

NanoScience – NanoTechnology / NST

ID analyst: Worksheet 2

Activity 1a

Referring to the quantum dots experiment we came across previously (ID student, activity 3):

1) Which STEM discipline(s) do each of the following representations relate to?

REPRESENTATION A

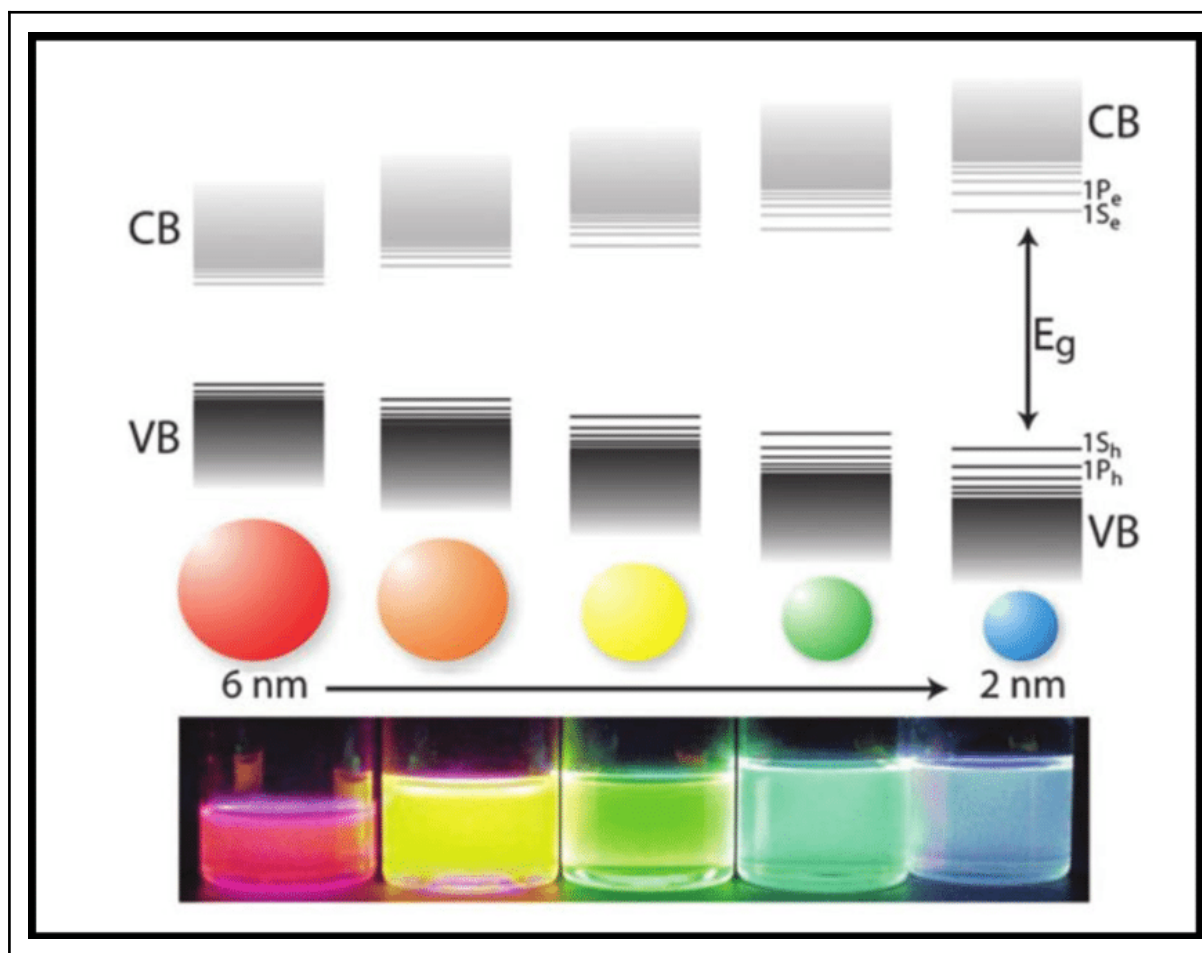


Image from: Donegá C. (2011) Synthesis and properties of colloidal heteronanocrystals. *Chemical Society Reviews*, 40, 1512-1546

REPRESENTATION B

$$E = E_g + \frac{h^2}{8mL^2} - \frac{1.786e^2}{\epsilon\epsilon' L} - 0.248 \frac{13.6}{Mr^2}$$

