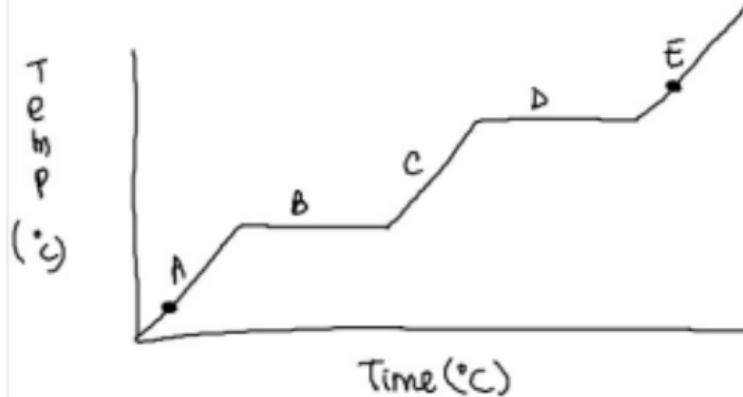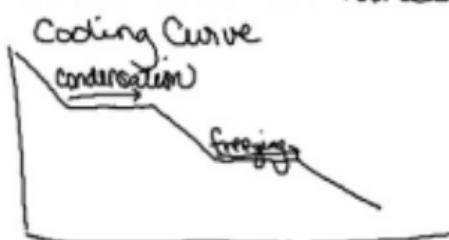
A = Energy = mass $(\Delta T)(Cp_{solid})$
$+$
B = Energy = mass (Heat of Fusion)
$+$
C = Energy = mass $(\Delta T)(Cp_{liquid})$
$+$
D = Energy = mass (Heat of Vap.)
$+$
E = Energy = mass $(\Delta T)(Cp_{gas})$

$\Delta T = T_{final} - T_{initial}$ * only for the line segment

Cp = specific heat capacity

$Cp_{H_2O} = 1\,\frac{cal}{g\cdot c} = 4.184\,\frac{joules}{g\cdot c}$ * liquid water

Heating Curve
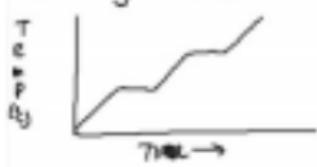
Cooling Curve
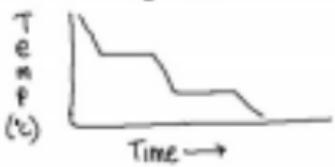
The plateaus represent the time needed for the substance to gather energy and change phase.

(A)

(B)
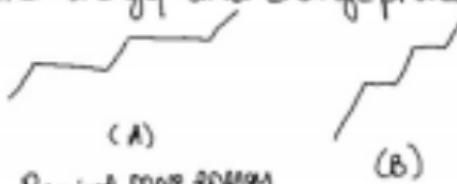
Required more energy to change phase ∴ greater intermolecular forces

D vaporization) E gas

C liquid
condensation
melting
or
freezing
solid

$\Delta T = T_{final} - T_{initial}$ $\left(\text{for the line segment}\right)$

C_p = specific heat capacity

$$C_{P_{H_2O\ liquid}} = 1\ cal/gr \cdot 4184\ J/gr$$

Time →

A solid   Energy = mass $\cdot \Delta T \cdot C_{P_{solid}}$
+
B melting   Energy = mass $\cdot$ Heat of fusion
+
C liquid   Energy = mass $\cdot \Delta T \cdot C_{P_{liquid}}$
+
D vaporization)   Energy = mass $\cdot$ Heat of vaporization)
+
E gas   Energy = mass $\cdot \Delta T \cdot C_{P_{gas}}$

Heating Curve

Temp (°C) — Time →

BP — melting → liquid, Vaporization → gas
FP — Solid

Cooling Curve

Temp (°C) — Time →

condensation, freezing


(A) ① ②

(B)
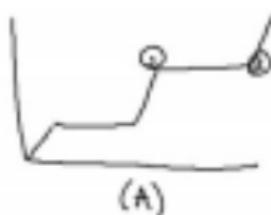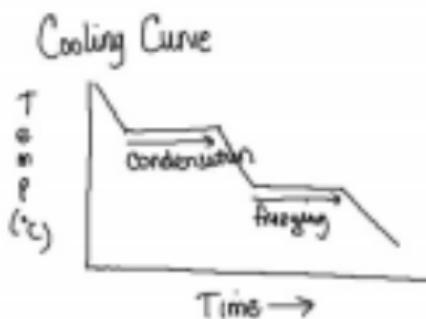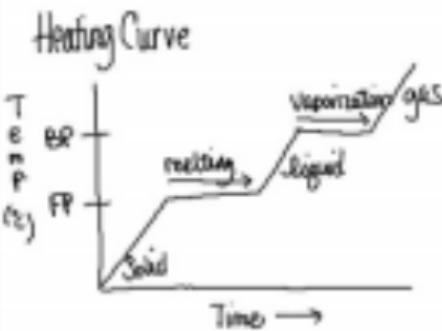
Substance A has stronger intermolecular forces
∴ it requires more energy to change phase

Looking at particle ① and ②   particles ① + ② have the same
temp, however ② has more energy.

