

[TP] The voltage of a chloride concentration cell is x V. If the pressure of the chlorine gas in the anode is doubled, the new voltage will …

25% 1. be larger than x V.
25% 2. remain x V.
25% 3. be smaller than x V.
25% 4. Further information needed.

BOSTON UNIVERSITY

Lecture 27 CH102 A1 (MWF 9:05 am)

Monday, April 2, 2018

- Complete concentration cells: Mixing → electric current

Begin ch 17: Spontaneous change: How far?

- The essence of change
- Counting particle dispersal
- Maximum particle dispersal = uniform pressure

Next lecture: Arrangements ⟶ Entropy; Counting energy dispersal. Heat (energy) flow → entropy change.

Notes: Spontaneity: Second law of thermodynamics

http://quantum.bu.edu/courses/ch102-spring-2018/handouts.html

BOSTON UNIVERSITY

Concentration cell construction

Sketch the construction of a chloride concentration cell.

BOSTON UNIVERSITY

[TP] The voltage of a chloride concentration cell is x V. If the pressure of the chlorine gas in the anode is doubled, the new voltage will …

25% 1. be larger than x V.
25% 2. remain x V.
25% 3. be smaller than x V.
25% 4. Further information needed.

BOSTON UNIVERSITY

[Group Quiz] A concentration cell is constructed with Q corresponding to the Cl^- concentration difference between sea water and river water at 25 °C. Assume that the Cl^- concentration (due to dissolved NaCl) of sea water is 35 g/L and than that of river water is 0.10 mg/L. The voltage of this cell is …

20% 1. $E = +0.67$ V
20% 2. $E = +0.50$ V
20% 3. $E = +0.33$ V
20% 4. $E = +0.17$ V
20% 5. Something else

Lecture 27 CH102 A1 (MWF 9:05 am) Spring 2018 Copyright © 2018 Dan Dill dan@bu.edu

Spontaneous change: How Far?

Mahaffy et al., ch 17 and

Notes: Spontaneity: Second law of thermodynamics, PDF, 14 pages

http://quantum.bu.edu/courses/ch102-spring-2018/handouts.html

Lecture 27 CH102 A1 (MWF 9:05 am) Spring 2018 Copyright © 2018 Dan Dill dan@bu.edu

The essence of change

Why does a drop of ink in water disperse?

Why do salt water and fresh water mix?

Lecture 27 CH102 A1 (MWF 9:05 am) Spring 2018 Copyright © 2018 Dan Dill dan@bu.edu

The essence of change

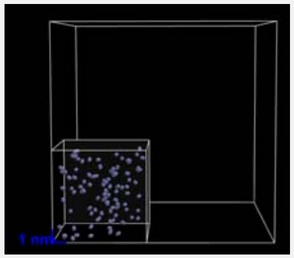
all complexity is an illusion …

things happen simply because they can happen
and because they are statistically
most likely to happen.”

Michael Munowitz, "Principles of Chemistry," W. W. Norton, 2000

Lecture 27 CH102 A1 (MWF 9:05 am) Spring 2018 Copyright © 2018 Dan Dill dan@bu.edu

A gas fills its container

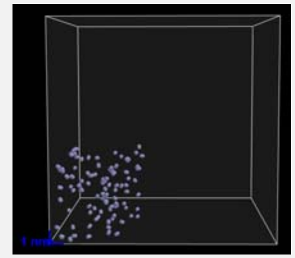


BOSTON UNIVERSITY

12

Lecture 27 CH102 A1 (MWF 9:05 am) Spring 2018 Copyright © 2018 Dan Dill dan@bu.edu

A gas fills its container

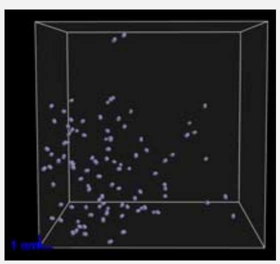


BOSTON UNIVERSITY

13

Lecture 27 CH102 A1 (MWF 9:05 am) Spring 2018 Copyright © 2018 Dan Dill dan@bu.edu

