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the mole

- A mole is a collection that contains
- the same numbers of particles as there are carbon atoms in 12.0 g of carbon.
- 6.02×10^{23} atoms of an element (Avogadro's number)

1 mole element		Number of Atoms
1 mole C	=	6.02×10^{23} C atoms
1 mole Na	=	6.02×10^{23} Na atoms
1 mole Au	=	6.02×10^{23} Au atoms

atoms → ذرّات

molecule → جزيء

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A mole of a covalent compound has "Avogadro's" number of molecule.

1 mole Co_2 = 6.02×10^{23} Co_2 molecules.

1 mole H_2O = 6.02×10^{23} H_2O molecules.

* of an ionic compound contains Avogadro's number of formula units.

1 mole NaCl = 6.02×10^{23} NaCl Formula units.

1 mole K_2SO_4 = 6.02×10^{23} K_2SO_4 Formula units.

1 mole C = 6.02×10^{23} C atoms.

1 mole Al = 6.02×10^{23} Al atoms.

1 mole S = 6.02×10^{23} S atoms.

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1 mole H_2O = 6.02×10^{22} H_2O molecules

1 mole CCl_4 = 6.02×10^{23} CCl_4 molecules

1 mole = 6.02×10^{23} particles

Conversion factors :

$\frac{6.02 \times 10^{23} \text{ particles}}{1 \text{ mole}}$ and $\frac{1 \text{ mole}}{6.02 \times 10^{22} \text{ particles}}$

□ How many Cu atoms are 0.50 mole Cu?

$$0.50 \text{ mole Cu} \times \frac{6.02 \times 10^{23} \text{ Cu atoms}}{1 \text{ mole Cu}}$$

$$= 3.01 \times 10^{23} \text{ Cu atoms.}$$

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[2] How many moles of CO_2 are in 2.50×10^{24} molecule?

$$* \quad 2.50 \times 10^{24} \text{ molecules } CO_2 \times \frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ molecules } CO_2}$$

$$= 4.15 \text{ mole } CO_2$$

[3] The number of atoms in 2.0 mole Al is

(a) 2.0 Al atoms

(b) 3.0×10^{23} Al atoms.

(c) 1.2×10^{24} Al atoms.

[4] The number of moles of S in 1.8×10^{24} atom S is

(a) 1.0 mole S atoms.

(b) 3.0 mole S atoms.

(c) 1.1×10^{48} mole S atoms.

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The subscripts in a formula show

- the relation ship of atoms in the formula
- the moles of each element in 1 mole of compand

$C_6 H_{12} O_6$

In 1 molecule : 6 atoms C 12 atoms H 6 atoms O

In 1 mole : 6 mole C 12 mole H 6 mole O

$C_9 H_8 O_4$

$\frac{9 \text{ mole C}}{1 \text{ mole } C_9H_8O_4}$ $\frac{8 \text{ mole H}}{1 \text{ mole } C_9H_8O_4}$ $\frac{4 \text{ mole O}}{1 \text{ mole } C_9H_8O_4}$

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5 How many mole O are in 0.150 mole aspirin $C_9H_8O_4$?

* $0.150 \text{ mole } C_9H_8O_4 \times \frac{4 \text{ mole O}}{1 \text{ mole } C_9H_8O_4}$

$= 0.600 \text{ mole O}$

6 How many atom O are in 0.150 mole aspirin $C_9H_8O_4$?

* $0.150 \text{ mole } C_9H_8O_4 \times \frac{4 \text{ mole O}}{1 \text{ mole } C_9H_8O_4} \times \frac{6.02 \times 10^{23} \text{ O atoms}}{1 \text{ mole O}}$

$= 3.61 \times 10^{23} \text{ O atoms}$

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Molar Mass الكتلة المولية

* is the mass of one mole of an element of compound.

* is the atomic mass expressed in grams.

Q1 Give the molar mass for each :-

* من الجدول الدوري.

(A) 1 mole K atoms = 39.1 g

(B) 1 mole Sn atoms = 118.7 g

Q1 calculate the molar mass of $CaCl_2$.

$CaCl_2$		molar mass
	Ca	40.1 g
* 2 × 35.5 = 71.0 g		
	Cl	35.5 g
* 71.0 + 40.1 = 111.1		

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Q| calculate the molar mass K_3PO_4 ?

* $4 \times 16.0 + 1 \times 31.0 + 3 \times 39.1$

* $64.0 + 31.0 + 117.3$

$= 212.3\ g$

	molar mass
K	39.1
P	31.0
O	16.0

Q| what is the molar mass of each of the following:

(A) K_2O

* $1 \times 16.0 + 2 \times 39.1$

$= 94.2\ g$

	molar mass
K	39.1
O	16.0
Al	27.0
H	1.01

(B) $Al(OH_3)$

* $1 \times 27.0 + 3 \times 16.0 + 3 \times 1.01$

$= 78.03\ g$

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Q| Prozac, $C_{17}H_{18}F_3NO$ is an antidepressant that inhibits the uptake of serotonion by the brain.

what is the molar mass of prozac?

1) 40.1 g/mole

2) 262 g/mole

3) 309 g/mole

Molar mass conversion factors

- are written from molar mass.
- relate grams and moles of an element or compound.

II write molar mass factors for methane, CH_4 used in gas stoves and gas heaters.

1 mol CH_4 = 16.0 g

conversion factors

$$\frac{16.0\ g\ CH_4}{1\ mole\ CH_4} \quad \text{and} \quad \frac{1\ mole\ CH_4}{16.0\ g\ CH_4}$$

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[2] Acetic acid $C_2H_4O_2$ gives the sour taste to vinegar write two molar mass factors for acetic.

"molarmass"

↳ * 24.0 + 4.04 + 32.0 = 60.0 g/mole

1 mole of acetic acid = 60.0 g acetic acid

$$\frac{1 \text{ mole acetic acid}}{60.0 \text{ g acetic acid}} \quad \text{and} \quad \frac{60.0 \text{ g acetic acid}}{1 \text{ mole acetic acid}}$$

* molar mass factors are used to convert between the grams of a substance and the number of moles.

Grams ← Molar mass factor → Moles

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3. Aluminum is often used to build light weight bicycle frams. How many grams of Al are in 3.00 mole Al_2

* Molar mass equality : 1 mole Al = 27.0 g Al
setup with molar mass as a factor :

$$3.00 \text{ mole Al} \times \frac{27.0 \text{ g Al}}{1 \text{ mole Al}} = 81.0 \text{ g Al}$$

4. Alkyl sulfide $C_6H_{10}S$ is a compound that has the odor of grafic. How many moles of $C_6H_{10}S$ are in 225 g?

* (molar mass) $6 \times 12.0 + 10 \times 1.01 + 1 \times 32.1$
$= 114.2 \text{ g/mole}$

$$225 \text{ g } C_6H_{10}S \times \frac{1 \text{ mole } C_6H_{10}S}{114.2 \text{ g } C_6H_{10}S}$$

$= 1.97 \text{ mole } C_6H_{10}S$

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A molar mass factor and Avogadro's number

* grams to particles

g $\xrightarrow{\text{molar mass}}$ mole $\xrightarrow{\text{Avogadro's number}}$ particles

* particles to grams

particles $\xrightarrow{\text{Avogadro's number}}$ mole $\xrightarrow{\text{molar mass}}$ g

Q1 How many H_2O molecules are in 24.0 g H_2O?

① 4.52×10^{23}

② 1.44×10^{25}

③ 8.03×10^{23}

Q1

$$24.0\ g\ H_2O \times \frac{1\ mole\ H_2O}{18.0\ g\ H_2O} \times \frac{6.02 \times 10^{23}}{1\ mole\ H_2O}$$

$= 8.03 \times 10^{23}$ H_2O molecules.

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Q1 If the odor of $C_6H_{10}S$ can be detected from 2×10^{-13} in one liter how many molecules of $C_6H_{10}S$ are present.

$$* 2 \times 10^{-13}\ g \times \frac{1\ mole}{114.2\ g} \times \frac{6.02 \times 10^{23}\ molecule}{1\ mole}$$

$$= 1 \times 10^{9}\ molecules\ C_6H_{10}S$$

Conservation of Mass قانون حفظ الكتلة

$$2\ moles\ Ag + 1\ mole\ S \longrightarrow 1\ mole\ Ag_2S$$

$$2(107.9) + 1(32.1)\ g = 247.9\ g$$

247.9 g reactants = 247.9 g product

الممسوحة ضوئيا بـ CamScanner

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Q] Consider the following equation:

$4\,Fe + 3O_2 \longrightarrow 2\,Fe_2O_3$

4 moles Fe + 3 moles O_2 → 2 moles Fe_2O_3

A mole - mole factor is a ratio of the moles for any two substances in an equation

Fe and O_2 $\frac{4 \text{ moles Fe}}{3 \text{ moles } O_2}$ and $\frac{3 \text{ moles } O_2}{4 \text{ moles Fe}}$

Fe and Fe_2O_3 $\frac{4 \text{ moles Fe}}{2 \text{ moles } Fe_2O_3}$ and $\frac{2 \text{ moles } Fe_2O_3}{4 \text{ moles Fe}}$

O_2 and Fe_2O_3 $\frac{3 \text{ moles } O_2}{2 \text{ moles } Fe_2O_3}$ and $\frac{2 \text{ moles } Fe_2O_3}{3 \text{ moles } O_2}$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Consider the following equation :

$3H_2 + N_2 \longrightarrow 2NH_3$

A. Amole _ mole factor for H_2 and N_2 is

1. $\frac{3 \text{ moles } N_2}{1 \text{ mole } H_2}$

2. $\frac{1 \text{ mole } N_2}{3 \text{ moles } H_2}$

3. $\frac{1 \text{ mole } N_2}{2 \text{ moles } H_2}$

B. Amole _ mole factor for NH_3 and H_2 is

1. $\frac{1 \text{ mole } H_2}{2 \text{ mole } NH_3}$

2. $\frac{2 \text{ mole } NH_3}{3 \text{ moles } H_2}$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Q1 How many moles of Fe_2O_3 can form 6.0 mole?

$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$

A. write a mole - mole factor to determine the moles of Fe_2O_3

$* 6.0 \text{ mole } O_2 \times \frac{2 \text{ mole } Fe_2O_3}{3 \text{ mole } O_2}$

$= 4.0 \text{ mole } Fe_2O_3$

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Suppose we want to determine the mass (g) of NH_3 that can form from 2.50 moles N_2.

$$N_2 + 3H_2 \longrightarrow 2NH_3$$

The plan needed would be

moles N_2 $\longrightarrow$ moles NH_3 $\longrightarrow$ grams NH_3

The factor needed would be :

mole factor NH_3 / N_2 and the molar mass NH_3

$$2.50 \text{ mole } N_2 \times \frac{2 \text{ moles } NH_3}{1 \text{ mole } N_2} \times \frac{17.09 \text{ g } NH_3}{1 \text{ mole } NH_3}$$

$$= 85.0 \text{ g } NH_3$$

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Q1 How many grams of O_2 are needed to produce 0.400 mole Fe_2O_3 in the following reaction?

$$4\,Fe + 3O_2 \longrightarrow 2\,Fe_2O_3$$

1) 38.4 g O_2

2) 19.2 g O_2 $\longrightarrow$ $0.400\,\text{mol}\,Fe_2O_3 \times \frac{3\,\text{mole}\,O_2}{2\,\text{mole}\,Fe_2O_3} \times \frac{32.0\,g\,O_2}{1\,\text{mole}\,O_2}$

3) 1.90 g O_2 $= 19.2\,g\,O_2$

Q1 The reaction between H_2 and O_2 produces 13.1 g water. How many grams of O_2 reacted?

$$2H_2 + O_2 \longrightarrow 2H_2O$$

The plan and factors would be

g H_2O $\longrightarrow$ mole H_2O $\longrightarrow$ mole O_2 $\longrightarrow$ g O_2

$$13.1\,g\,H_2O \times \frac{1\,\text{mole}\,H_2O}{18.0\,g\,H_2O} \times \frac{1\,\text{mole}\,O_2}{2\,\text{mole}\,H_2O} \times \frac{32.0\,g\,O_2}{1\,\text{mole}\,O_2}$$

$$= 11.6\,g\,O_2$$

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Q) Acetylene gas C_2H_2 burns in the oxyacetylene torch for welding. How many grams of C_2H_2 are burned if the reaction produces 75.0 g CO_2?

$$2C_2H_2 + 5O_2 \longrightarrow 4CO_2 + 2H_2O$$

1) 88.6 g C_2H_2

2) 44.3 g C_2H_2

3) 22.2 g C_2H_2 $\longrightarrow$ $75.0\ g\ CO_2 \times \frac{1\ mole\ CO_2}{44.0\ g\ CO_2} \times \frac{2\ mol\ C_2H_2}{4\ mole\ CO_2} \times \frac{26.0\ g\ C_2H_2}{1\ mole\ C_2H_2}$

$= 22.2\ g\ C_2H_2$

الممسوحة ضوئيا بـ CamScanner

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Q1 How many grams H_2O are produced when 35.8 g C_3H_8 react by the following equation

$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

D) 14.6 g H_2O

2) 58.4 g H_2O $\longrightarrow$ $35.8\ g\ C_3H_8 \times \frac{1\ mole\ C_3H_8}{44.1\ g\ C_3H_8} \times \frac{4\ mole\ H_2O}{1\ mole\ C_3H_8} \times \frac{18.0}{1\ mole}$

3) 117 g H_2O

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Limiting reagent defined المادة المحددة للتفاعل

Limiting reagent : reagent (reactant) that is completely consumed in are action.

Limiting reagent : reagent (reactant) that limit amount of product.

الممسوحة ضوئيا بـ CamScanner

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$Zn + S \longrightarrow ZnS$

12 g of Zn are mixed with 6.5 g S

① Determine the L.R

$* 12.0\,g\,Zn \times \frac{1\,moles\,Zn}{65.4\,g\,Zn} = 0.183\ moles\ Zn$

$* 6.5\,g\,S \times \frac{1\,moles\,S}{32.1\,g\,S} = 0.202\ moles\ S$

Zn (L.R)

② How many grams of ZnS produced

$* 0.183\ \cancel{mole\ Zn} \times \frac{1\ \cancel{mole\ ZnS}}{1\ \cancel{mole\ Zn}} \times \frac{97.5\,g\,ZnS}{1\ \cancel{mole\ ZnS}}$

$= 17.8\ ZnS$

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③ How many grams of which reactant will remain unreacted.

