A Template for Sustainability Education in Chemistry

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Who worries about?

- Climate change.
- Finite resources.
- Species and habitat loss.
- Energy security.

Raise your hand!

Survey: students, researchers, academics and industry.

71 %

wanted **more sustainability education**
during their degree studies.
79 respondents.

Barriers to teaching sustainability.

- Constrained by a crowded curriculum.
- Educators felt a lack of subject knowledge.
- Time and cost to develop new materials.

Jennifer J. MacKellar et al. ‘Toward a Green and Sustainable Chemistry Education Road Map’. In: Journal of Chemical Education 97.8 (2020), pp. 2104–2113. issn: 19381328. doi: 10.1021/acs.jchemed.0c00288.

FRAMEWORK

Clear structure, 3 education activities.

Aim for Educators

Easy to understand, deliver and embed in *any* chemistry course.

Aim for Students

Consider chemistry problems in context of sustainability.
Identify pathways for solving sustainability issues.

FRAMEWORK: 3 Activities.

- Activity 1: Discuss Sustainable Chemistry.
- Activity 2: Systems Map - chemistry topic – overview.
- Activity 3: Network Map – chemistry topic – problem specific.

Activity 1. Discuss Sustainable Chemistry.

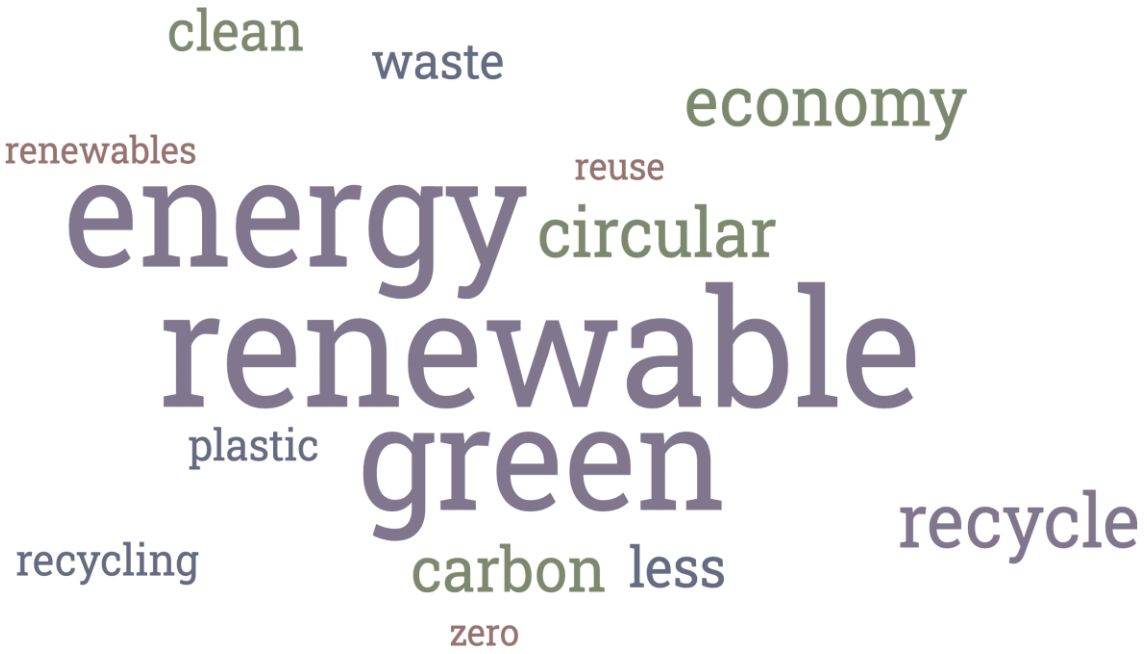
- **LEARNING OBJECTIVES.**

Describe and discuss meaning of sustainability in chemistry.

- **PROMPT - MENTIMETER.**

Give 3 words or phrases you associate with sustainability.

