4/5/16

Phases of Matter

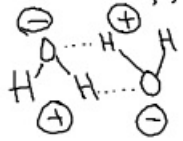
Solid
Liquid
Gas

Intermolecular Forces attraction between molecules

1. Vander Waals or Dispersion Forces: temporary attraction, very limited, weak
   temporary shift of e⁻ that leads to a +/− for the moment.

2. Dipole-Dipole – attraction between molecules that have permanently charged areas. ⊕ CaF ⊖

3. Hydrogen bond – F, O, N, attached to a hydrogen – strongest attraction
   requires a great deal of energy to separate



Solid → liquid melting (measured by Heat of Fusion)
Solid → gas Sublimation
liquid → solid freezing (measured by (-) Heat of Fusion)
liquid → gas evaporation (NOT HEATED!)
* Vaporization (needs heat) (measured by Heat of Vaporization)
gas → liquid Condensation (measured by (-) Heat of Vaporization)
gas → solid deposition

Boiling – the process of heating a liquid to vaporize it.

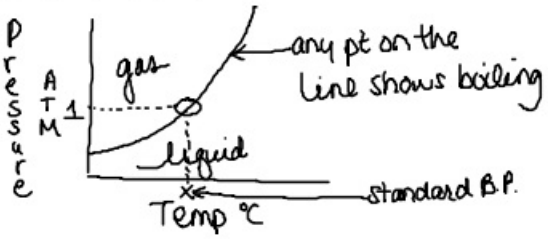
↓pressure ↓B.P.
↑ pressure ↑B.P.

Freezing/Melting happen at the same temperature.

To freeze energy must be removed from the system.

To melt energy must enter the system.

Vapor Pressure Curve - illustrates relationship between pressure & boiling



STP = Standard temperature & pressure

0°C or 273K 1ATM = 101.3kPa = 760mmHg

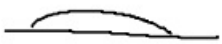
atmosphere kilopascal millimeters of mercury

Standard Boiling Point happens @ Stand. Pressure.

Practice:

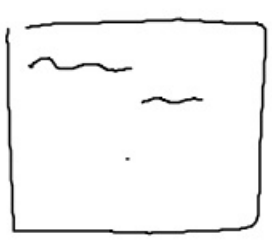
1. A ~ 34 kPa B ~ 7-9 kPa
2. 70°C
3. ~20-23kPa
4. A 73-75°C B 112-117°C

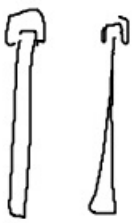
Surface tension



low surface tension

high surface tension





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Phases of Matter

Solid, Liquid, Gas

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)

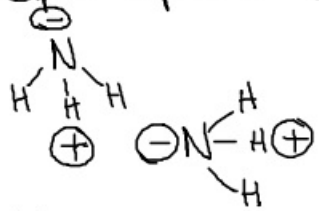
gas → liquid Condensation (measured by (-) Heat of Vaporization)

gas → Solid deposition

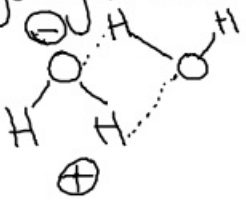
Intermolecular Forces : connection between molecules

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.



3. Hydrogen bond: F, O, N, + H Very strong attraction



Boiling – the process of vaporizing a liquid

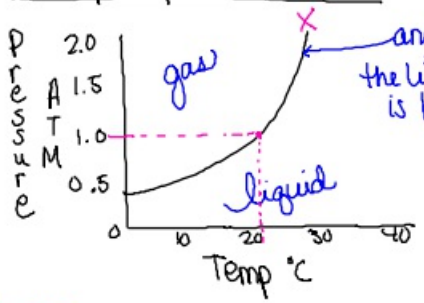
STP = Standard Temperature & Pressure

0°C/273K 1ATM atmosphere 101.3kPa Kilopascal 760 mmHg milimeters of Mercury

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

↑ pressure ↑ BP. ↓ pressure ↓ BP.

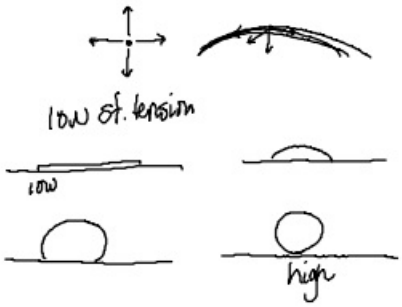
Vapor-pressure curve illustrates pressure vs. temp to indicate boiling pt.



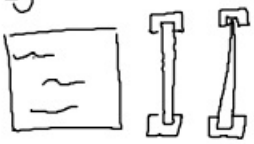
? Standard B.P. = 21-22°C

Practice

1. A ~34.0 kPa B ~7 kPa.
2. 70°C
3. ~20 kPa
4. A 73-75°C B 112-114°C



glass



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Phases of Matter

Solid, liquid, gas

Changes in Phases

Solid → Liquid melting (measured by the Heat of Fusion)

Solid → gas Sublimation

Liquid → solid freezing (measured by the (-) Heat of Fusion)

Liquid → gas evaporation (no heat required)

* vaporization (requires heat) (measured by the Heat of vaporization)

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

gas → solid deposition

Intramolecular attraction – bonding inside a molecule (covalent, ionic, bond)

Intermolecular attraction – attraction between molecules

1. London Dispersion or Van der Waals Forces: Weak temporary

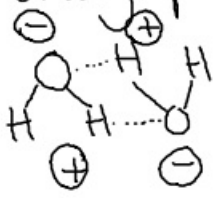
(+) · N : : (-)(+) N : : (-) occurs due to the movement of e⁻ around the nucleus.

2. Dipole-Dipole: attraction between molecules that have permanent +/- Strong attraction

+NaCl-
-ClNa+

3. Hydrogen-bonds F, O, N attached to Hydrogen

requires existing dipoles Very strong attraction



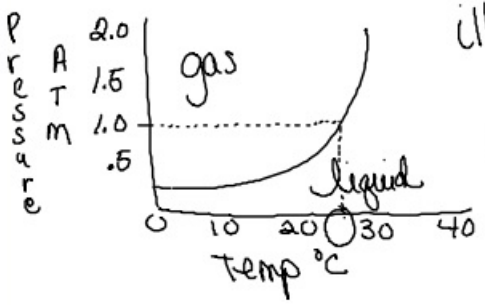
STP = Standard Temperature & Pressure
0°C/273K 1 ATM 101.3 kPa 760 mm Hg
atmosphere Kilopascal millimeters of mercury

Boiling – the process of adding energy to vaporize a liquid

↑ Pressure ↑ BP ↓ Pressure ↓ BP

The standard or "normal" boiling point is measured at Stand. Pressure

Vapor Pressure Curve – Plots Pressure vs. Temperature illustrating boiling point (the line)



Standard "normal" BP = 26.5°C
(Stand. pressure = 1 ATM)

Practice:
1 A ~34 kPa B ~7 kPa
2 70°C
3 ~20 kPa
4 A 73-75°C B 112-116°C