* 0.202 − 0.183 = 0.019 moles left

$$0.019 \text{ moles } S \times \frac{32.1 \text{ g } S}{1 \text{ mole } S} = 0.61 \text{ g } S$$

④ If you obtain 8.9 g of ZnS from your reaction what is the percent yields.

$$\text{* percent yields} = \frac{8.9}{17.8} \times 100\% = 50\%$$

$$A + B \rightarrow C$$

A is LR → calculate amount of C

B is LR → calculate amount of C

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Date

Ex

$4Al + 3O_2 \longrightarrow 2Al_2O_3$

5 g of Al are mixed with 5 g O_2

How many grams of Al_2O_3 are produced

1) 9.44 g
2) 10.6 g
3) 11.6 g
4) 15.6 g

* Al is LR

$$5\ g\ Al \times \frac{1\ mole\ Al}{27\ g\ Al} \times \frac{2\ mole\ Al_2O_3}{4\ mole\ Al} \times \frac{102\ g\ Al_2O_3}{1\ mole\ Al_2O_3}$$

$$= 9.44\ g\ Al_2O_3$$

* O_2 is LR

$$5\ g\ O_2 \times \frac{1\ mole\ O_2}{32\ g\ O_2} \times \frac{2\ mole\ Al_2O_3}{3\ mole\ O_2} \times \frac{102\ g\ Al_2O_3}{1\ mole\ Al_2O_3}$$

$$= 10.6\ g\ Al_2O_3$$

* [illegible]

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Q| How many grams of $AgBr$ can be produced when 50.0 g of $MgBr_2$ is mixed with 100.0 g of $AgNO_3$ as shown below!

$$MgBr_2 + 2AgNO_3 \longrightarrow 2AgBr + Mg(NO_3)_2$$

* $MgBr_2$ is LR

$$50.0\ g\ MgBr_2 \times \frac{1\ mole\ MgBr_2}{184.1\ g\ MgBr_2} \times \frac{2\ mole\ AgBr}{1\ mole\ MgBr_2} \times \frac{187.8\ g\ AgBr}{1\ mole\ AgBr}$$

$$= 102\ g\ AgBr$$

* $AgNO_3$ is LR

$$100\ g\ AgNO_3 \times \frac{1\ mole\ AgNO_3}{169.9\ g\ AgNO_3} \times \frac{2\ mole\ AgBr}{2\ mole\ AgNO_3} \times \frac{187.8\ g\ AgBr}{1\ mole\ AgBr}$$

$$= 111\ g\ AgBr$$

$MgBr_2$ is LR

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Percent composition

For ethanol, C_2H_5OH

molar mass C_2H_5OH

$= 2 \times 12.01 + 6 \times 1.008 + 1 \times 15.999$

$= 46.069$ g/mol

of C_2H_5OH

molar mass

C 12.011

H 1.008

O 15.999

$\%C = (24.022 \text{ g/mol} \div 46.069 \text{ g/mol}) \times 10^2$

$= 52.14\%$

$\%H = (6.048 \text{ g/mol} \div 46.069 \text{ g/mol}) \times 10^2$

$= 13.13\%$

$\%O = (15.999 \text{ g/mol} \div 46.069 \text{ g/mol}) \times 10^2$

$= 34.73\%$

Sum $= 100\%$

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Q1 Calculate the precent composition of R-22 chlorodifluoromethane, CHF_2Cl, the refrigorant used in home air conditioners.

* percent of element in a compounds:

(molar mass) = 35.5 + 2X19 + 1 + 12

= 86.5

%C = (12 ÷ 86.5) X 10^2 = 13.9 %

%H = (1 ÷ 86.5) X 10^2 = 1.15 %

%F = (2X19 ÷ 86.5) X 10^2 = 43.9 %

%Cl = (35.5 ÷ 86.5) X 10^2 = 41 %

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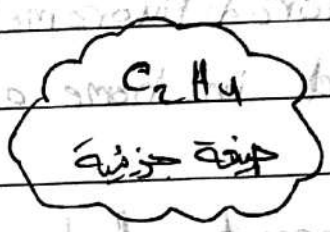
* Consider the following compounds

Ethylene C_2H_4



propylene C_3H_6

cyclobutane C_4H_8

cyclohexane C_6H_{12}

* All have the same empirical formula eH_2.

Empirical formula → a formula describing the lowest whole number ratio of atoms in a compound.

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Ex/ A white compound has been analyzed and found to contain 43.6 wt % phosphorous and 56.4% oxygen. In separate study its molecular weight has been found to be 284 g/mol

what is the empirical formula of this compound?

*

Assume exactly 100 g of the compound, then one has

$$43.6 \text{ g P} \times \frac{1 \text{ mol P}}{30.974 \text{ g P}} = 1.408 \text{ mol of P}$$

$$56.4 \text{ g O} \times \frac{1 \text{ mol O}}{15.999 \text{ g O}} = 3.525 \text{ mol of O}$$

then the molar are

$1.408 \text{ mol} \div 1.408 \text{ mol} = 1.000 \text{ mol P}$

$3.525 \text{ mol} \div 1.408 \text{ mol} = 2.503 \text{ mol O}$

(the ratio to get the lowest whole number ratio 0.50 ? Multiply by 2

and the empirical formula is P_2O_5

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Subject

* what do you do if you get a ratio with something that ends in

0.50 ?

* Multiply by 2

0.33 or 0.66 ?

* Multiply by 3

0.25 or 0.75 ?

* Multiply by 4

0.20, 0.40, 0.60 or 0.80 ?

* Multiply by 5

Subject _____ Day _____ Date _____

Ex| A white compound has been analyzed and found to contain 43.6 wt % phosphorous and 56.4 wt. % oxygen In a separate study it molecular weight has been found to be 284 g/mol

what is the molecular formula of this compound?

* First determine the empirical weight of P_2O_5!

2 X 30.974 g/mol P = 61.948 g/mol P

5 X 15.999 g/mol O = 79.997 g/mol O

The empirical weight of P_2O_5 = the sum = 141.945 g/mol

Molecular weight = Empirical weight = 284 g/mol ÷ 141.945 g/m

= 2.001

and the molecular formula is twice the empirical formula and the molecular formula is P_4O_{10}

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plan

percent to mass

Mass to mole

Divide by small

Multiply 'til whole

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If the odor of $C_6H_{10}S$ can be detected from 2×10^{-13} g in one liter of air, how many atom carbon of $C_6H_{10}S$?

$$1 \times 10^{9} \text{ molecules } C_6H_{10}S \times \frac{6 \text{ atom carbon}}{1 \text{ molecules } C_6H_{10}S}$$

$$= 6 \times 10^{9} \text{ atom carbon}$$

Q) what is the molecular formula for a sample of compound that consists of 0.44 g hydrogen and 6.92 g oxygen ? The molar mass of the compound is 34.08 g/mol.

$$H \quad \frac{0.44}{1} = 0.44 \text{ mol}$$

$$O \quad \frac{6.92}{16} = 0.433 \text{ mol}$$

$H \rightarrow 0.44 \div 0.433 \approx 1$

$O \rightarrow 0.433 \div 0.433 = 1$

OH الصيغة الأولية

H_2O_2

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Properties of Gases : Gas pressure

Gases are described in terms of four properties pressure (p), volume (V), temperature (T), and amount (n).

property	Description	unit of Measurement
pressure (p)	The force exerted by gas the walls of the container.	atmosphere (atm) mm, Hg, torr pascal
volume (V)	the space accupied by the gas	Liter (L) milliliter (mL
Temperature (T)	Determines the kinetic energy and rate of motion of the gas.	Celsious (°C) Kelvin (K)
Amount	the quantity of gas present in a container	grams (g) moles (n)

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Gas pressure

* is described as a force acting on a specific area.

$$\text{pressure (P)} = \frac{\text{Force}}{\text{Area}}$$

Has units of atm, mm Hg, torr and kilopascals (KPa)

1 atm = 760 mm Hg (exact)

1 atm = 760 torr

1 atm = 101.325 KPa

Q| What is 475 mm Hg expressed in atm?

1) 475 atm

2) 0.625 atm

3) 3.61×10^5 atm

$$475 \text{ mm Hg} \times \frac{1 \text{ atm}}{760 \text{ mm Hg}}$$

$$= 0.625 \text{ atm}$$

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Q| The pressure in a tire is 2.00 atm. What is this pressure in mm Hg?

1) 2.00 mm Hg
2) 1520 mm Hg
3) 22300 mm Hg

(ص51)

$2 \text{ atm} \times \frac{760 \text{ mm Hg}}{1 \text{ atm}}$

$= 1520 \text{ mm Hg}$

Atmospheric pressure الضغط الجوي
is the pressure exerted by a column of air from the top of the atmospheric to the surface of the Earth. ↑ قاع الضغط

* is about 1 atmosphere at sea level.
* depends on the altitude and the weather.
* is lower at high altitudes where the density of air is less.
* is higher on a rainy day than on a sunny day.

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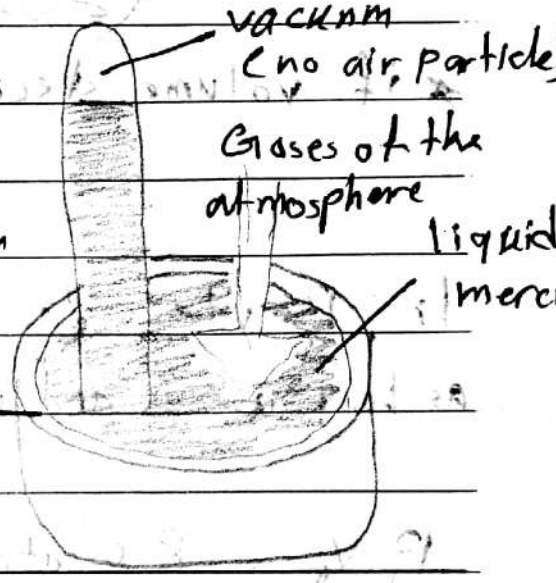
* measures the pressure exerted by the gases in the atmosphere.

* indicates atmospheric pressure as the height in mm of the mercury column.



جهاز لقياس الضغط الجوي

A) The downward pressure of the Hg in a barometer is _____ than (as) the pressure of the atmosphere.

1) greater 2) less 3) the same

B) A water barometer is 13.6 times taller than a Hg barometer ($D_{Hg} = 13.6$ g/ml) because:

1) H_2O is less dense than mercury (أقل كثافة)

2) H_2O is heavier than mercury 3) air is more dense than H_2O

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Boyle's law states that :

* the presure of agas is inversely related to its volume when T and n are constant

* if volume decreases , the pressure increases

In Boyle's law, the product P x V is constat as long as T and n do not change .

$P_1 V_1 = 8.0 \text{ atm} \times 2.0 \text{ L} = 16 \text{ atm L}$

$P_2 V_2 = 4.0 \text{ atm} \times 4.0 \text{ L} = 16 \text{ atm L}$

$P_3 V_3 = 2.0 \text{ atm} \times 8.0 \text{ L} = 16 \text{ atm L}$

Boyle's law can be stated as

$P_1 V_1 = P_2 V_2$ (T, n constant)

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Subject _____ Day _____ Date _____

* The equation for Boyle's Law can be rearranged to solve for any factor.

$$P_1 V_1 = P_2 V_2$$

To solve for V_2, divide both sides by P_2

$$V_2 = V_1 \frac{P_1}{P_2}$$

During an inhalation

* the lungs expand
* the pressure in the lungs decreases.
* air flows towards the lower pressure in the lungs.

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Subject _____ Day _____ Date _____

Q1 Freon-12 CCl_2F_2 is used in refrigeration systems, what is the new volume (L) of a 8.0 L sample of freon gas initially at 550 mm Hg after its pressure is changed to 2200 mm Hg at constant T?

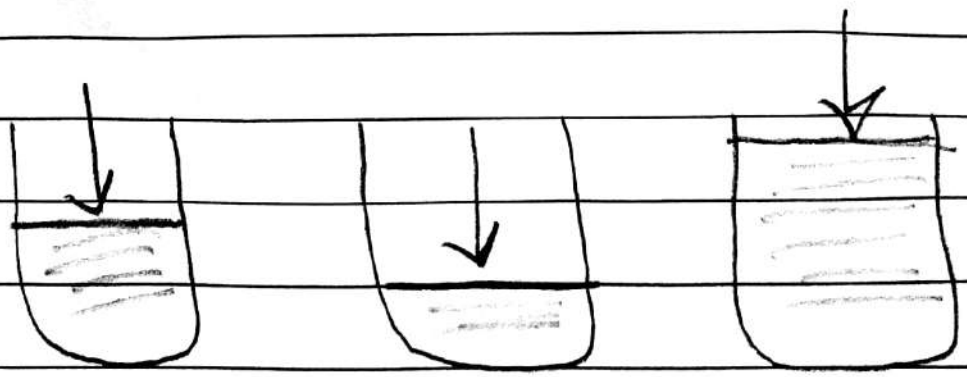
* $P_1V_1 = P_2V_2$

$$\frac{550 \text{ mm Hg} \times 8.0 \text{ L}}{2200 \text{ mm Hg}} = 2.0 \text{ L}$$

* For a cylinder containing helium gas indicate if cylinder A or cylinder B represents the new volume for the following changes (n and T are constant).

1) Pressure decreases (B)

2) pressure increases (A)



Initial → A or B

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Subject _____ Day _____ Date _____

Q1 If a sample of helium gas has a volume of 120 ml and a pressure of 850 mm Hg, what is the new volume if the pressure is changed to 425 mm Hg?