REPRESENTATION C

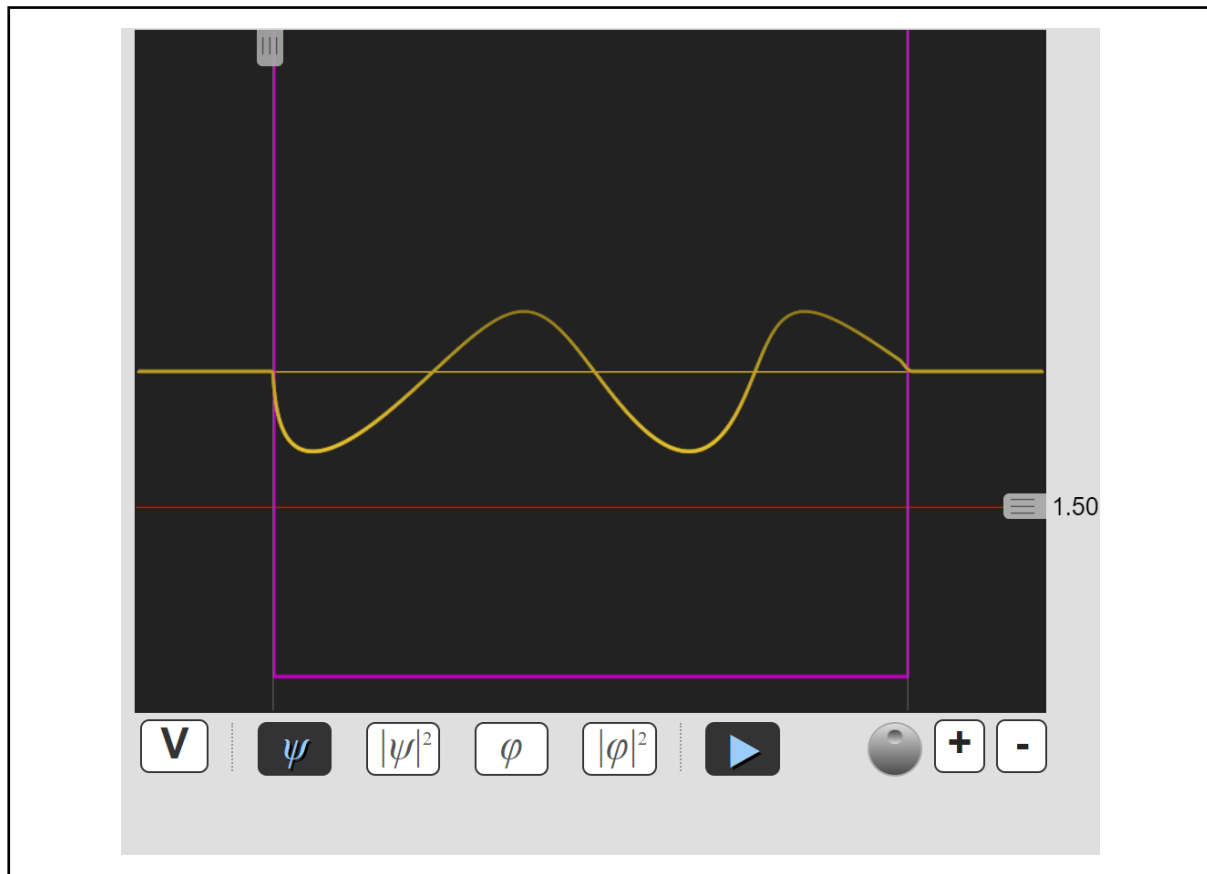


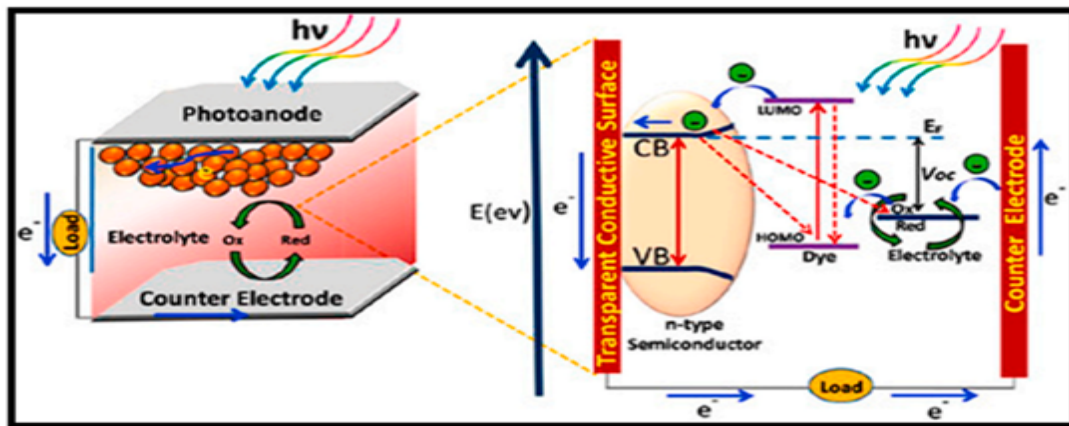
Image: <https://ridiculousfish.com/wavefiz/>

