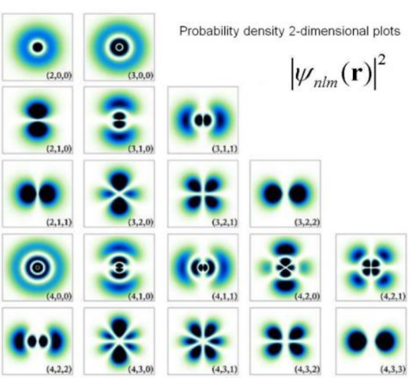
Imagine images for formative assessment.

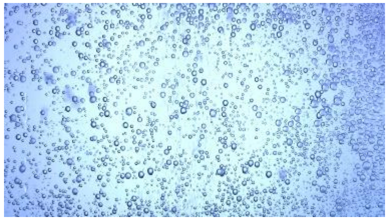
Dr Victoria Hilborne v.hilborne@ucl.ac.uk

University College London

Department of Chemistry



[4]



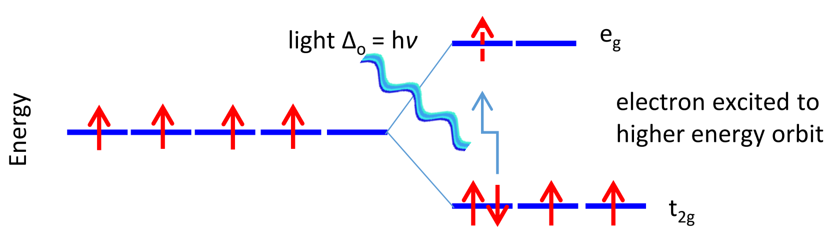
[5]

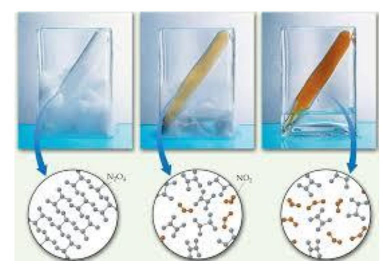
[6]

Fluency in Visualisation

- Metavisualisation
  - See the unseen, linking macroscopic / microscopic to symbolic and molecular [1] [2].
  - Representational competence.
  - Concept development.

Describe this image in terms of ligand field theory





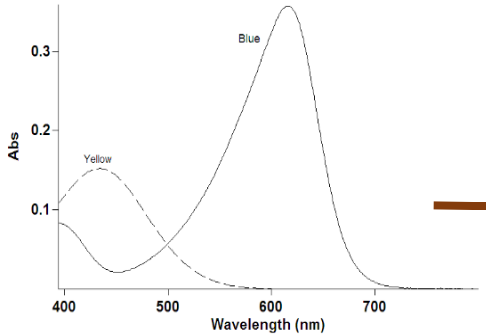
[3]

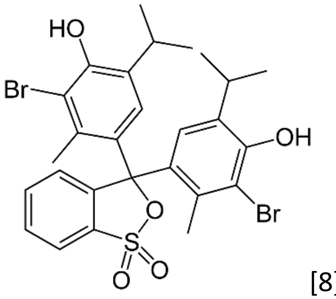
Use this image to describe Le Chatelier's principle

From macroscopic to symbolic and molecular:
Electronic transition and the Beer Lambert Law.

[7]

https://www.youtube.com/watch?v=VYw2csIBngY





[8]

[0.001 mol dm^{-3}]

$$I = I_0 e^{-\varepsilon c l}$$

$$log\frac{I}{I_0} = -\varepsilon c l$$

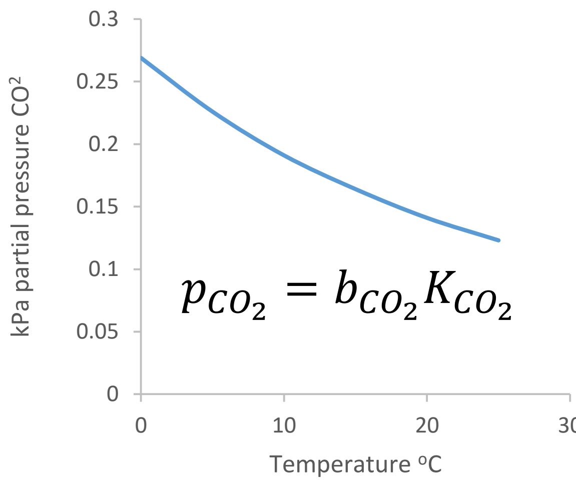
$$A = \log\frac{I_0}{I} = \varepsilon c l$$

From macroscopic to symbolic and molecular.
Gas solubility and Henry's Law.