1) 60 ml 2) 120 ml 3) 240 ml

Q51

$$P_1V_1 = P_2V_2$$

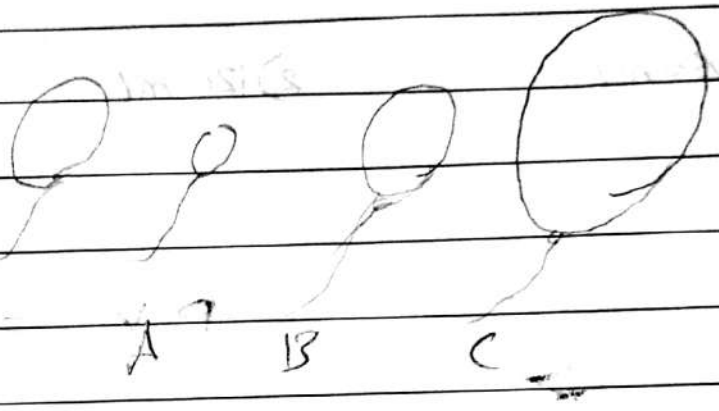
$$V_2 = 120\,ml \times \frac{850\,\cancel{mm\ Hg}}{425\,\cancel{mm\ Hg}}$$

$$V_2 = 240\ ml$$

CamScanner الممسوحة ضوئيا بـ

Subject _____ Day _____ Date _____

Q1. A sample of helium gas in a ballon has a volume of 6.4 at a pressure of 0.70 atm. At 1.40 atm (T constant), is the new volume represented by A, B or C?



* the new volume is represented by the smaller ballon A.

Q1 If the sample of helium gas has a volume of 6.4L at a pressure of 0.70 atm, what is the new volume when the pressure is increased to 1.40 atm?

A) 3.2L B) 6.4L C) 12.8L

$V_1 P_1 = V_2 P_2$

$6.4L \times \frac{0.70\ atm}{1.40\ atm}$

Subject _____ Day _____ Date _____

Charles's Law

* the Kelvin temperature (K) of a gas is directly related to its volume.

* كلما زادت درجة الحرارة زاد الحجم

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

* pressure and moles of gas are constant.

* when the temperature of a sample of gas increase its volume increases at constant pressure.

For two conditions, charles's law is written (P and n are constant)

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Rearranging charles's law to solve for V_2:

$$V_1 \times \frac{T_2}{T_1} = V_2 \times \frac{T_2}{T_2}$$

$$V_2 = V_1 \frac{T_2}{T_1}$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Q) A balloon has a volume of 785 ml at 21°C. If the temperature drops to 0°5, what is the new volume of the balloon at constant pressure and moles?

★ للتحويل من °C ← كلفن + ٢٧٣ °C

والعكس طرح

$T_1 = 21\,C^\circ = 294\,K$

$T_2 = 0\,C^\circ = 273\,K$

$$V_2 = 785\,ml \times \frac{273\,K}{294\,K} = 729\,ml$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

[redacted]

* the pressure exerted by a gas is directly related to the Kelvin temperature.

V and n are constant.

الحجم ثابت

كلما زادت درجة الحرارة زاد الضغط

(الحجم ثابت)

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Q| A gas has a pressure at 2.0 atm at 18°C. what is the new pressure when the temperature is 62°C?

* $P_1 = 2.0$ atm $\qquad P_2 = ??$

$T_1 = 18^\circ C + 273 = 291\ K$ $\qquad T_2 = 62^\circ C + 273 = 335\ K$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$P_2 = P_1 \times \frac{T_2}{T_1}$$

$$P_2 = 2.0\ atm \times \frac{335\ K}{291\ K} = 2.3\ atm$$

الممسوحة ضوئيا بـ CamScanner

Q1 A gas has a pressure of 645 torr at 128°C. what is the temperature in Celsius if the pressure increases to 1.50 atm (n and v remain constant)?

* $P_1 = 645$ torr

$P_2 = 1.50 \text{ atm} \times \frac{760 \text{ torr}}{1 \text{ atm}}$

$P_2 = 1140$ torr

$T_1 = 128\,^{\circ}C + 273$

$= 401$ K

$T_2 = K - 273$

$= ?\,^{\circ}C$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$T_2 = T_1 \times \frac{P_2}{P_1}$$

$$T_2 = 401 \text{ K} \times \frac{1140 \text{ torr}}{645 \text{ torr}} = 709 \text{ K}$$

$709 \text{ K} - 273 = 436\,^{\circ}C$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

The combined gas law uses Boyle's Law, Charles Law, and Gay-Lussac's Law (n is constant)

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$ (القانون العام)

Q1 A gas has a volume of 675 ml at 35° C and 0.850 atm pressure. what is the volume (mL) of the gas at -95° C and a pressure of 802 mmHg?

* $T_1 = 35^\circ C + 273$ $T_2 = -95^\circ C + 273$

$T_1 = 308\ K$ $T_2 = 178\ K$

$V_1 = 675\ mL$ $V_2 = ??$

$P_1 = 646\ mm\ Hg$ $P_2 = 802\ mm\ Hg$

$$V_2 = V_1 \times \frac{P_1}{P_2} \times \frac{T_2}{T_1}$$

$$V_2 = 675\ mL \times \frac{646\ \cancel{mm\ Hg}}{802\ \cancel{mm\ Hg}} \times \frac{178\ \cancel{K}}{308\ \cancel{K}}$$

$$V_2 = 314\ mL$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Q1 A sample of helium gas has a volume of 0.180 L, a pressure of 0.800 atm and a temperature of 29°C. At what temperature (°C) will the helium have a volume of 90.0 ml and a pressure of 3.20 atm

1 L = 1000 ml

* $P_1 = 0.800$ atm $P_2 = 3.20$ atm

$V_1 = 0.180$ L (180 mL) $V_2 = 90.0$ mL

$T_1 = 29°C + 273 = 302$ K $T_2 = ??$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$T_2 = T_1 \times \frac{P_2}{P_1} \times \frac{V_2}{V_1}$$

$$T_2 = 302\,K \times \frac{3.20\ \cancel{atm}}{0.800\ \cancel{atm}} \times \frac{90.0\ \cancel{mL}}{180\ \cancel{mL}} = 604\,K$$

$T_2 = 604\,K - 273 = 331\,^{\circ}C$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

[redacted]

* the volume of agas is directly related to the number of moles (n) of gas.

* T and P are constant

علاقة طردية

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

Q1 If 0.75 mole helium gas accupies a volume of 1.5 L, what volume will 1.2 mole helium accup at the same temperature and pressure ?

1) 0.94 L
2) 1.8 L
3) 2.4 L

الحل

$$V_2 = V_1 \frac{n_2}{n_1}$$

$$V_2 = 1.5\,L \times \frac{1.2 \text{ moles He}}{0.75 \text{ mole He}}$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

The volumes of gases can be compared at STP standard temperature and pressure, when they have

* the same temperature
  standard temperature (T)
  0°C or 273K

* the same pressure
  standard pressure (P)
  1 atm (760 mmHg)

اعمل عنداي غاز حجمه ٢٢,٤ لتر

At standard temperature and pressure (s
1 mole of a gas occupies a volume of 22.4
which is called its molar volume.

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

The molar volume at STP can be used to form conversion factors

$$\frac{22.4\ L}{1\ mole} \quad \text{and} \quad \frac{1\ mole}{22.4\ L}$$

what is the volume occupied by 2.75 moles N_2 gas at STP?

* The molar volume is used to convert moles to liters.

Molar of gas ← Molar volume 22.4 L/mol → volume of ga

$$2.75\ \text{moles}\ N_2 \times \frac{22.4\ L}{1\ \text{mole}} = 61.6\ L$$

الممسوحة ضوئيا بـ CamScanner

Subject Day Date

A) what is the volume at STP at 4.00 g of CH_4

[redacted] 2) 11.2 L 3) 44.8 L

4) 5.60 L

B) How many grams of He are present in 8.00 L of gas at STP?

1) 25.6 g 2) 0.357 g [redacted]

3) 1.43 g

Q1 what volume (L) of O_2 gas is needed to completely react with 15.0 g of aluminum at STP?

$4Al(s) + 3O_2(g) \longrightarrow 2Al_2O_3(s)$

g Al → mole Al → mole O_2 → L O_2 (STP)

$$15.0\text{ g Al} \times \frac{1\text{ mole Al}}{27.0\text{ g Al}} \times \frac{3\text{ moles } O_2}{4\text{ moles Al}} \times \frac{22.4\text{ L (STP)}}{1\text{ mole } O_2}$$

$$= 9.33\text{ L } O_2 \text{ at STP}$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

What mass of Fe will react with 5.50 L O_2 at STP?

$$\underset{?\,?}{4\,Fe(s)} + 3\,O_2(g) \longrightarrow 2\,Fe_2O_3(s)$$

$$5.50\ \cancel{L}\ O_2 \times \frac{1\ mole}{22.4\ \cancel{L}} \times \frac{4\ \cancel{moles\ Fe}}{3\ \cancel{moles}\ O_2} \times \frac{55.9\ g\ Fe}{1\ \cancel{mole\ Fe}}$$

$$= 18.3\ g$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

[redacted]

* Boyles law $V \propto \frac{1}{P}$

* charles law $V \propto T$

* Avogadro's law $V \propto n$

Combining these, we get $V \propto \frac{nT}{P}$ $\propto \rightarrow = R$

Then $V = \frac{nRT}{P}$ or $PV = nRT$

R (constan

$R = \frac{PV}{nT}$

في الظروف القياسية

$R = \frac{(1.00\ atm)(22.4\ L)}{(1\ mole)(273\ k)} = \frac{0.0821\ L\ atm}{mole\ k}$

أو

$R = \frac{(760\ mmHg)(22.4\ L)}{(1\ mole)(273\ k)} = \frac{62.4\ L\ mmHg}{mole\ k}$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Q1 Dinitorgen oxide N_2O, which is used in dentistry, is an anesthetic also called laughing gas. what is the pressure in atmosphere of 0.350 mole of N_2O at 22°C in a 5.00-L contain

* $PV = nRT$

$22°C + 273 = 295\ K$

$$P = \frac{nRT}{V}$$

$$P = \frac{0.350\ \text{mole} \times \frac{0.0821\ L\ atm}{\text{mole}} \times 295\ K}{5.00\ L}$$

$$P = 1.70\ atm$$

Ideal Gas Constant (R)	$\frac{0.0821\ L \cdot atm}{mole \cdot K}$	$\frac{62.4\ L \cdot mmHg}{mole \cdot K}$
Pressure (P)	atm	mmHg
volume (V)	L	L
Amount (n)	moles	moles
Temperature (T)	K	K

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Q) A 5.0 cylinder gas contains oxygen gas at 20.0 °C and 735 mm Hg. How many grams of oxygen are in the cylinder?

* $n = \frac{PV}{RT}$

$$n = \frac{(735\ mm\ Hg)(5.0\ L)(mol \cdot K)}{(62.4\ mm\ Hg \cdot L)(293\ K)}$$

$$n = 0.2\ mol\ O_2$$

So in grams $= 0.2\ mol\ O_2 \times \frac{32.0\ g\ O_2}{1\ mol\ O_2} = 6.4\ g$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Q1 what is the molar mass of a gas if 0.250 of the gas occupy 215 ml at 0.813 atm and 30.0°C ?

* $n = \frac{PV}{RT}$

$$n = \frac{(0.813\ atm)(0.215\ L)(mol \cdot K)}{(0.0821\ atm \cdot L)(303\ K)}$$

$n = 0.00703\ mol$

$$Mol = \frac{mass}{molar\ mass}$$

$$Molar\ mass = \frac{0.250\ g}{0.00703\ mol} = 35.6\ g/mol$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

* Calculate the density in g/L of oxygen gas at STP.

* $PV = nRT$

$$\frac{PV}{RTV} = \frac{nRT}{RTV}$$

$$\frac{P}{RT} = \frac{n}{V}$$

density = mass / volume

$$\frac{P}{RT} = \frac{\text{mass}}{V} / \text{molar mass} \rightarrow \text{density} = \frac{\text{Molar mass} \times P}{RT}$$

$$\text{Density} = \frac{32.0\ g/mol\ (mol.K) \times 1.00\ atm}{(0.0821\ atm.L)(273\ K)}$$

$$= 1.43\ g/L$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Nitrogen gas reacts with hydrogen gas to produce ammonia (NH_3) gas. How many liters of NH_3 can be produced at 0.93 atm and 24 °C from a 16.0 g sample of nitrogen gas and an excess of hydrogen gas?

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

* $$n = \frac{PV}{RT}$$

$$16.0\ g\ N_2 \times \frac{1\ mole\ N_2}{28.02\ g\ N_2} \times \frac{2\ moles\ NH_3}{1\ mole\ N_2}$$

$$= 1.14\ moles\ NH_3$$

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Subject _____ Day _____ Date _____

Dalton's law)

the total pressure exerted by gases in a mixture is the sum of the partial pressures of gases!

$$P_T = P_1 + P_2 + P_3$$

For example, at STP, one mole of a pure gas in a volume of 22.4 L will exert the same pressure as one mole of a gas mixture in 22.4 L

$V = 22.4\,L$

	0.6 mole He	0.5 mole O_2
1.0 mole N_2	0.4 mole O_2	0.3 mole Ne
	1.0 mole	0.2 mole Ar
1.0 atm	1.0 atm	1.0 atm

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Q/ A scuba tank contains O_2 with a pressure of 0.450 atm and He at 855 mm Hg. What is the total pressure in mm Hg in the tank?

* $0.450 \text{ atm} \times \frac{760 \text{ mm Hg}}{1 \text{ atm}}$

$= 342 \text{ mm Hg} = P_{O_2}$

$P_{total} = P_{O_2} + P_{He}$

$342 \text{ mm Hg} + 855 \text{ mm Hg}$

$= 1197 \text{ mm Hg}$

الممسوحة ضوئيا بـ CamScanner

Subject Day Date

Q| For a deep dive, a scuba diver uses a mixture of helium and oxygen with a pressure of 8.00 atm. If the oxygen has a partial pressure of 1280 mm Hg.
what is the partial pressure of the helium?