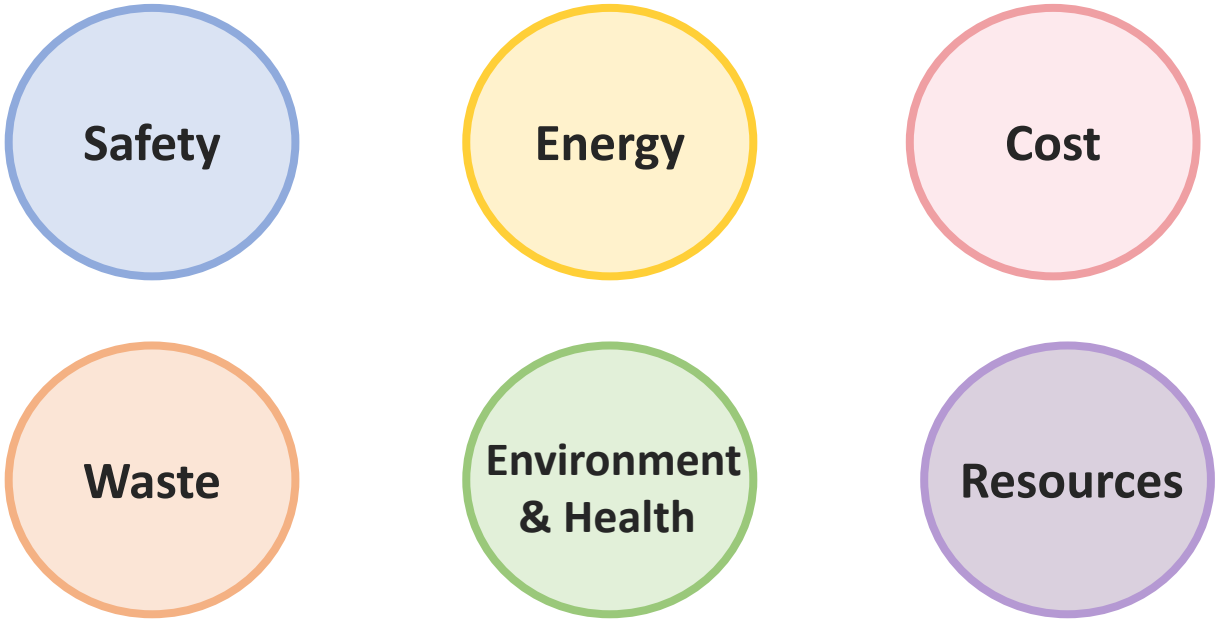
- **TIME.** 10 - 20 minutes.



What is Sustainability?

- Safety
- Energy
- Cost
- Waste
- Environment & Health
- Resources

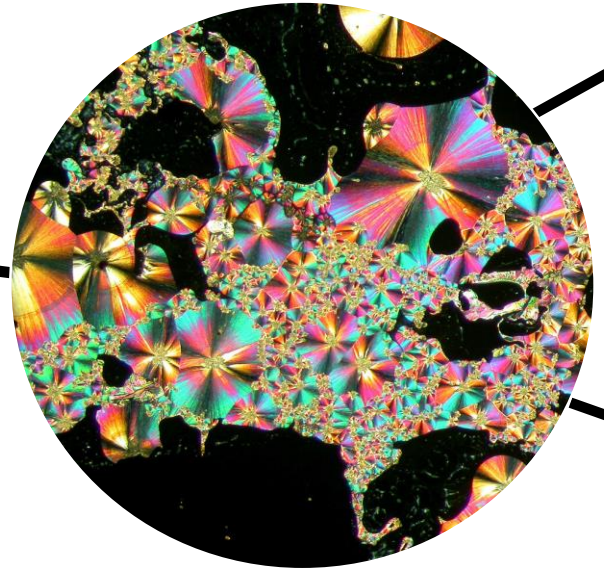
Six areas of sustainable chemistry.



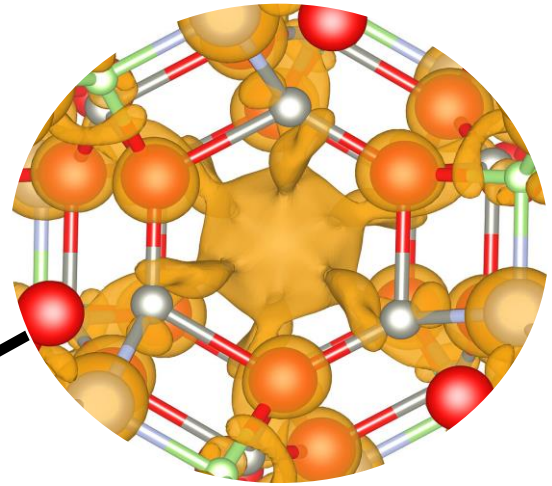
Use these to structure and guide conversations about sustainability in chemistry.