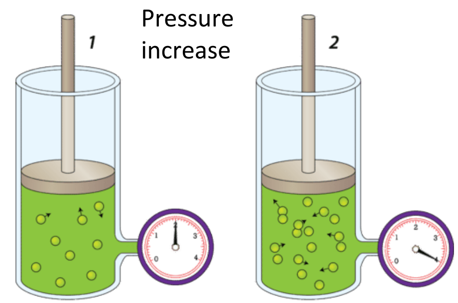
Macroscopic (observable) [6]

CO_2 partial pressure versus temperature:

(0.2×10^{-3} dissolved CO_2 mole fraction).



Symbolic



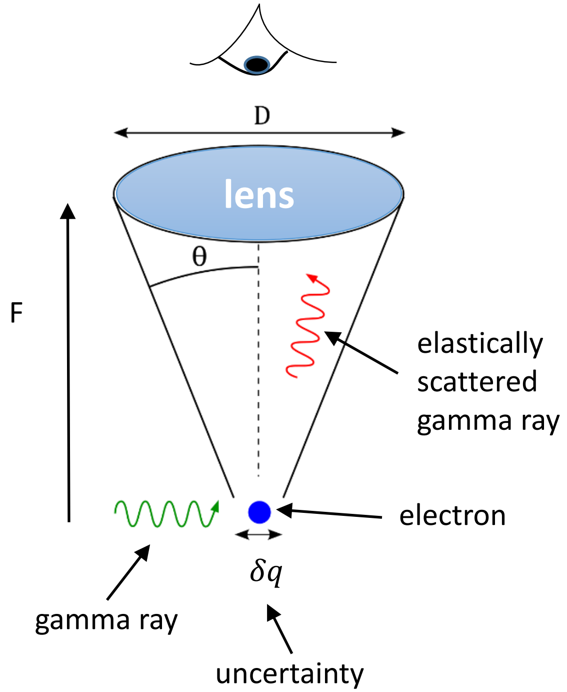
$n_2 > n_1$
$p_2 > p_1$
$V \text{ and } T \text{ are constant}$

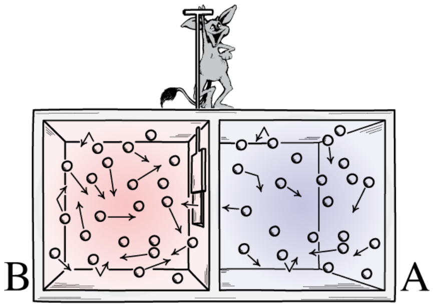
[9]

Molecular

Thought experiments.

- Heisenberg's x ray microscope.
- Maxwell's demon.