1) 520 mm Hg
2) 2040 mm Hg
3) 4800 mm Hg

الحل

$$P_{total} = 8.00\ atm \times \frac{760\ mm\ Hg}{1\ atm} = 6080\ mm$$

$$P_{total} = P_{O_2} + P_{He}$$

$$P_{He} = P_{total} - P_{O_2}$$

$$P_{He} = 6080\ mm\ Hg - 1280\ mm\ Hg$$

$$= 4800\ mm\ Hg$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

$P_{total} = P_{O_2} + P_{He}$ $\quad PV = nRT$

$$\frac{n_{O_2} RT}{V} + \frac{n_{He} RT}{V}$$

$$P_{total} = (n_{O_2} + n_{He}) \frac{RT}{V}$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Q| A 5.0 L scuba tank contains 1.05 mole of O_2 and 0.418 mole He, at 25°C. what is the partial pressure of each gas, and what is the total pressure in atm in the tank ?

$$P_{total} = P_{O_2} + P_{He}$$

$$= \frac{n_{O_2} T R}{V} + \frac{n_{He} R T}{V}$$

$$= \frac{1.05 \text{ mol} \times 0.0821 \text{ L.atm} \times 298 \text{ K}}{5.0 \text{ L} (\text{K.mol})} + \frac{0.418 \text{ mol} \times 0.0821 \times 298}{5.0 \text{ L} (\text{K.mol})}$$

$$= 5.14 \text{ atm} + 2.05 \text{ atm}$$

$$= 7.19 \text{ atm}$$

or] $P_{total} = (n_{O_2} + n_{He}) \frac{RT}{V} = 7.19 \text{ atm}$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Q1 A gaseous mixture made from 6.00 g O_2 and 9.00 g CH_4 is placed in a 15.0 L vessel at 0°C. what is the partial pressure of each gas and what is the total pressure in the vessel?

$$n_{O_2} = (6.00\ g\ O_2)\left(\frac{1\ mol\ O_2}{32.0\ g\ O_2}\right) = 0.188\ mol\ O_2$$

$$n_{CH_4} = (9.00\ g\ CH_4)\left(\frac{1\ mol\ CH_4}{16.0\ g\ CH_4}\right) = 0.563\ mol$$

$$P_{O_2} = \frac{n_{O_2}RT}{V} = \frac{(0.188\ mol)(0.0821\ L\text{-}atm/mol\text{-}K)(273\ K)}{15.0\ L}$$

$$= 0.281\ atm$$

$$P_{CH_4} = \frac{n_{CH_4}RT}{V} = \frac{(0.563\ mol)(0.0821\ L\text{-}atm/mol\text{-}K)(273\ K)}{15.0\ L}$$

$$= 0.841\ atm$$

$$P_{total} = 0.281\ atm + 0.841\ atm$$

$$= 1.122\ atm$$

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Subject _____ Day _____ Date _____

$$\frac{P_1}{P_{total}} = \frac{n_1 RTN}{n_{total} RTN}$$

$PV = nRT$ so $P = \frac{nRT}{V}$

$\frac{P_1}{P_{total}} = \frac{n_1}{n_{total}}$ and we know that mol fraction

$$X = \frac{n_1}{n_{total}}$$

$$\frac{P_1}{P_{total}} = X \longrightarrow P_1 = X P_{total}$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Q] NH_3 decomposes to N_2 and H_2 as

$$2NH_3 \longrightarrow N_2 + 3H_2$$

If 4 atm of NH_3 was initially decomposed, calculate the total pressure in the container when the reaction is finised (assume the volume and temperature in the container are constant)

a) 2.0 atm
b) 10.0 atm
c) 8.0 atm
d) 6.0 atm

051

$$\frac{P_1}{P_{total}} = \frac{n_1}{n_{total}}$$

$$\frac{4}{P_{total}} = \frac{2}{4}$$

$$P_{total} = 8 \text{ atm}$$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

$P_T = P_{O_2} + P_{H_2O}$

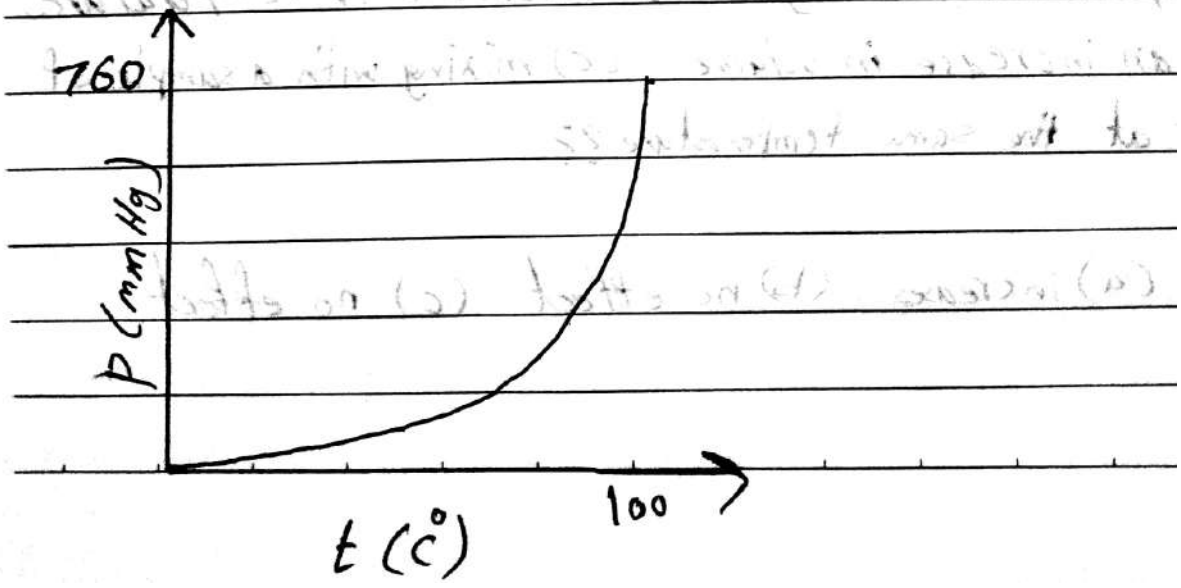
كلما زادت درجة الحرارة فإن بخار الماء يزيد.

*Oxygen gas generated by the decomposition of potassium is collected.

* The volume of oxygen collected at 24°c and atmospheric pressure of 762 mmHg is 128 ml

* calculate the mas (in grams) of oxygen gas obtained.

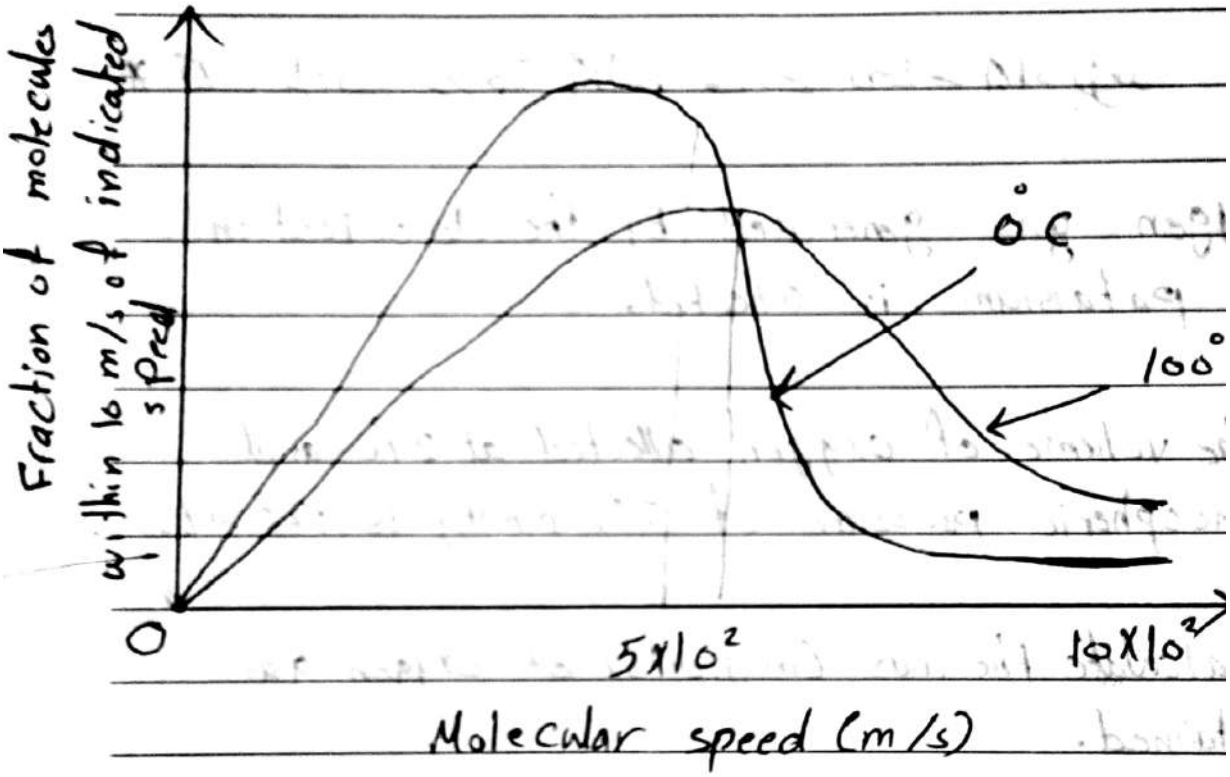
[Hint] the pressure of the water vapor at 24° is 224 mm Hg.



الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

The average kinetic energy of the molecules is proportional to the absol temperature.



Q] How is the speed of N_2 molecules in a ga sample changed by (a) an increase in temperatu (b) an increase in volume, (c) mixing with a sample Ar at the same temperature??

* (a) increases (b) no effect (c) no effect

Subject _____ Day _____ Date _____

Effusion - تَفَيُّض

* the escape of gas molecules through a tiny hole an evacuated space.

* the spread of one substance throughout a space or throughout a second substance.

* Averge molecular kinetic energy depends only on temperature for ideal gases.

There fore:

- Higher temperature means higher root-mean-square speed (RMS), rms

- The higher the molecular weight (molar mass), the lower the u_{rms} speed (same temperature).

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Subject _____ Day _____ Date _____

Calculate the rms speed, u of an N_2 molecule at 25°C

$$u_{rms} = \sqrt{\frac{3RT}{M}}$$

$T = 25 + 273 = 298\,K$

$M = 28.0\ g/mol = 28.0 \times 10^{-3}\ Kg/mol$

$R = 8.314\ J/mol\text{-}K = 8.314\ Kg\text{-}m^2/s^2\text{-}mol\text{-}K$

(these units follow the fact that $1J = 1\ Kg\text{-}m^2/s^2$)

$$u = \sqrt{\frac{3(8.314\ Kg\text{-}m^2/s^2\text{-}mol\text{-}K)(298K)}{28.0 \times 10^{-3}\ Kg/mol}}$$

$u = 5.15 \times 10^2\ m/s$

Q| what is the rms speed of an He at 25°C?

* $1.36 \times 10^3\ m/s$

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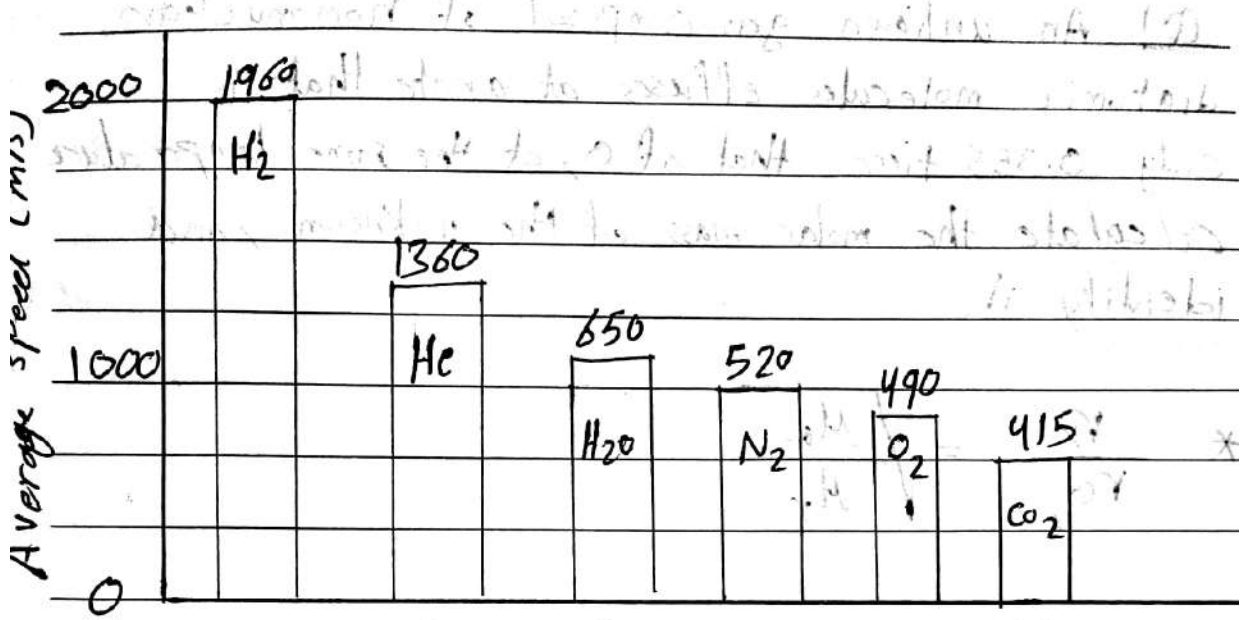
Subject _____ Day _____ Date _____



Meler = 2.0 4.0 18.0 28.0 32.0 44.0

Mass

أسرع جزيء H_2

علاقة عكسية بين الكتلة المولية والسرعة.