Sustainability - Complex Systems.

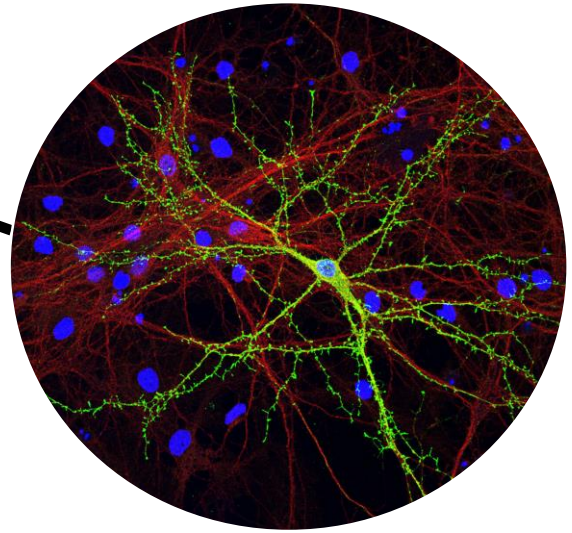
Ms Hend Abdelhakim, UCL School of Pharmacy. Pharmaceutical Nanotechnology



Floral patterns in the crystallisation of mefenamic acid, Miss Rona Watson, Chemistry



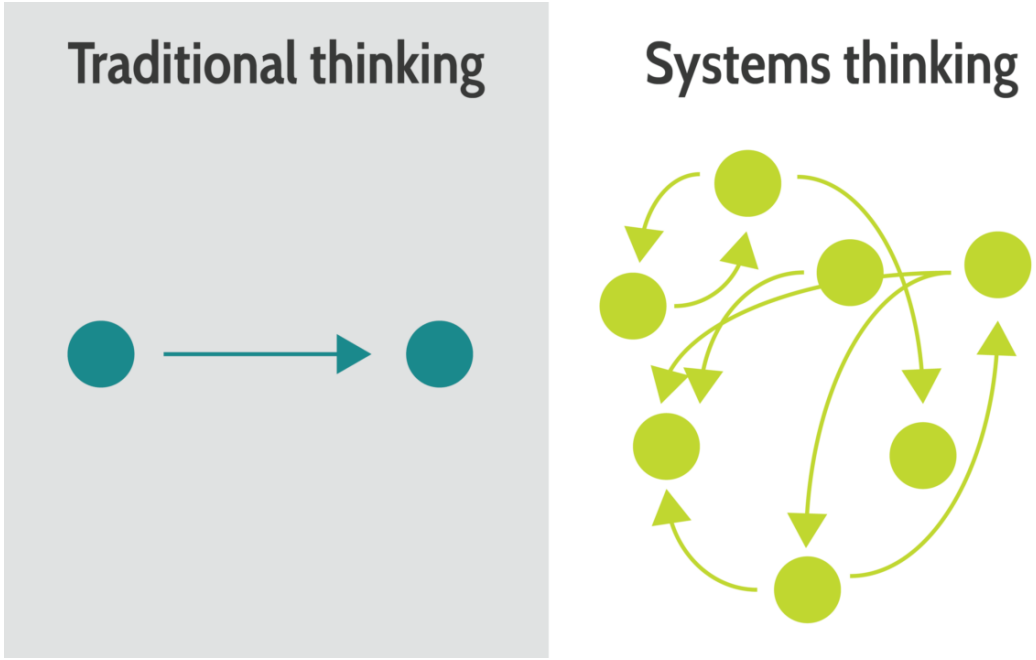
Electronic density in a ZnO/GaN sodalite framework. Dr John Buckeridge, Chemistry