A gas fills its container

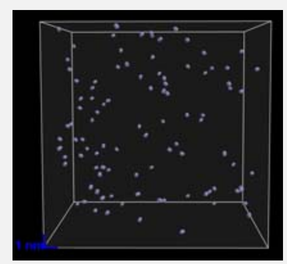


BOSTON UNIVERSITY

14

Lecture 27 CH102 A1 (MWF 9:05 am) Spring 2018 Copyright © 2018 Dan Dill dan@bu.edu

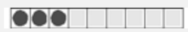
A gas fills its container



BOSTON UNIVERSITY

15

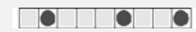
A gas fills its container



Gas all on left of container

BOSTON UNIVERSITY 16

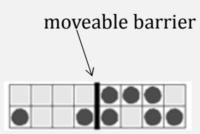
A gas fills its container



Gas evenly distributed throughout container

BOSTON UNIVERSITY 17

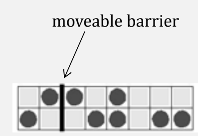
Pressure in a gas is uniform



P proportional to n/V ("lattice gas")
P higher on the right

BOSTON UNIVERSITY 18

Pressure in a gas is uniform

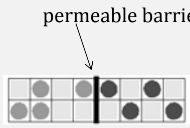


P proportional to n/V ("lattice gas")
P the same on the left and right

BOSTON UNIVERSITY 19

Lecture 27 CH102 A1 (MWF 9:05 am) Spring 2018 Copyright © 2018 Dan Dill dan@bu.edu

Gases mix evenly

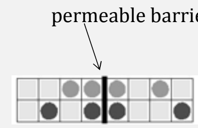


One gas on left, another on right

20

Lecture 27 CH102 A1 (MWF 9:05 am) Spring 2018 Copyright © 2018 Dan Dill dan@bu.edu

Gases mix evenly



Equal amounts throughout

21

Lecture 27 CH102 A1 (MWF 9:05 am) Spring 2018 Copyright © 2018 Dan Dill dan@bu.edu

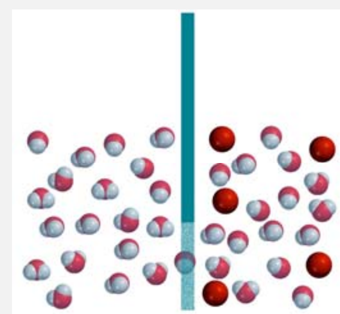
Osmotic pressure across semipermeable membrane

Pressure equal (n/V) on both sides of membrane, but solute (light grey) cannot pass across membrane to left

22

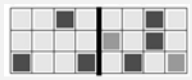
Lecture 27 CH102 A1 (MWF 9:05 am) Spring 2018 Copyright © 2018 Dan Dill dan@bu.edu

Osmotic pressure across semipermeable membrane



23

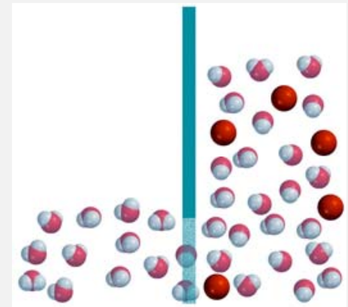
Osmotic pressure across semipermeable membrane



Solvent passes across membrane to right making pressure higher (n/V) on right

BOSTON UNIVERSITY

Osmotic pressure across semipermeable membrane



BOSTON UNIVERSITY

Blind chance & dumb luck

Everything—absolutely everything—that happens, happens solely because of blind chance and dumb luck.

To quantify this ...

1. Learn to count the ways
2. Search for greatest number of ways

BOSTON UNIVERSITY

Counting distinguishable (unique) arrangements

The number of distinguishable arrangements of
j identical objects of one kind, say $j = 2$ water molecules, and
k identical objects of another kind, say $k = 1$ ink molecules ...

$$W(2,1) = \frac{(2+1)!}{2!\,1!} = \frac{3 \times 2!}{2!\,1!} = 3$$

BOSTON UNIVERSITY