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Q1 An unkown gas composed of homonuclear diatomic molecules effuses at a rate that is only 0.355 times that of O_2 at the same temperatur calcalate the molar mass of the unknown, and identify it.

$$\frac{r_x}{r_{O_2}} = \sqrt{\frac{M_{O_2}}{M_x}}$$

$$r_x = 0.355 \times r_{O_2}$$

$$\frac{r_x}{r_{O_2}} = 0.355 = \sqrt{\frac{32.0\ g/mol}{M_x}}$$

$$(0.355)^2 = \frac{32.0\ g/mol}{M_x} = 0.126$$

(I_2)

$$M_x = \frac{32.0\ g/mol}{0.126} = 254\ g/mol$$

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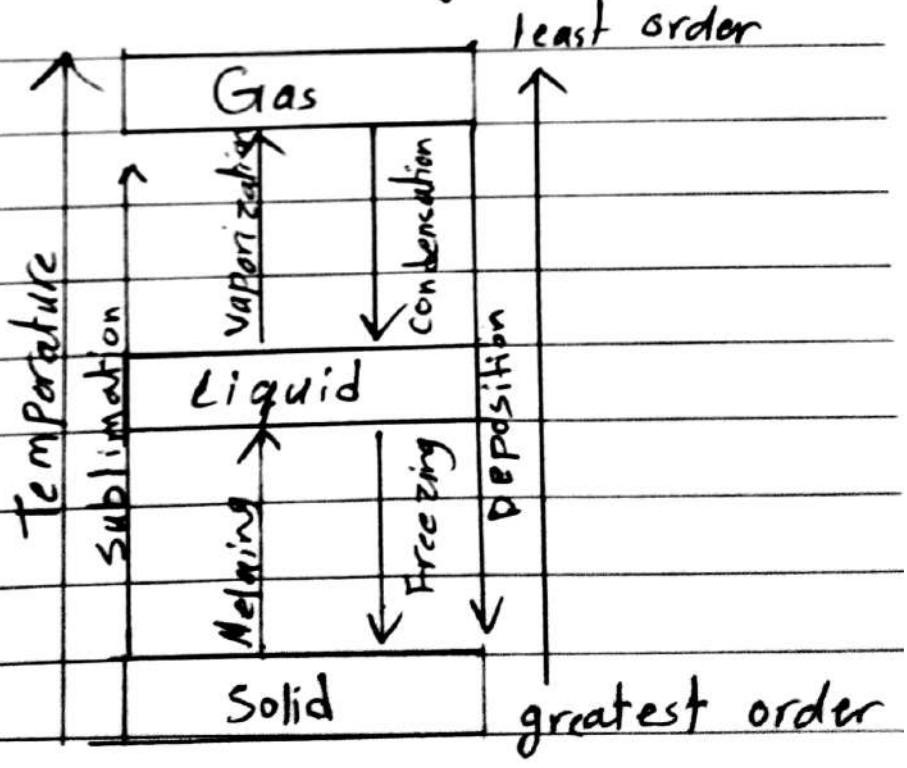
Intermdecular Forces and Liquids and Solids

A phase is a homogeneous part of the system in contact with other parts of the system but separated from them by a well-defined boundary.

2 phases

Solid phase = ice
Liquid phase = water

Phase changes



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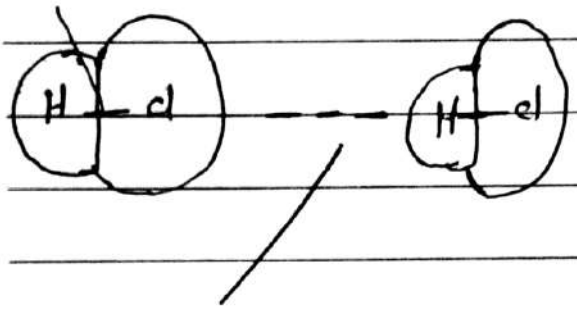
Intermolecular Forces

* are in general much weaker than intramolecular forces.

covalent bond (strong)



Intermolecular attraction (weak)

intermolecular forces are generally less than 15% as strong as ionic or covalent bonds.

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Intermolecular Forces

* are attractive forces between molecules.
* hold atoms together in a molecule (ionic bond NaCl and covalent bond HCl)

Intermolecular vs Intramolecular

- 41 J to vaporize 1 mole of water (inter)
- 930 KJ to break all O-H bonds in 1 mole of water (intra)

* intermolecular forces are much weaker than intramolecular forces.

" Measure of intermolecular force"

boiling point
melting point
$\triangle H_{vap}$
$\triangle H_{fus}$
$\triangle H_{sub}$

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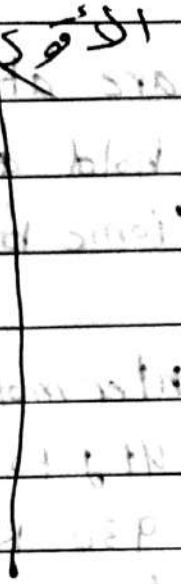
What are Intermolecular Forces?

1) Ion - dipole (strongest)

2) hydrogen" bonding

3) dipole - dipole

4) dispersion (weakest)



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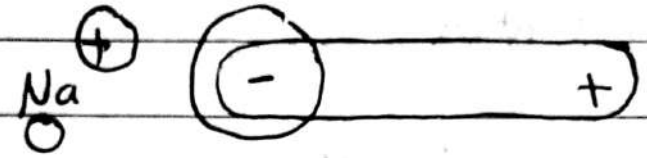
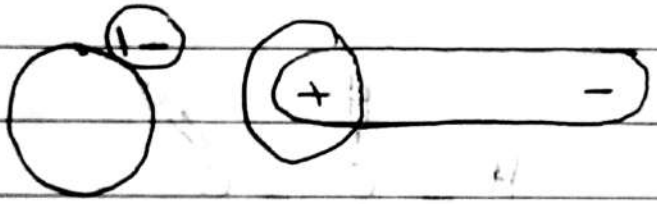
Ion - Dipole Forces

Attractive forces between an ion and apolar molecule.





* the attachment of water to solute partic is called hydration, hydration of ions is du to the polar character of the H_2O molecule.

* Hydrogen bonding is a weak to moderate attr force that exists between a hydrogen atom covalently bonded to avery small and highly electronegative atom and alone pair of electrons another small electronegative atom (F, O, or N

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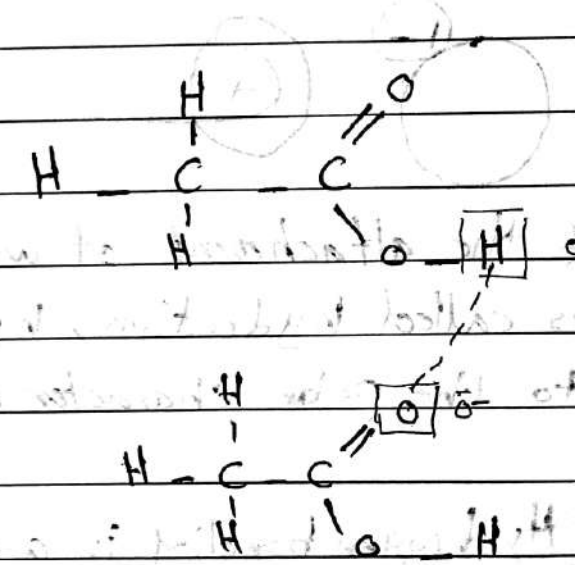
Hydrogen Bond

* the hydrogen bond is a special dipole-dipole interaction between they hydrogen atom in a polar N-H, O-H, or F-H bond and an electronegative O, N or F atom.

A ___ H ... B or A _ H ... A

CH_3COOH

Acetic acid



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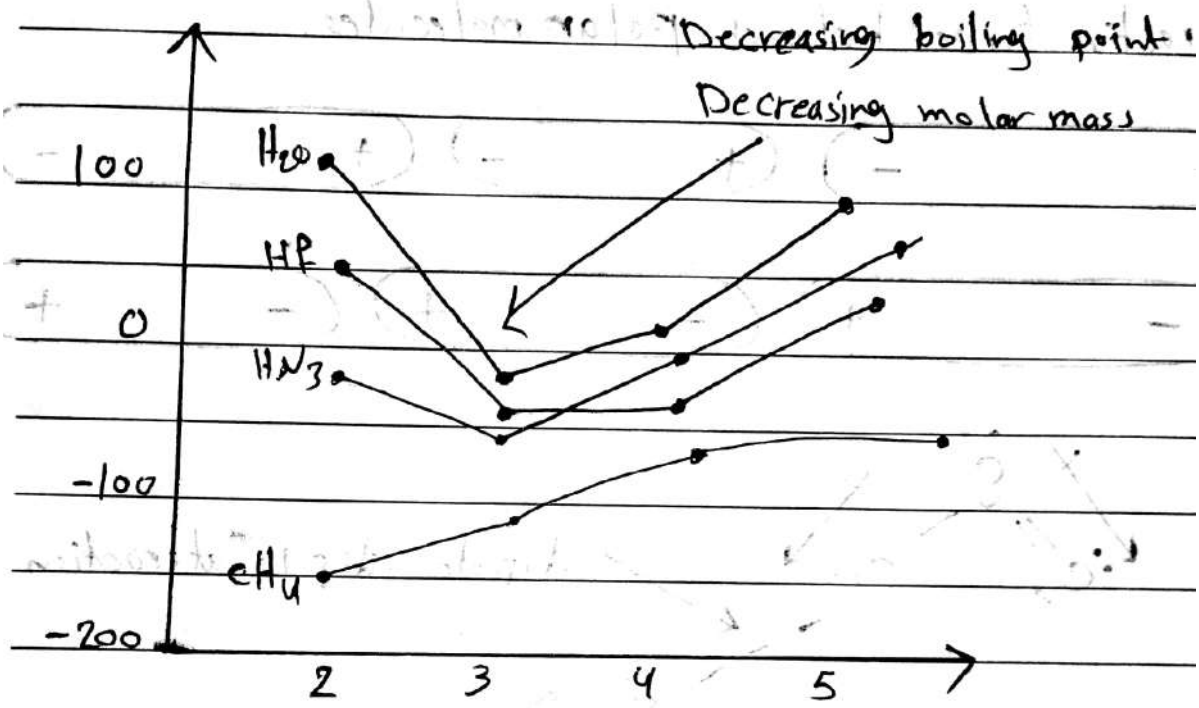
Q| why is the hydrogen boned considered a "special" dipole-dipole interaction?



Q| which of the following can from hydrogen bonds with water?

CH_3OCH_3

CH_4

F_2

$HCOOH$

Na^+

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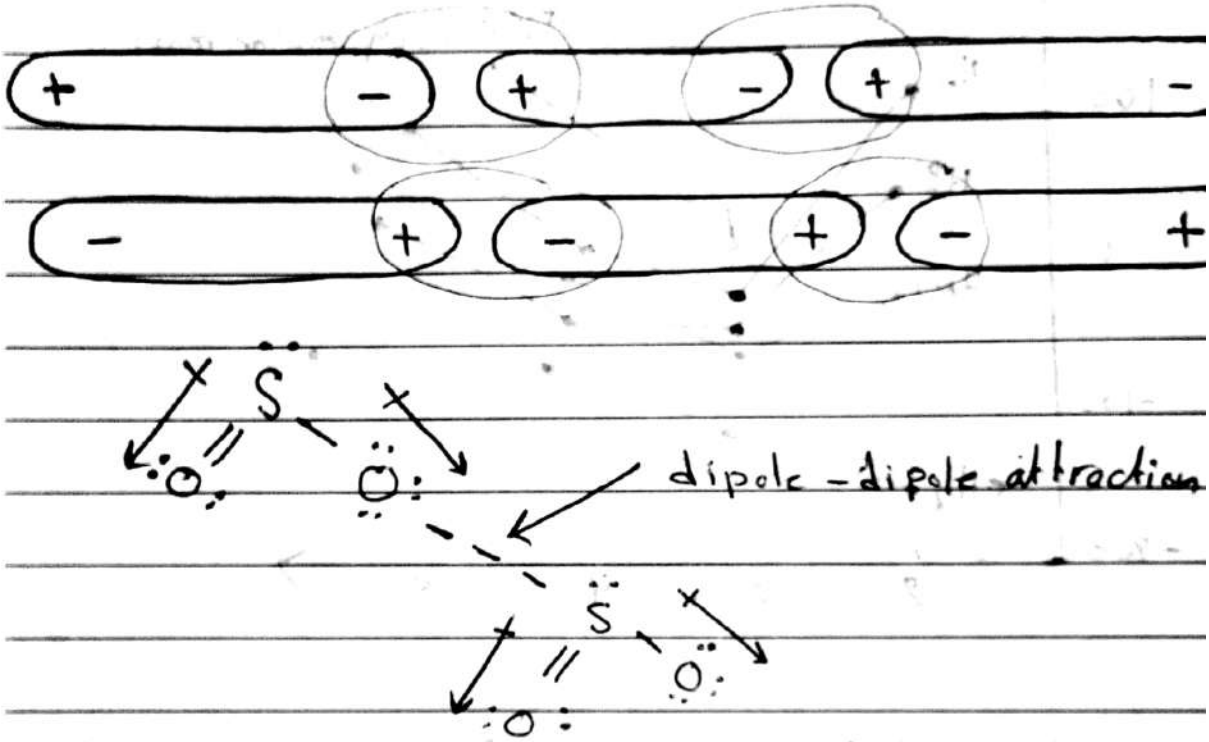
Dipole - Dipole Forces

Attractive forces between polar molecules.



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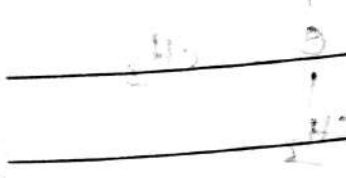
Dispersion Forces

* usually forces increase with molar mass.

(Factors Affecting London Forces)

* the shape of the molecule affects the strength of dispersion forces: long, skinny molecules (like n-pentane tend to have stronger dispersion forces than short, fat ones (like neopentane)

* this is due to the increased surface area in n-pentane.



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Factors that affect boiling point

1. Intermolecular forces :

* London dispersion forces < Dipole-Dipole interaction < Hydrogen

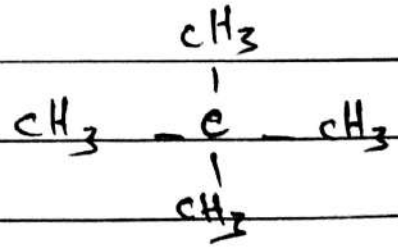
2. Number of sites for intermolecular interaction (surface area).

- Larger surface (more electrons) → more sites for London

→ ↑ b.p. $CH_3-CH_2-CH_2-CH_2-CH_3 > CH_3-CH_2-CH_3$

3. Molecular shape : the same molecular weight

linear $CH_3-CH_2-CH_2-CH_2-CH_3$ > spherical



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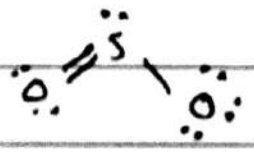
Rod-like molecules have a greater surface area, more contact points for molecules to join together.	Ball or spherical shaped molecules have fewer contact points for molecules to join together.
Boiling points: 36°C	isomers 10°C

what type of intermolecular forces exist between each of the following molecules?

HBr (is apolar molecule: dipole - dipole forces. There are also dispersion forces between HBr molecules)

CH_4 (is nonpolar: dispersion force)

SO_2 

(is apolar molecule: dipole - dipole forces. There are also dispersion forces between SO_2 molecules.