Dr Faye Mcleod, Cell and Developmental Biology

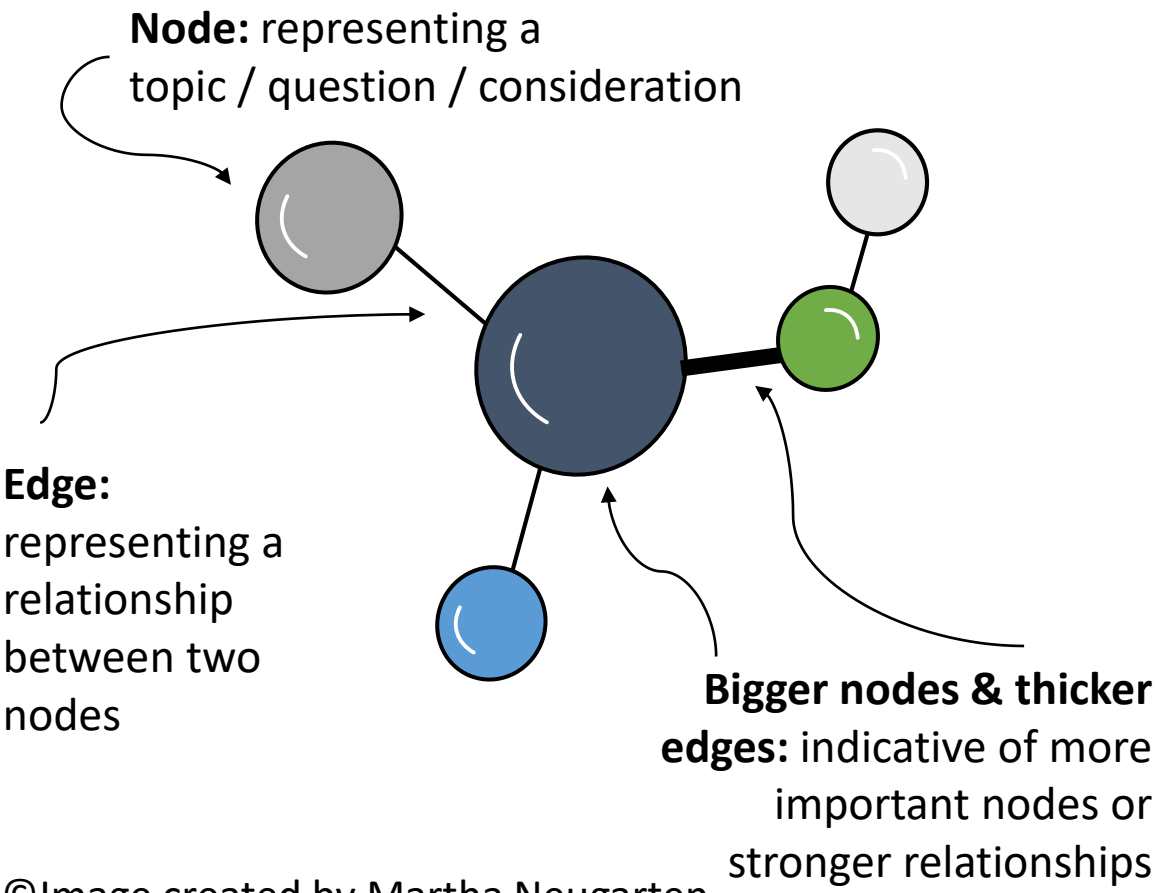
Framework for Activities 2 and 3.

Systems thinking



https://kindling.xyz/futures/systems-thinking/

Graph theory



Activity 2: Systems Map.