Temp (°C) — Time →

120°, 100°, 0°, -10°
A Solid, B, C, D, E

$\Delta T = T_{final} - T_{initial}$ (for each segment)
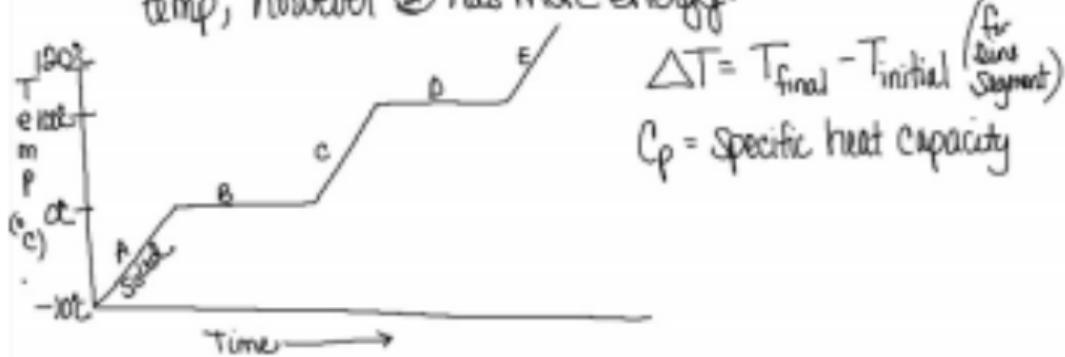
C_p = Specific heat capacity

A = energy = mass · ΔT · $C_{p\,solid}$
+
B = energy = mass · heat of fusion
+
C = energy = mass · ΔT · $C_{p\,liquid}$
+
D = energy = mass · heat of vaporization
+
E = energy = mass · ΔT · $C_{p\,gas}$
_____
Total sum

Practice

Heating Curve for Water
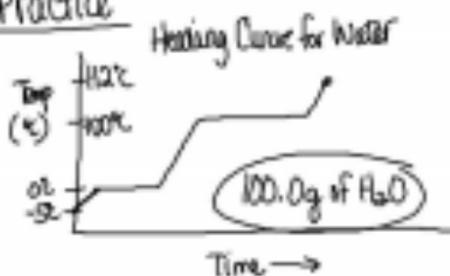
$C_{Psd} = 2.06 \, J/g \cdot c$ $H_{fus} = 333 \, J/g$

$C_{Pliq} = 4.184 \, J/g \cdot c$ $H_{vap} = 2260 \, J/g$

$C_{Pgas} = 2.03 \, J/g \cdot c$

100.0g of H_2O

Temp (°c): 112°c, 100°c, 0°c, -5°c

Time →

A = $(100g)(5c)(2.06 \, J/g \cdot c) =$ 1030 J

B = $(100g)(333 \, J/g) =$ 33300 J

C = $(100g)(100°c)(4.184 \, J/g \cdot c) =$ 41840   J

D = $(100g)(2260 \, J/g) =$ 226 000 J

E = $(100g)(12c)(2.03 \, J/g \cdot c) =$ 2436 J
_____
total $\overline{304606 \, J} \rightarrow \boxed{3 \times 10^5 \, J}$

Phase Diagram

Pressure
ATM

SOLID   melting→   Liquid

←freezing

Condensation

Vaporation

deposition

sublimation

Gas

Temp (°C)
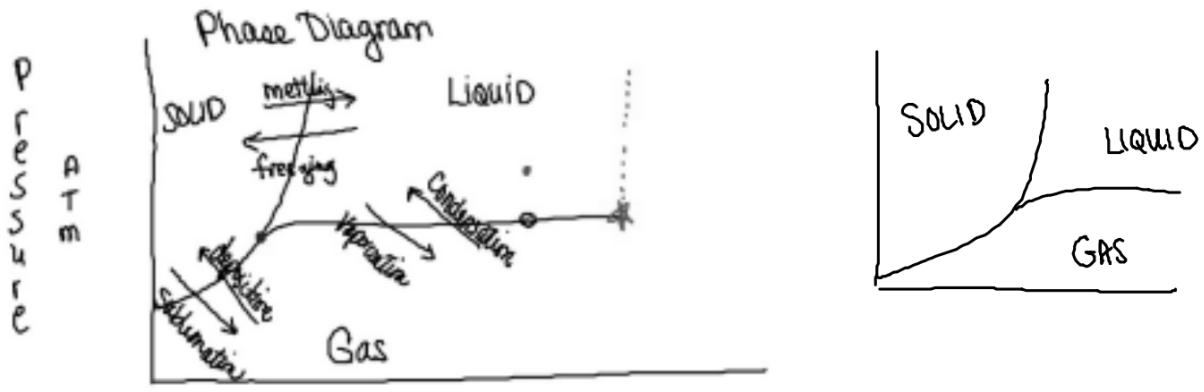
- Triple Point = all 3 phases of matter exist in equilibrium

☆ Critical Point = the point at which you can no longer change
   the gas back into liquid by applying pressure.

SOLID

LIQUID

GAS