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Q) what type of intermolecular forces exist between the following pairs?

1. HBr and H_2S

* are polar molecules. Therefore, the intermolecul forces present are dipole - dipole forces, as well a disporsion forces.

2. Cl_2 and CBr_4

* are nonpolar, so there are only dispersion forces between these molecules.

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Properties of Liquids

1_ Viscosity. اللزوجة
2_ surface tension. التوتر السطحي
3_ cohesive and adhesive forces. قوة التماسك
4_ Vapor pressure. البخار

(viscosity) اللزوجة

_ Resistance of a liquid to flow is called viscosity
_ It is related to the case with which molecules can move past each other.
_ Viscosity increases with stronger intermolecular forces and decreases with higher temperature.

strong intermolecular ⟶ High viscosity

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(surface tension) is the amount of energy required to stretch or increase the surface of a liquid by a unit area.

strong intermolecular forces ⟶ High surface tension

* surface tension for

$Hg > H_2O > CH_3OCH_3$ surface tension increases with stronger intermolecular.

Cohesion ⟶ is the intermolecular attraction between like molecules (bind molecules of the same type together)

Adhesion ⟶ is an attraction between unlike molecules (bind substance to surface)

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(capillary action) is how liquids flow up narrow tubes.

The upward curved meniscus of water forms (concave مقعر) because water bind to glass

Adhesion > cohesion ← الماء

The downward meniscus of mercury forms (convex محدب) because the cohesive forces i mercury is strong than between mercury atoms and the glass.

cohesion > Adhesion ← الزئبق

السوائل ترتفع في الأنابيب الضيقة.

(vapor pressure)

البخار أكثر عندما تكون الحرارة عالية.

اذا كانت الروابط قوية لا يوجد بخار.

أقوى الروابط هي الماء.

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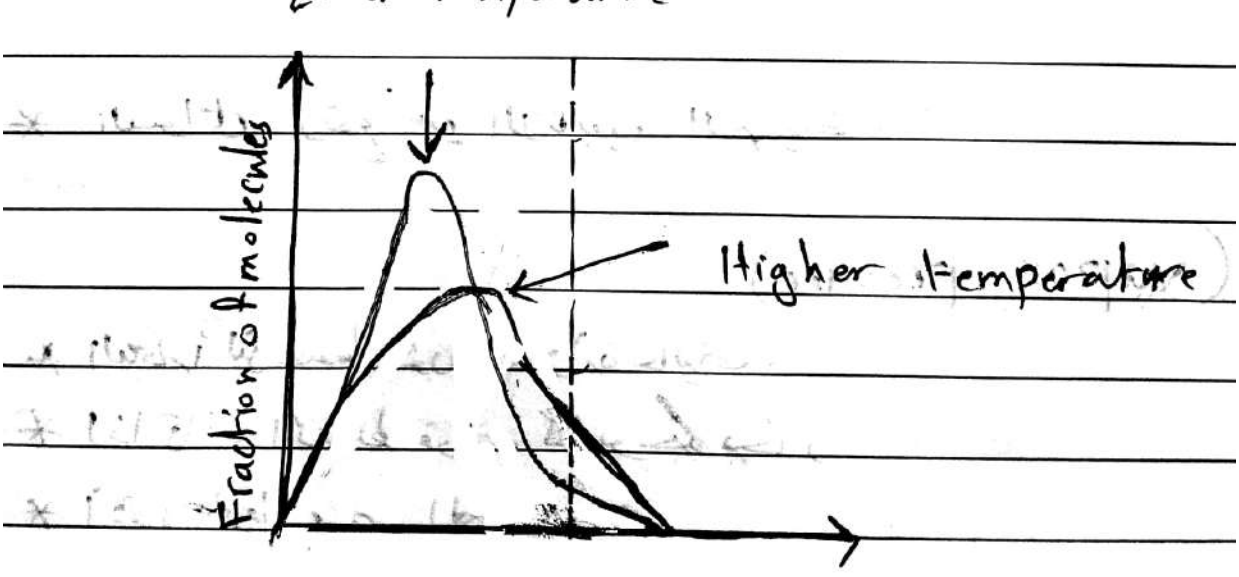
* The normal boiling point is the temperature at which its vapor pressure is 760 torr.

* Liquids in which the intermolecular forces are strong have relatively low vapor pressure.

* vapor pressure increases significantly with temperature.

* At any temperature, some molecules in liquid have enough energy to escape.

* As the temperature rises, the fraction of molecules that have enough to escape increases.



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* The boiling point (B.P) for a liquid give indication about its vapor pressure (the liquid with higher boiling point will have lower vapor pressure)

Q/ which one of liquid have highest vapor pressure.

① $CH_3CH_2OCH_2CH_3$ B.P → 34.5 °C

• CH_3CH_2OH B.P → 78.5 °C

• H_2O B.P → 100 °C

• $HOCH_2CH_2OH$ B.P → 198 °C

الأقل درجة غليان (بخار أكثر)

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Clausius - clapeyron Equation

$$\ln \frac{P_{vap\,T_1}}{P_{vap\,T_2}} = \frac{\Delta H}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

or

$$\ln \frac{P_1}{P_2} = \frac{\Delta H}{R}\left(\frac{T_1 - T_2}{T_1 T_2}\right)$$

P_{vap} : vaper pressure.

ΔH_{vap} : enthalpy of vaporization.

* R : 8.3145 J / k mol

T : temperature (in kelvin)

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Q) what is the vapor pressure of water at 100°C?

* 760 torr

Q) The vapor pressure of water at 25°C is 23.8 torr, and the heat of vaporization of water at 25°C is 43.9 KJ/mol. calculate the vapor pressure of water at 65°C.

* 194 torr

Q) In the heat of vaporization of water (ΔH_v is 40.7 KJ/mol. Calculate the vapor pressure of pure water at 73°C.

* 273 torr

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Q1 Diethyl ether $[(C_2H_5)_2O]$ is a volatile, highly flammable organic liquid that is used mainly as a solvent.
The vapor pressure of diethly ether is 401 mm Hg at 18°C. calculate its vapor pressure at 32°C.

* $P_1 = 401\ mm\,Hg$ $\qquad P_2 = ??$

$T_1 = 18^\circ C = 291\ K$. $\qquad T_2 = 32^\circ C = 305\ K$

$$\ln \frac{401}{P_2} = \frac{26000\ J/mol}{8.314\ J/K.mol} \left[\frac{291\ K - 305\ K}{(291\ K)(305\ K)}\right]$$

$$= -0.493$$

$$-0.493$$

$$\frac{401}{P_2} = e \qquad = 0.611$$

$$P_2 = 656\ mm\,Hg$$

* we expect the vapor pressure to be greater at a higher temperature.

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Q1 The vapor pressure of ccly at 40°c is 313 torr, and at 80°c is 512 torr. what is the normal Boiling point for ccly

* 120° c

(Intermolecular Forces and Liquids and Solids)

1_ change of state.

2_ Heating curve For water.

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(change of state)

Solid – Liquid Equilibrium

(s) $H_2O \rightleftarrows H_2O$ (l)

The melting point of a solid or the freezing point of a liquid is the temperature at which the solid and liquid phases coexist in equilibrium.

(s) $H_2O \rightleftarrows H_2O$ (g)

Molar heat of sublimation (ΔH_{sub}) is the energy required to sublime 1 mole of a solid.

$\Delta H_{sub} = \Delta H \quad + \Delta H$

$= 6.01 \text{ KJ/mol} + 40.79 \text{ KJ/mol}$

$= 46.80 \text{ KJ/mol}$

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The boiling point is the temperature at which the (equilibrium) vapor pressure of a liquid is equal to the external pressure.

The normal boiling point is the temperature at which a liquid boils when the external pressure is 1 atm.

(Temperature and Heat)

. when you add heat energy to an object, its temperature may increase

(Measuring Heat Energy)

. Since heat is energy, it can be measured in joules.

. A common (and old-fashioned) unit of heat energy is the caloric.

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(Specific Heat)

- The amount of heat energy required to 1g of an object to raise its temperature by 1°c is called specific heat.

- Specific heat $= \frac{q \text{ or } (\Delta H)}{\text{mass} \times \Delta T} = \frac{J}{g \cdot C^\circ}$

- q or (ΔH) = mass × specific heat × ΔT

(Specific Heat of water)

- By definition, the specific heat of water is 4.18 j/g. C°.

- The specific heat of water, meaning one gram of water it takes 4.18 j of energy to raise the temperature of water 1°c (25°C to 26°C as an example)

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(Calculating Heat Energy)

- The amount of heat energy needed to raise th temperature of a substance depends on:

- The amount of the substance.
- The specific heat of the substance.
- The change in temperature.

$$q = mc\Delta T$$

q: heat energy added / removed.
m: mass
c: specific heat
ΔT: change in temperature.

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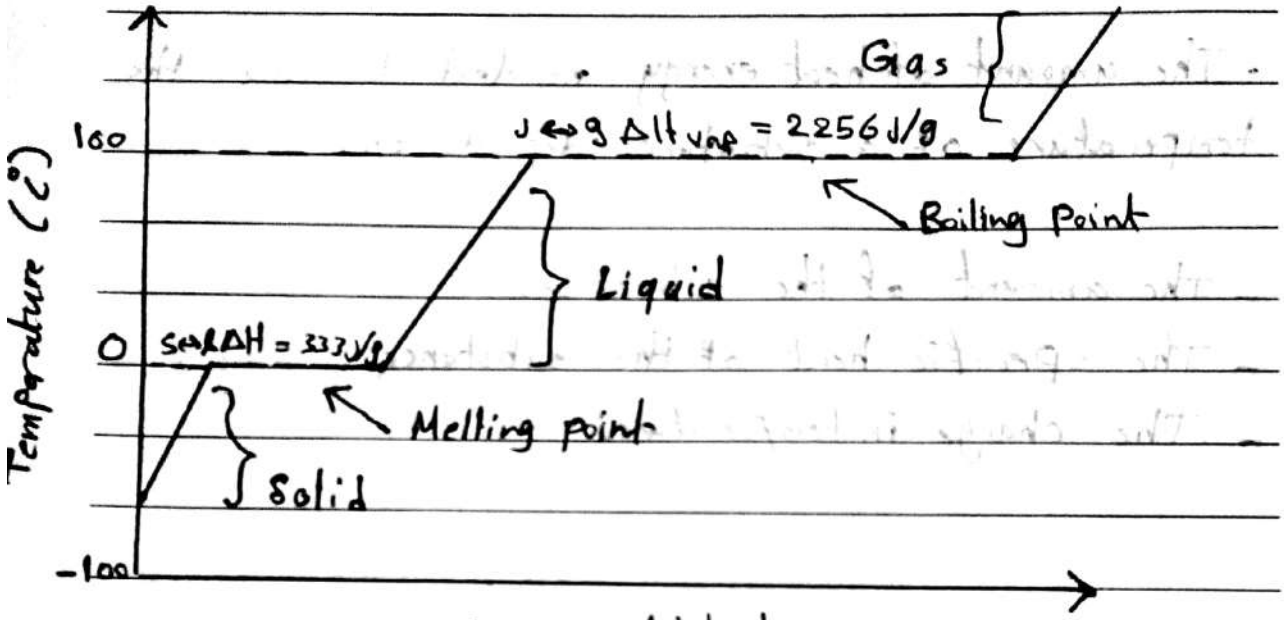
Heating curve of water



- Temperature change within phase
- depends on heat capacity of phase

$cH_2O(l) = 4.184\ J/g \cdot C$ (requires the most heat)

$cH_2O(s) = 2.077\ J/g\ C^\circ$

$cH_2O(g) = 2.042\ J/g\ C$ (requires the least heat)

- Phase changes ($s \leftrightarrow l \leftrightarrow g$)

* temperature remains constant
* overcoming intermolecular forces.

$\Delta H_{fus} = 333\ J/g = 6.01\ KJ/mol$ ($s \leftrightarrow l$)

$\Delta H_{vap} = 2256\ J/g = 40.79\ KJ/mol$ ($l \leftrightarrow g$)

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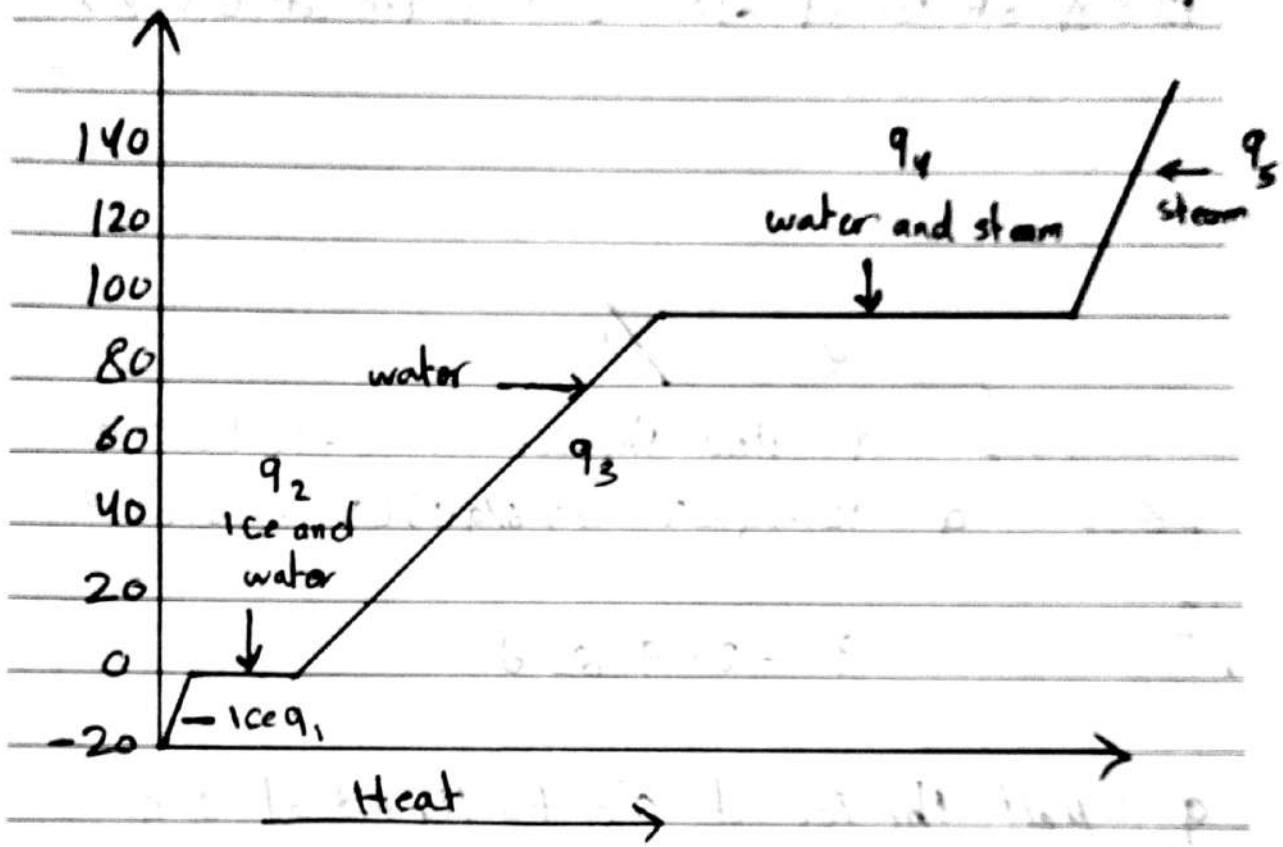
Heating curve of water