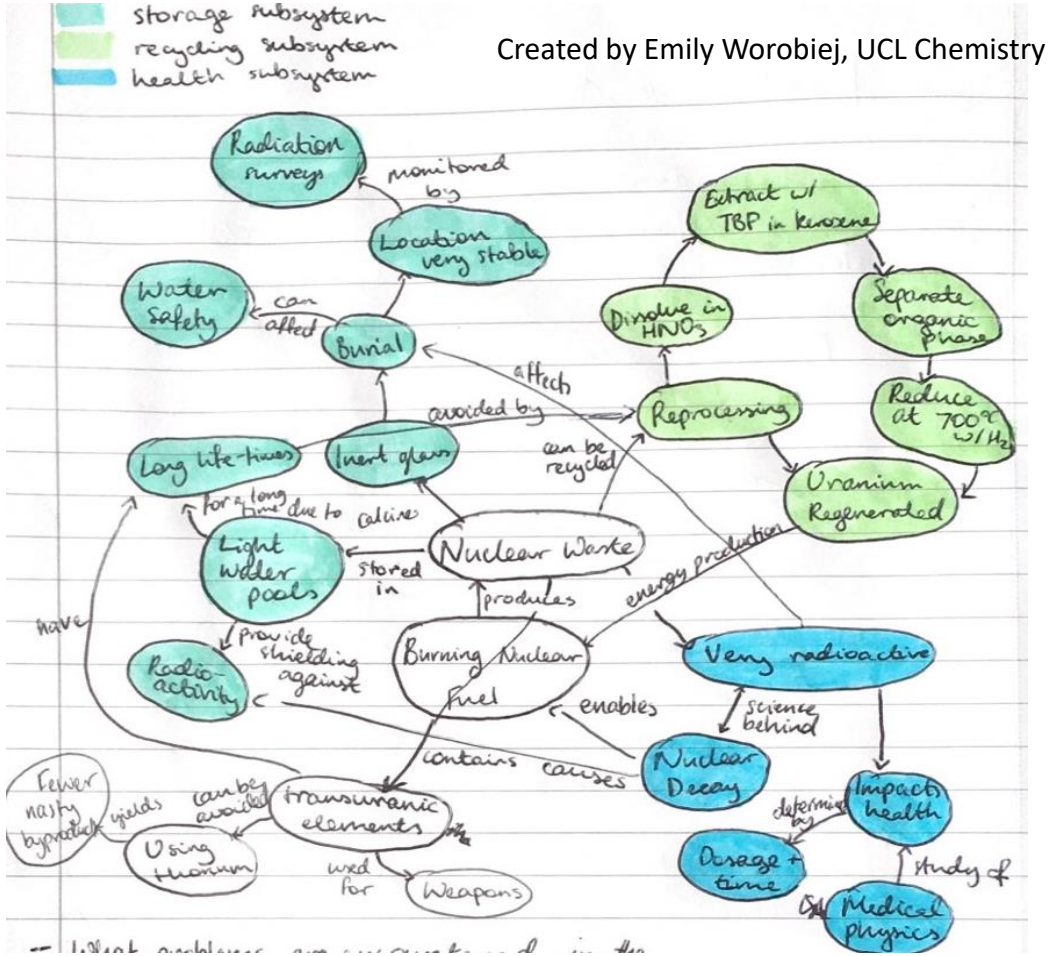
- **LEARNING OBJECTIVES.**

Systems thinking. Handling ill defined problems, communication / teamwork and critical analysis.

- **EDUCATOR LED.**

With the student class, create a systems map around a particular topic, ie. carbon capture, nuclear energy.

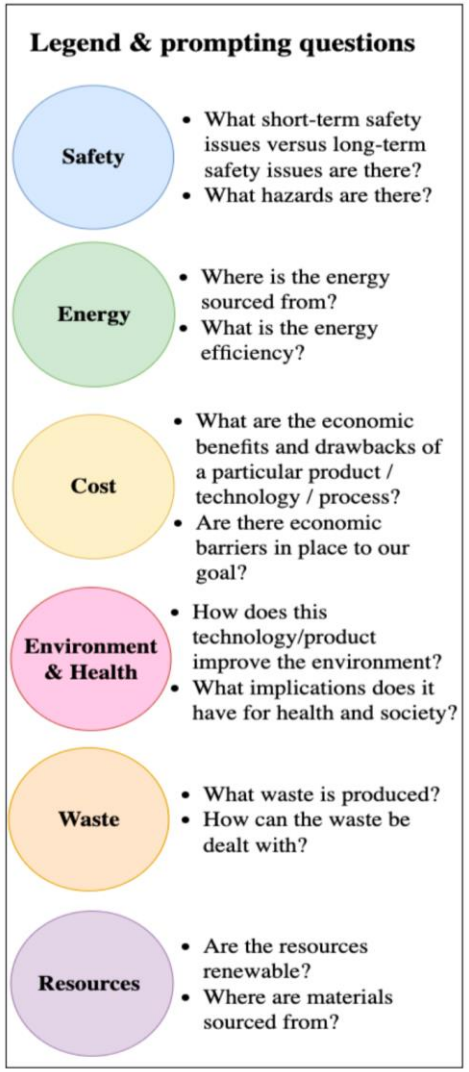
- **TIME.** 15 – 30 minutes.