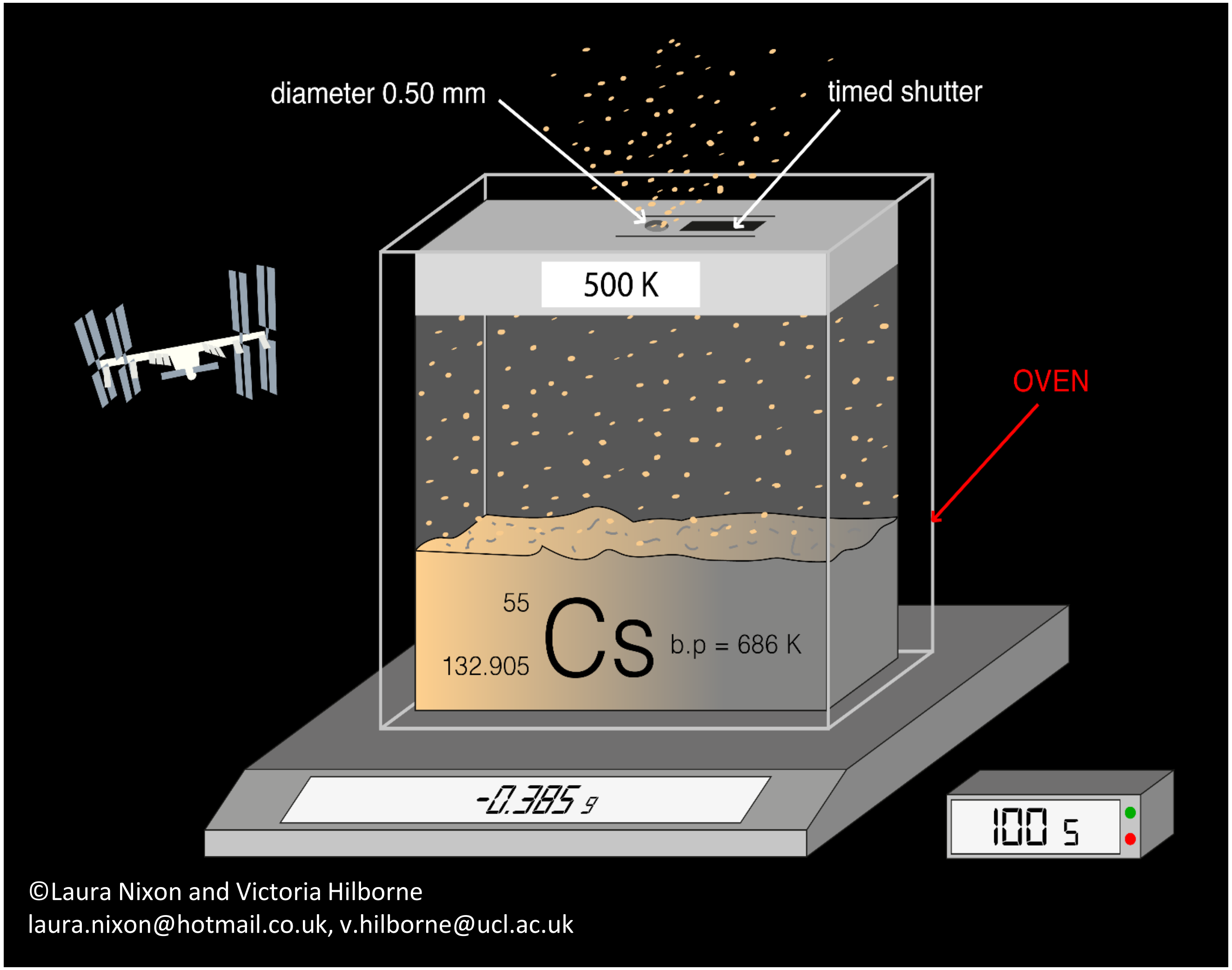




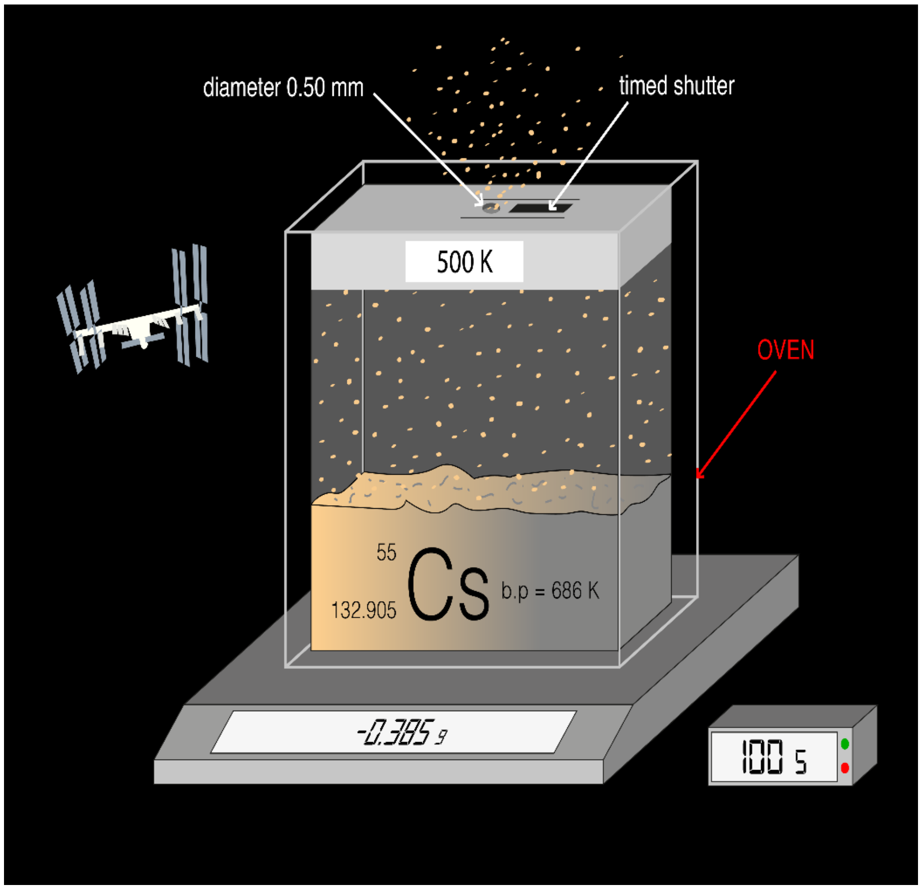
[10]