2) Which is the role of each representation in the NST field? Is there any differentiation in the use of these representations?

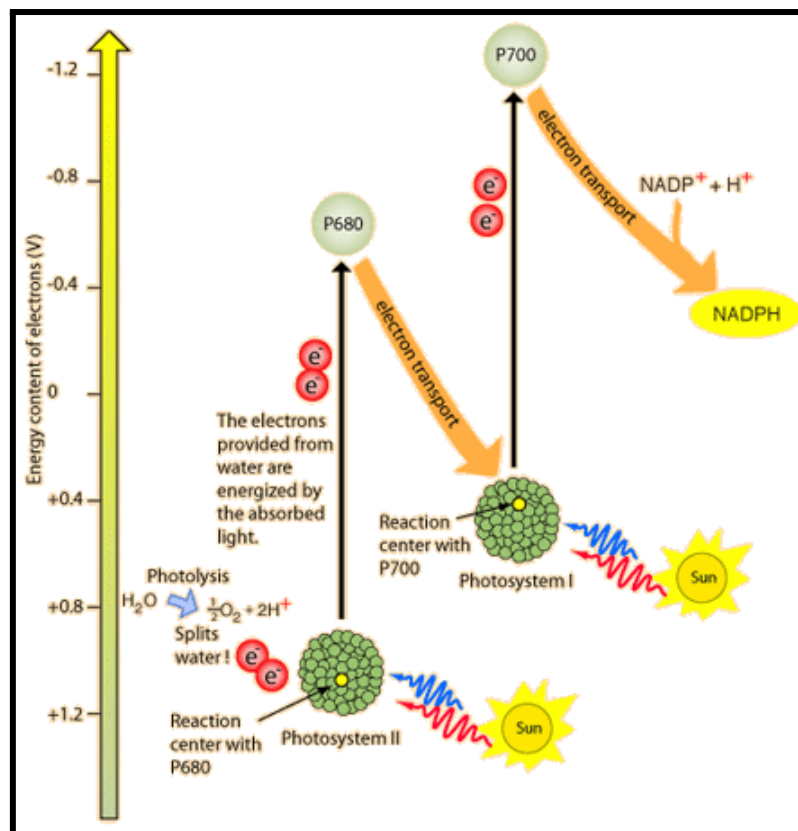
3) What is the role of Modelling/ Simulations in Research & Development of NST? Can you identify different modelling practices/ perspectives among S-T-E-M disciplines?

Activity 2

Regarding the DSSC photovoltaics activity you experienced previously (ID student, activity 2), take a look at the following schematic representations of the DSSC's mechanism and the mechanism of natural photosynthesis.



Schematic representation of the working principle of a DSSC device. (Yahya et al. 2021)



Schematic representation of photosynthesis. <http://hyperphysics.phy-astr.gsu.edu/hbase/Biology/etnoncyc.html>

4) Do you observe any similarities/differences between them? Comment on those.

5) How do you think research evolved on studying photoinduced processes? How would you describe the process through which researchers applied photoinduced processes to harvest solar energy?

6) How does each S-T-E-M field contribute to the development of using photoinduced processes to harvest solar energy?

7) What is the role of Biomimetics in Research & Development of NST?

8) Can you identify different practices/ perspectives on Biomimesis among S-T-E-M disciplines?

Activity 3

The following excerpts are describing the meaning of the words a) *nanoscale*, b) *efficiency*, c) *artificial - natural* . Read the texts and reflect on the given questions.

Nanoscale

a.

Although conceptually dividing the universe into these worlds can be useful as a guide, it is more accurate to consider the worlds on a continuum, in which divisions between them are somewhat blurred rather than explicitly defined. For example, the nanoscale is generally numerically defined as 1 to 100 nanometers (nm) (Roco 2004). In terms of matter, it is considered to represent the transition between bulk matter and individual atoms and molecules.