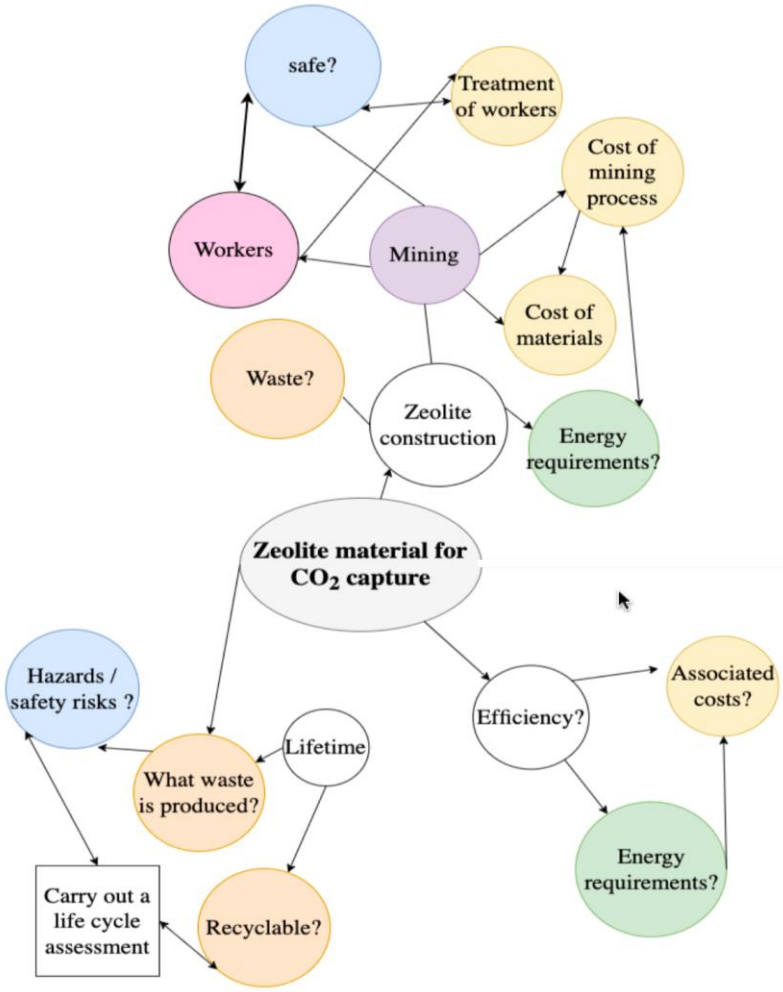


Created by Emily Worobiej, UCL Chemistry

Weber JM, Lindenmeyer CP, Liò P, Lapkin AA. Teaching sustainability as complex systems approach: a sustainable development goals workshop. International Journal of Sustainability in Higher Education. 2021;22(8):25-41.