[11]

What is this image showing?



Effusion



- Explain what each of the mathematical symbols represent with respect to the image shown.

$$Z_W = \frac{\Delta m}{A_0 m \Delta t} \qquad m = M/N_A$$

$$Z_W A_0 = \frac{p A_0 N_A}{(2\pi MRT)^{1/2}}$$

$$1\ Pa = 1\ N\ m^{-2} = 1\ Jm^{-1}$$

- Is the mean free path of heated Cs atoms > 0.5 mm?
- Calculate the vapour pressure from the mass loss.
- How long would it take for 1 g of Cs to effuse out of the oven under the same conditions?

References

1. Gilbert J.K., Reiner M. and Nakhleh M., Eds. *Models and Modeling in Science Education: Visualisation Theory and Practice in Science Education*, 2008, Vol. 3, New York: Springer Science and Business Media B.V.
2. Dangar V., Avargil S., Peskin U. and Dory Y. J., *Chemistry Education Research and Practice*, 2014, 15, 297 – 310.
3. https://www.unf.edu/~michael.lufaso/chem2046H/2046chapter15.pdf
4. https://www.science20.com/reformulation_feasible/zoom_atom_or_unknown_physics_short_distances
5. https://us.clipdealer.com/video/media/9297360
6. https://en.wikipedia.org/wiki/Copper(II)_acetate
7. https://climate.nasa.gov/blog/1081/
8. https://en.wikipedia.org/wiki/Bromothymol_blue
9. https://www.ck12.org/chemistry/factors-affecting-gas-pressure/lesson/Factors-Affecting-Gas-Pressure-CHEM/
10. https://www.pitt.edu/~jdnorton/homepage/research/Maxwell_demon.html
11. https://en.wikipedia.org/wiki/Mysore_Agarbathi

Solution:

1.

$$\left(\frac{2\pi RT}{M}\right)^{1/2}\frac{m_{loss}}{tA_0}=p$$

$$\left(\frac{2\times\pi\ \times 8.314\,mol^{-1}K^{-1}\times 500\ K}{0.132906\ kg}\right)^{1/2}\times\frac{0.385\ \times 10^{-6}kg}{(\pi\times(0.250\times 10^{-3})^2)m^2\times 100\ s}$$

$$p=8.7\ kPa$$

2.

$$\left(\frac{2\pi RT}{M}\right)^{1/2}\frac{m_{loss}}{pA_0}=t$$

$$\left(\frac{2\times\pi\times 8.314\times 500}{0.132906}\right)^{1/2}\frac{1\ \times 10^{-6}}{8.7\times 6.25\times 10^{-8}}$$

$$=260\ seconds$$

$$Z_W=\frac{\Delta m}{A_0 m\Delta t}$$

$$Z_W A_0=\frac{pA_0N_A}{(2\pi MRT)^{1/2}}$$

$$\frac{\Delta m}{A_0 m\Delta t}=\frac{pA_0N_A}{(2\pi MRT)^{1/2}}$$

$$(2\pi MRT)^{1/2}\frac{\Delta m}{m\Delta t}=pA_0N_A$$

$$m=\frac{M}{N_A},\qquad (2\pi MRT)^{1/2}\frac{\Delta m}{M/N_A\Delta t}=pA_0N_A$$

$$M^{1/2}(2\pi RT)^{1/2}\frac{\Delta m}{M\Delta tA_0}=p$$

$$\left(\frac{2\pi RT}{M}\right)^{1/2}\frac{m_{loss}}{tA_0}=p$$