(Stevens et al, 2009)

b.

The 1rst example of artificial (synthetic) nano-motors with diameters in the sub-micron domain (370 nm diameter) was reported by Crespi, Mallouk and Sen in 2004, consisting of platinum (Pt) and gold (Au) segments.⁴

(Abdelmohsen et al 2014“Micro- and nano-motors for biomedical application”)

c.

In terms of matter, it is considered to represent the transition between bulk matter and individual atoms and molecules. However, protein and DNA *molecules* are often considered landmark nanoscale objects for the nanoworld. Therefore, the scales and worlds must be used as *guides* to the size landscape rather than as absolute, rigid categories.

(Stevens et al. 2009)

d.

Their size and optical properties can be put to practical use: nanoscale gold particles selectively accumulate in tumors, where they can enable both precise imaging and targeted laser destruction of the tumor by means that avoid harming healthy cells.....

(International Center for Nanosystems and Quantum Technologies
<http://icnqt.com/what-is-so-special-about-nano-scale/>)

9) What is the meaning of “nanoscale” between the above various contexts?

10) Does the meaning of the same word differentiate between different STEM disciplines/communities/contexts?

11) Do you regard this different meaning as an obstacle regarding the interplay of STEM disciplines in the field of NST?

Efficiency

a.

The treatment significantly improves the performance of PSCs (*Perovskite Solar Cells*) compared to that of the controls (without doping; Fig. 4a). This is particularly reflected in the VOC, which is improved from 1.08 ± 0.01 V to 1.17 ± 0.01 V and the fill factor (FF), which improves from $75.7 \pm 0.9\%$ to $79.7 \pm 0.9\%$, resulting in a significant improvement of the power conversion efficiency (PCE) (average) from $20.56 \pm 0.21\%$ to $23.62 \pm 0.43\%$.

(Zhang et al. 2021 “Multimodal host-guest complexation for efficient and stable perovskite photovoltaics”)

b.

Further results reveal that the eight world regions contain the fastest growing countries, having the latest technology and the largest amount of foreign capital and managerial expertise to improve environmental efficiency by decreasing fossil fuel and increasing the consumption of renewable energy. Lower energy efficiency and environmental index score show that the fast economic growth and development cause heavy pressure on environmental protection and energy consumption, while higher energy efficiency and environmental index score show that even though fast economic growth and development exist, these countries are fighting against environmental degradation by adopting renewable energy.

(Anser, M.K., Iqbal, W., Ahmad, U.S. et al. 2020 “Environmental efficiency and the role of energy innovation in emissions reduction”)

12) What is the meaning of “efficiency” between the above various contexts?

12) Does the meaning of the same word differentiate between different STEM disciplines/communities/contexts?

13) Do you regard this different meaning as an obstacle regarding the interplay of STEM disciplines in the field of NST?

Natural/ Artificial

a.

In addition to providing an inexpensive source of vanillin—in higher purity than one could obtain from natural vanilla extract—this synthesis enables production of vanillin derivatives possessing desirable qualities, like increased flavor potency and thermal stability. For example adding one extra carbon atom to vanillin affords ethyl vanillin, which is 2–4 times more flavorful than vanillin itself

(C. Rose Kennedy Science in the News, Harvard University 2015
<https://sitn.hms.harvard.edu/flash/2015/the-flavor-rundown-natural-vs-artificial-flavors/>)

b.

Researchers have been trying to create artificial cells for more than 20 years — piecing together biomolecules in just the right context to approximate different aspects of life. Although there are many such aspects, they generally fall into three categories: compartmentalization, or the separation of biomolecules in space; metabolism, the biochemistry that sustains life; and informational control, the storage and management of cellular instructions.

(Kendal Powell, Nature 2018 <https://www.nature.com/articles/d41586-018-07289-x>) .

14) What is the meaning of “artificial/natural” between the above various contexts?

15) Does the meaning of the same word differentiate between different STEM disciplines/communities/contexts?

16) Do you regard this different meaning as an obstacle regarding the interplay of STEM disciplines in the field of NST?

17) Can you identify **other a) concepts, b) methods/techniques, c) artefacts/tools, d) questions** that bridge discontinuities in action/ interaction between different STEM disciplines?

18) Can you think of **other linguistic terms** that gain diverse meanings/interpretations between S-T-E-M disciplines in the context of NST?

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