q_1 : Heat the ice to 0°C

$$q_1 = m C_g \Delta T$$

q_2 : Melt the ice into a liquid at 0°C

$$q_2 = m \Delta H$$

q_3 : Heat the water from 0°C to 100°C

$$q_3 = m C \Delta T$$

q_4 : Boil the liquid into a gas at 100°C

$$q_4 = m \Delta H_{vap}$$

q_5 : Heat the gas above 100°C

$$q_5 = m C \Delta T$$

$$q = q_1 + q_2 + q_3 + q_4 + q_5$$

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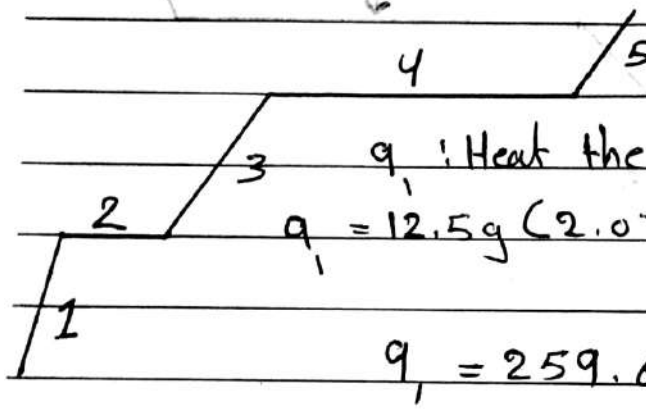
1. How much energy (J) is required to heat 12.5 g of ice at -10.0°C to water at 0.0°C?



q_1 : Heat the ice from -10 to 0°C

$q_1 = 12.5\,g\,(2.077\,J/g°C)(0.0 - -10.0°C)$

$q_1 = 259.63\,J$

q_2 : Melt the ice at 0°C to liquid at 0°C

$q_2 = 12.5\,g\,(333\,J/g)$

$q_2 = 4162.5\,J$

$q = q_1 + q_2$

$= 259.63\,J + 4162.5\,J$

$q = 4420\,J$

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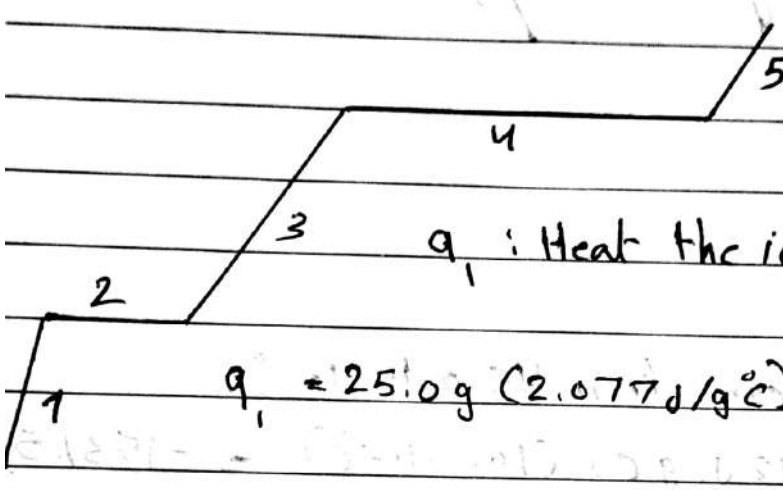
2. How much energy (J) is required to heat 25.0 g of ice at -25.0°C to water at 95.0°C?



q_1 : Heat the ice from -25 to 0°

$q_1 = 25.0\,g\,(2.077\,J/g°C)(0.0 - -25.0°C)$

$q_1 = 1298.1\,J$

q_2 : Melt the ice at 0°C to liquid at 0°C

$q_2 = 25.0\,g\,(333\,J/g)$

$q_2 = 8325\,J$

q_3 : Heat the water from 0°C to 95°C

$q_3 = 25.0\,g\,(4.184\,J/g°C)(95.0 - 0.0°C)$

$q_3 = 9937\,J$

$q = q_1 + q_2 + q_3$

$1298.1 + 8325 + 9937 = 19560\,J$

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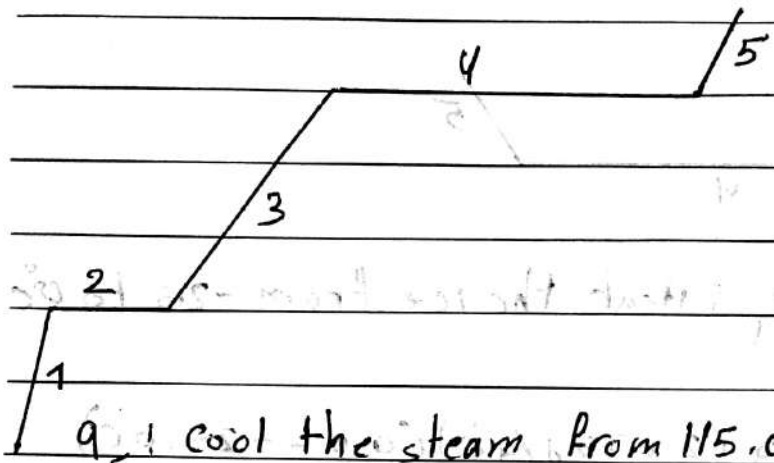
3. How much energy (J) is removed to cool 50 g of steam at 115 °C to ice at -5.0 °C?



q_5 : cool the steam from 115.0 to 100°C

$q_5 = 50\,g\,(2.042\,J/g°C)\,(100-115°C) = -1531.5\,J$

q_4 : condense the steam into liquid at 100°C

$q_4 = 50\,g\,(-2256\,J/g) = -112.800\,J$

q_3 : cool the water from 100°C to 0°C

$q_3 = 50g\,(4.184\,J/g°C)\,(0-100°C) = -20920\,J$

q_2 : Freeze the water into ice at 0°C

$q_2 = 50\,g\,(-333\,J/g) = -16650\,J$

$q_1 = 50g\,(2.077\,J/g°C)(-5-0°C) = -519.25\,J$

$q = q_1 + q_2 + q_3 + q_4 + q_5 = -152,000\,J$

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physical properties of solutions

الخصائص الطبيعية للمحاليل

A solution is a homogenous mixture of 2 or more substances (2g of Nacl in 100 g H_2O)

- The solute is (are) the substance (s) present in the smaller amount (s) (2g Nacl)

- The solvent is the substance present in the larger amount (100g H_2O)

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Molarity (M) = $\frac{\text{moles of solute}}{\text{liters of solution}}$

Mass (weight) percent = $\frac{\text{mass of solute}}{\text{mass of solution}} \times 100\%$

Mole fraction (X_A) = $\frac{\text{moles A}}{\text{total moles of solution}}$

Molality (m) = $\frac{\text{moles of solute}}{\text{Kilogram of solvent}}$

Molarity (M) = $\frac{\text{moles of solute}}{\text{liters of solution}}$

Molarity (M) = $\frac{\frac{\text{mass of solute}}{\text{Molar mass of solute}}}{\text{liters of solution}}$

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Q/ you have 1.00 mol of suger in 125.0 mL of solution. Calculate the concentration in units of molarity.

* 8.00 M

Q/ you have a 10.0 M sugar solution. what volume of this solution do you need to have 2.00 mol of sugar?

* 0.200L

Mass percent

$$\text{Mass (weight) percent} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100\,\%$$

$$\text{Weight \% of A} = \frac{\text{mass}_A}{\text{mass}_A + \text{mass}_b + \text{mass}_C + \ldots} \times 100$$

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Q1 what is the percent - by - mass concentration of glucose in a solution made by dissolving 5.5 g of glucose in 78.2 g of water?

* 6.6 %

Mole Fraction

$$\text{Mole fraction } (X_A) = \frac{\text{moles}_A}{\text{total moles of solution}}$$

$$\text{Mole Fraction } (X_A) = \frac{n_A}{n_A + n_u + n_c + \dots}$$

$$\text{Mole Fraction } (X) = \frac{\text{amount (mol) of solute}}{\text{amount (mol) of solute} + \text{amount (mol) of solvent}}$$

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Q1 A sample of rubbing alcohol contains 1.42g of isopropyl alcohol (C_3H_7OH) and 58.0 g of water. what are the mole fractions of alcohol and water?

* moles isopropy alcohol $= 1.24\,g \times \frac{1\,mole}{60.09\,g}$

$= 2.36\,mol\ C_3H_7OH$

moles water $= 58.0\,g \times \frac{1\,mole}{18.02\,g} = 3.22\,mol\ H_2O$

$$X_{C_3H_7OH} = \frac{2.36\,mol\ C_3H_7OH}{2.36\,mol\ C_3H_7OH + 3.22\,mol\ H_2O} = 0.423$$

$$X_{H_2O} = \frac{3.22\,mol\ H_2O}{2.36\,mol\ C_3H_7OH + 3.22\,mol\ H_2O} = 0.577$$

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Q1 A solution of phosphoric acid was made by dissolving 8.00 g of H_3PO_4 (M.M = 98 g/mol) in 100.0 ml of water (M.M = 18 g/mol). Calculate the mole fraction of H_3PO_4. (Assume water has a density of 1.00 g/ml).

* 0.0145

Molality

$$\text{Molality (m)} = \frac{\text{moles of solute}}{\text{kilogram of solvent}}$$

$$\text{Molality (m)} = \frac{\frac{\text{mass of solute}}{\text{molar mass of solute}}}{\text{kilogram of solvent}}$$

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Q] A solution of phosphoric acid was made by dissolving 8.00 g of H_3PO_4 (M.M = 98 g/mol) in 100.0 ml of water. Calculate the molality of the solution. (Assume water has a density of 1.00 g/ml).

* 0.816 m

component 1	component 2	state of resulting solution	Examples
Gas	Gas	Gas	Air
Gas	Liquid	Liquid	soda water
Solid	Liquid	Liquid	Nacl in water

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Q1 A sample of rubbing alcohol contains 142 g of isopropyl alcohol (C_3H_7OH) and 58.0 g of water. what are the mole fractions of alcohol and water?

*

moles Isopropyl alcohol $= 142\,g \times \frac{1\,mole}{60.09\,g}$

$= 2.36\,mol\ C_3H_7OH$

moles water $= 58.0\,g \times \frac{1\,mole}{18.02\,g} = 3.22\,mol\ H_2O$

$X_{C_3H_7OH} = \frac{2.36\,mol\ C_3H_7OH}{2.36\,mol\ C_3H_7OH + 3.22\,mol\ H_2O}$

$= 0.423$

$X_{H_2O} = \frac{3.22\,mol\ H_2O}{2.36\,mol\ C_3H_7OH + 3.22\,mol\ H_2O}$

$= 0.577$

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Subject _____ Day _____ Date _____

Q1 what is the molality of a 5.86 M ethanol (C_2H_5OH) solution whose density is 0.927 g/ml?

* $m = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}}$ $M = \frac{\text{moles of solute}}{\text{liters of solution}}$

Assume 1L of solution:

5.86 moles ethanol = 270 g ethanol

927 g of solution (1000 ml X 0.927 g/ml)

mass of solvent = mass of solution − mass of solute

= 927g − 270g = 657g = 0.657kg

$m = \frac{\text{moles of solute}}{\text{mass of solvent (Kg)}} = \frac{5.86 \text{ moles } C_2H_5OH}{0.657 \text{ Kg solvent}}$

$= 8.92\ m$

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Q/ Hydrogen peroxide is a powerful oxidizing agent used in concentrated solution is rocket fuels and in dilute solution as a hair bleach. An aqueous solution of H_2O_2 is 30.0% by mass and has a density of 1.11 g/ml. Calculate its

(a) Molality (b) Mole fraction of H_2O_2

(c) Molarity

Sol

(a) From mass % to molality:

g of H_2O = 100 g solution − 30.0 g H_2O_2

= 70.0 g H_2O

$$30.0\ g\ H_2O_2 \times \frac{1\ mol\ H_2O_2}{34.02\ g\ H_2O_2} = 0.882\ mol\ H_2O_2$$

$$molality = \frac{0.882\ mol\ H_2O_2}{70.0\ g \times \frac{1\ kg}{10^3\ g}} = 12.6\ m\ H_2O_2$$

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(b) From mass % to mole fraction:

$$70.0\ g\ H_2O \times \frac{1\ mol\ H_2O}{18.02\ g\ H_2O} = 3.88\ mol\ H_2O$$

$$X_{H_2O_2} = \frac{0.882\ mol\ H_2O_2}{3.88\ mol\ H_2O + 0.882\ mol\ H_2O_2} = 0.185$$

(c) From mass % and density to molarity:

$$\text{volume (mL) of solution} = 100.0\ g \times \frac{1\ mL}{1.11\ g} = 90.1\ mL$$

$$\text{molarity} = \frac{\text{mol } H_2O_2}{L\ \text{soln}} = \frac{0.882\ mol\ H_2O_2}{90.1\ mL \times \frac{1\ L\ soln}{10^3\ mL}}$$

$$= 9.79\ M\ H_2O_2$$

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Subject _____ Day _____ Date _____

* Colligative Properties

properties of solutions which depend on the number of solute particles in the solution and not the nature of the solute.

* Four Colligative Properties

1) Vaper pressure lowering. خفض الضغط البخاري

2) Boiling point elevation. ارتفاع درجة الغليان

3) Freezing point depression. انخفاض درجة التجمد

4) Osmosis

Subject _____ Day _____ Date _____

* vapor Pressure Lowering

the vapor pressure of the solution is lowered the solute particles at the liquid /vapor boundary block the solvent particle from jumping into vapor state.

$$P_{sol} = X_{sol\,X} \; P^{\circ}_{sol\,X}$$

or

$$\Delta P_{sol\,X} = X_{Solute} \; P^{\circ}_{sol\,X}$$

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Q1 Find the vapor pressure solution in (torr) P_s when 10.0 ml of glyceral ($C_3H_8O_3$) is added to 500 ml of water at 50°C. At this temperature, the vapor pressure of pure water is 92.5 torr and its density is 1.00 g/ml. The density of glyceral is 1.26 g/mL.

$$10.0\ mL\ C_3H_8O_3 \times \frac{1.26\ g\ C_3H_8O_3}{1\ mL\ C_3H_8O_3} \times \frac{1\ mol\ C_3H_8O_3}{92.09\ g\ C_3H_8O_3}$$

$$= 0.137\ mol\ C_3H_8O_3$$

$$500.0\ mL\ H_2O \times \frac{1.00\ g\ H_2O}{1\ ml\ H_2O} \times \frac{1\ mol\ H_2O}{18.0\ g\ H_2O}$$

$$= 27.8\ mol\ H_2O$$

$$\%_{H_2O} = \frac{27.8\ mol\ H_2O}{0.137\ mol\ C_3H_8O_3 + 27.8\ mol\ H_2O} = 0.995$$

$$P = 0.995 \times 92.5\ torr = 92.04\ torr$$

$$\Delta P = 92.5 - 92.04 = 0.46\ torr$$

vapor pressure lowering.

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Subject _____ Day _____ Date _____

* Boiling Point Elevation

For nonvolatile, nonelectrolyte solvents the change in boiling point (ΔT_{bp}) is:

$$\Delta T_{bp} = K_{bp} \, m_{solute}$$

K_{bp} ; boiling point elevation constant.

m_{solute} ; molality of solute.

Q| A solution was prepared by dissolving 25.00 g glucose in 200.0 g water. The molar mass of glucose is 180.16 g/mol. what is the boiling point of the resulting solution (in °C) ? Glucose is a molecular solid that is present as individual molecules in solution.

* 100.35 °C

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Q/ A solution was prepared by dissolving 25.00 g glucose in 200.0 g water. The molar mass of glucose is 180.16 g/mol. what is the boiling point of the resulting solution (in °C)? Glucose is a molecular solid that is present as individual molecules in solution.

$T_b = 100^\circ C$

$\Delta T_b = K_b m$ $\qquad K_b \text{ water} = 0.51\ ^\circ C/m$

$m = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}} = \frac{25g \times \frac{1mol}{180.16g}}{0.200kg \text{ solvent}}$

$= 0.69\ m$

$\Delta T_b = K_b m = 0.51\ ^\circ C/m \times 0.69m = 0.35^\circ C$

$\Delta T_b = T_b - T_b^\circ$

$T_b = T_b^\circ + \Delta T_b = 100^\circ C + 0.35^\circ C = 100.35^\circ C$

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Subject _____ Day _____ Date _____

* Freezing Point Depression

For nonvolatile, nonelectrolyte solvents the change in freezing point (ΔT_{fp}) is:

$$\Delta T_{fp} = K_{fp} \, m_{solute}$$

K_{fp} : freezing point depression constant.

m_{solute} : molality of solute.

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Q| what is the freezing point of a solution containing 478 g of ethylene glycol (antifreeze) in 3202 g of water? The molar mass of ethylene glycol is 62.01 g

$\Delta T_f = K_f m$ $\quad K_f$ water $= 1.86\ ^\circ C/m$

$$m = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}} = \frac{478\ g \times \frac{1\ mol}{62.01\ g}}{3.202\ kg\ \text{solvent}}$$

$$= 2.41\ m$$

$\Delta T_f = K_f m = 1.86\ ^\circ C/m \times 2.41\ m = 4.48\ ^\circ C$

$\Delta T_f = T_f^\circ - T_f$

$T_f = T_f^\circ - \Delta T_f = 0.00\ ^\circ C - 4.48\ ^\circ C = -4.48\ ^\circ C$

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* Colligative Properties and Molar Mass Determination

Colligative Properties can be used to determine the molar mass of a solute when it is dissolved in a solvent of appreciable vapor pressure and a known K_{bp} or K_{fp}.

Measure a change in VP, BP elevation, FP depression, or osmotic pressure. → Solution Conc (Use mass of solvent) → Moles of Solute → Molar Mass ($\frac{g\ solute}{mol\ solute}$)

* Osmosis and Osmotic Pressure.

The pressure created by a column of solution for a system in equilibrium.

$PV = nRT$

$P = MRT$

$\pi = MRT$

* انتقال الماء من المحلول الأقل الى الأكثر تركيز

π: osmotic pressure

M: molar conc (mol/L)

R: 0.08206 $\frac{L\ atm}{mol\ K}$

T: Temperature (K)

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Q1 Biochemists have discovered more than 400 mutant varieties of hemoglobin, the blood protein that carries O_2. A physician dissolves 21.5 mg of one variety in water to make 1.50 mL of solution at 5.0°C. measures an osmotic pressure of 3.61 torr. what is the molar mass of the protein?

$$* M = \frac{\pi}{RT} = \frac{3.61 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}}}{(0.0821 \text{ L} \cdot \text{atm/mol} \cdot \text{K})(278.15 \text{ K})}$$

$$= 2.08 \times 10^{-4} \text{ M}$$

$$M = \text{mole/V (solution)} \longrightarrow \text{mol} = M \times V$$

$$\frac{2.08 \times 10^{-4} \text{ mol}}{1 \text{ L}} \times 0.00150 \text{ L} = 3.12 \times 10^{-7} \text{ mol}$$

$$21.5 \text{ mg} \times \frac{1 \text{ g}}{10^3 \text{ mg}} = 0.0215 \text{ g}$$

$$\text{M} = \text{mass/mol} = \frac{0.0215 \text{ g}}{3.12 \times 10^{-7} \text{ mol}} = 6.89 \times 10^4 \text{ g/mol}$$

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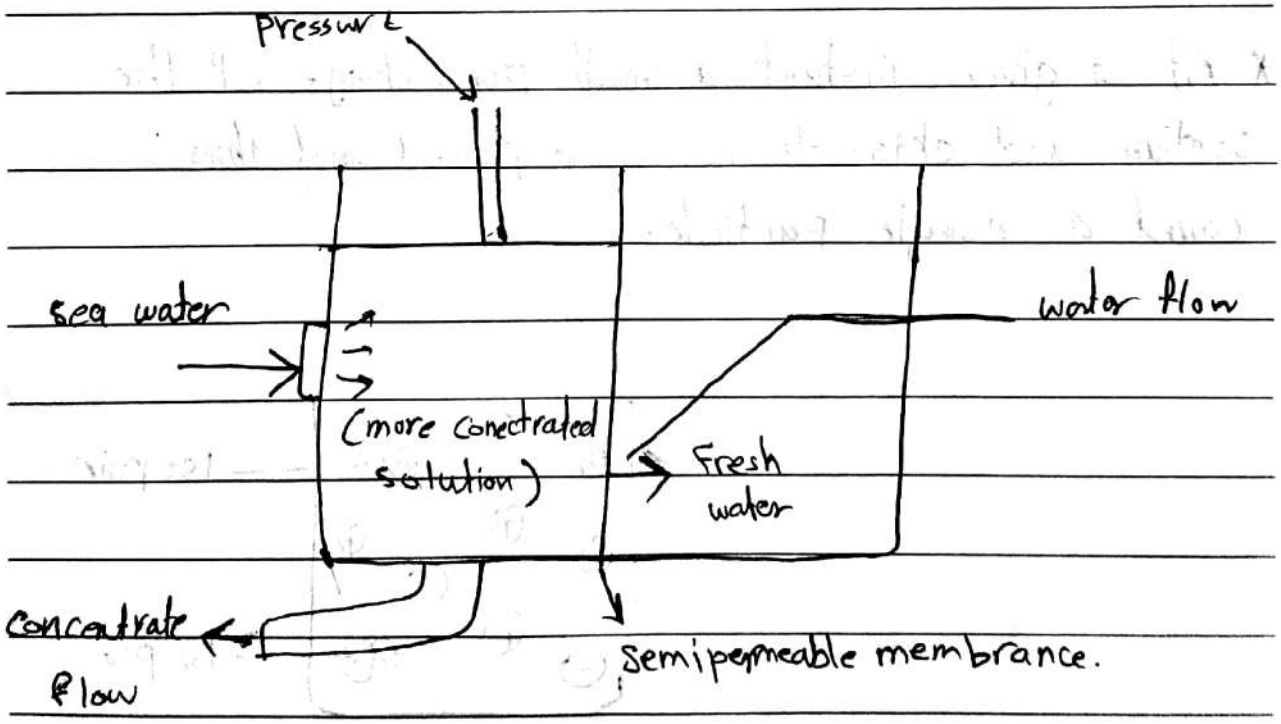
Subject _____ Day _____

Q1 when 33.4 mg of a compound is dissolved in 10.0 ml of water at 25°c the solution has an osmotic pressure of 558 torr. calculate the molar mass of this compound.

* 111 g/mol

Reverse Osmosis is used for water purification



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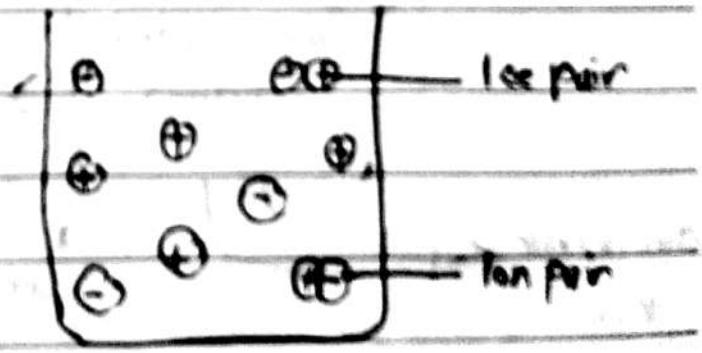
* The relationship between the moles of solute dissolved and the moles of particles in solution is usually expressed as:

$$i = \frac{\text{moles of particles in solution}}{\text{moles of solute dissolved.}}$$

Ion pairing

* At a given instant a small percentage of the sodium and chloride ions are paired and thus count as a single particle.



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* The expected value for i can be determined for a salt by noting the number of ions per formula unit (assuming complete dissociation and that ion pairing does not occur).

NaCl $i = 2$

KNO_3 $i = 2$

Na_3PO_4 $i = 4$

* Ion pairing is most important in concentrated solutions.

* As the solution becomes more dilute, the ions are farther apart and less ion pairing occurs.

* Ion pairing occurs to some extent in all electrolyte solutions.

* Ion pairing is most important for highly charged ions.

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Colligative Properties of Solutions Containing Ions.

* The change in VP, BP, FP, osmotic pressure is greater than expected for electrolyte (ionic salt) solutions.

* Colligative properties depend on the total number of solute particles in solution, ionic compounds form ions in solution so the total number of solute particles in solution is equal to the total ions in solution.

$NaCl(s) \rightarrow Na^+(aq) + Cl^-(aq)$

0.100 m — 0.100 m — 0.100 m

0.200 m total

$\Delta T_{bp} = i K_{bp} m$ $\Delta T_{fp} = i K_{fp} m$

$\pi = iMRT$

$P_{solvent} = \chi_{solvent} P^{\circ}_{solvent}$

الممسوحة ضوئيا بـ CamScanner

Subject _____ Day _____ Date _____

Q) Find the vapor pressure solution in (torr) P, when 35.0 g of solid Na_2SO_4 (M.M = 142 g/mol) is added to 175 g of water at 25° C. At this temperature the vapor pressure of pure water is 23.76 torr.

* $Na_2SO_4(s) \longrightarrow 2Na^+(aq) + SO_4^{2-}(aq)$

2 particles + 1 particle = 3 particles

$i_{predicted} = 3$

$$35.0\ g\ Na_2SO_4 \times \frac{1\ mol\ Na_2SO_4}{142\ g\ Na_2SO_4} = 0.246\ mol\ Na_2SO_4$$

$$175.0\ g\ H_2O \times \frac{1\ mol\ H_2O}{18.00\ g\ H_2O} = 9.72\ mol\ H_2O$$

$$\%_{H_2O} = \frac{9.72\ mol\ H_2O}{3(0.246\ mol\ Na_2SO_4) + 9.72\ mol\ H_2O} = 0.929$$

$$P = 0.929 \times 23.76\ torr = 22.07\ torr$$

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Predicting van't Hoff factors

$NaCl(s) \longrightarrow Na^+(aq) + Cl^-(aq)$

1 particle + 1 particle = 2 particle

$i_{predicted} = 2$

$Na_2SO_4(s) \longrightarrow 2\,Na^+(aq) + SO_4^{2-}(aq)$

2 particles + 1 particles = 3 particles

$i_{predicted} = 3$

---

which solution have higher boiling point elevation 0.2 m NaCl or 0.2 m $Na_2SO_4(s)$

$i_{predicted} = 2$ $\qquad$ $i_{predicted} = 3$

$\Delta T_{bp} = i K_{bp} m$

$\Delta T_{bp} = i K_{bp} m = 2 K_{bp} 0.2 = 0.4 K_{bp}$

$\Delta T_{bp} = i K_{bp} m = 3 K_{bp} 0.2 = 0.6 K_{bp}$

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$C_6H_{12}O_6 = 5\%$

A red blood cell in an isotonic solution has its normal shape

$C_6H_{12}O_6 = 3\%$

A hypotonic solution has a lower concentration of particles than the cell. A cell in a hypotonic solution absorbs water and swells until it bursts.

$C_6H_{12}O_6 = 15\%$

A hypertonic solution has a higher concentration of dissolved particles than the cell. if a cell is placed in a hypertonic solution, water moves out of the cell, causing it to shrink.

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