Activity 2: Systems Map

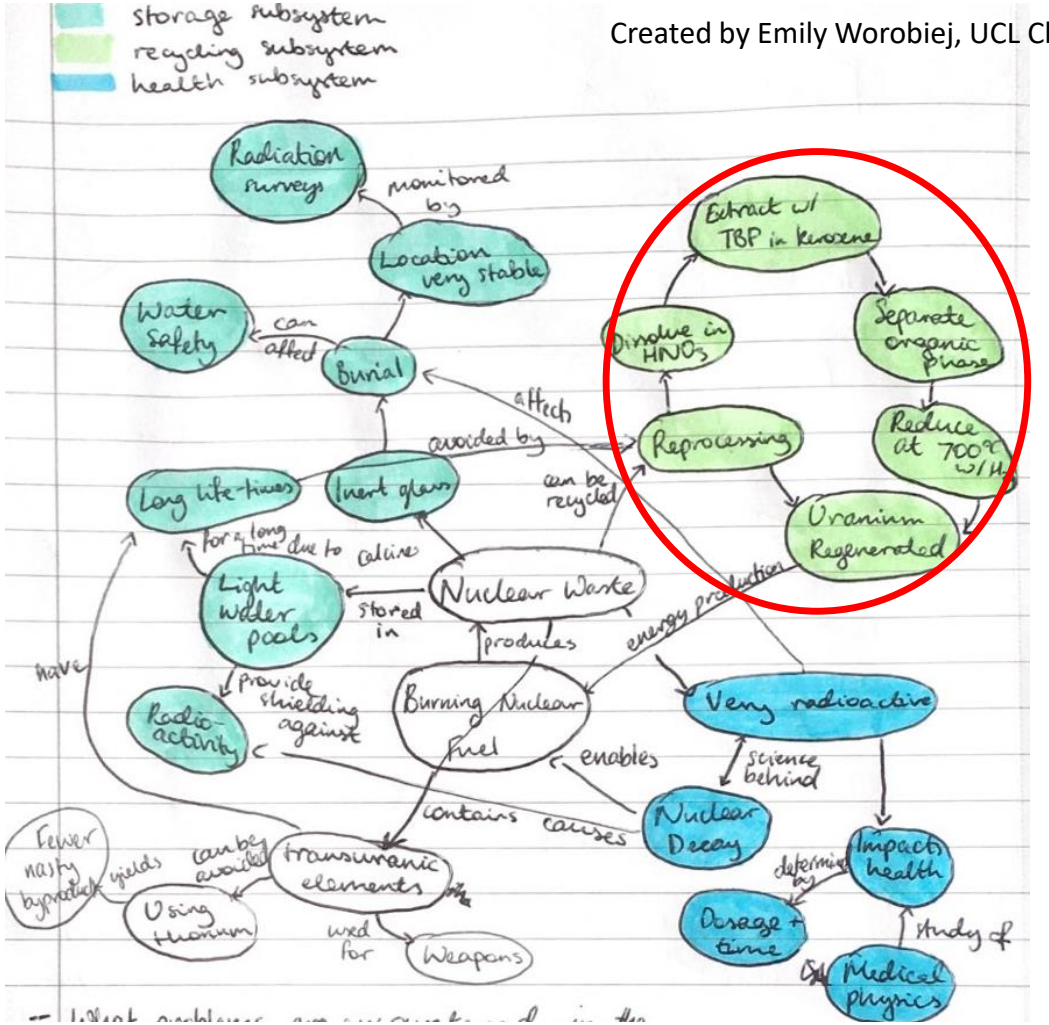




Activity 2, Systems Map: Learning Outcomes.

- Formulate problems.
- Handle multidisciplinary material / complexity - systems thinking.
- Work with dynamic structures – time and space.
- Interpersonal, teamwork and communication skills – *peer learning.*
- Empathy, changing perspective.
- Critical thinking / analysis, strategic action.

Activity 3: systems to **network maps**.



Created by Emily Worobiej, UCL Chemistry

- Split students into groups.
- Students select a particular sustainability problem shown in the system and create a network map.
- The student group spends 2 minutes presenting their network map.

Activity 3: Network Map.

- **LEARNING OBJECTIVES.**

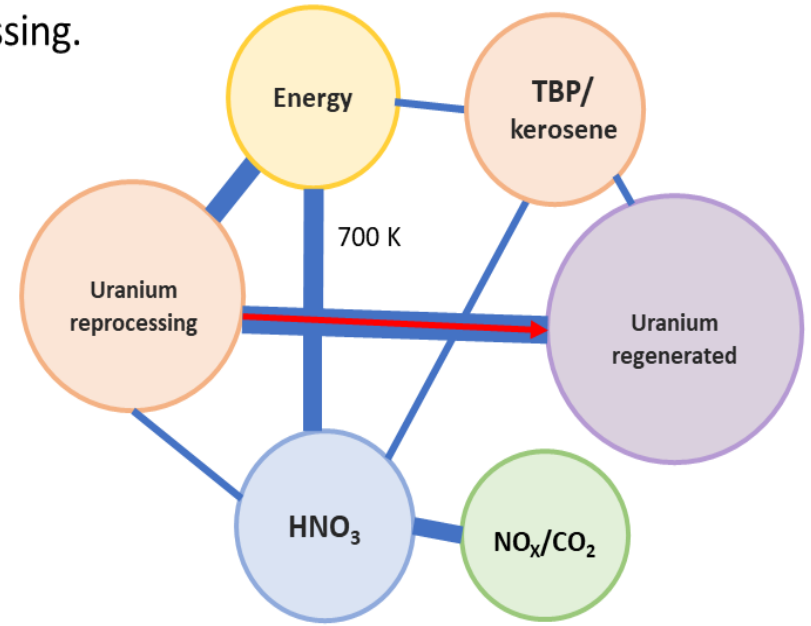
Identify pathways for solving sustainability, communication / teamwork.

- **STUDENT LED.**

Create a network map of a sustainability problem identified in the system map eg. waste, energy, safety, environment. 2 minute presentation of each network map.

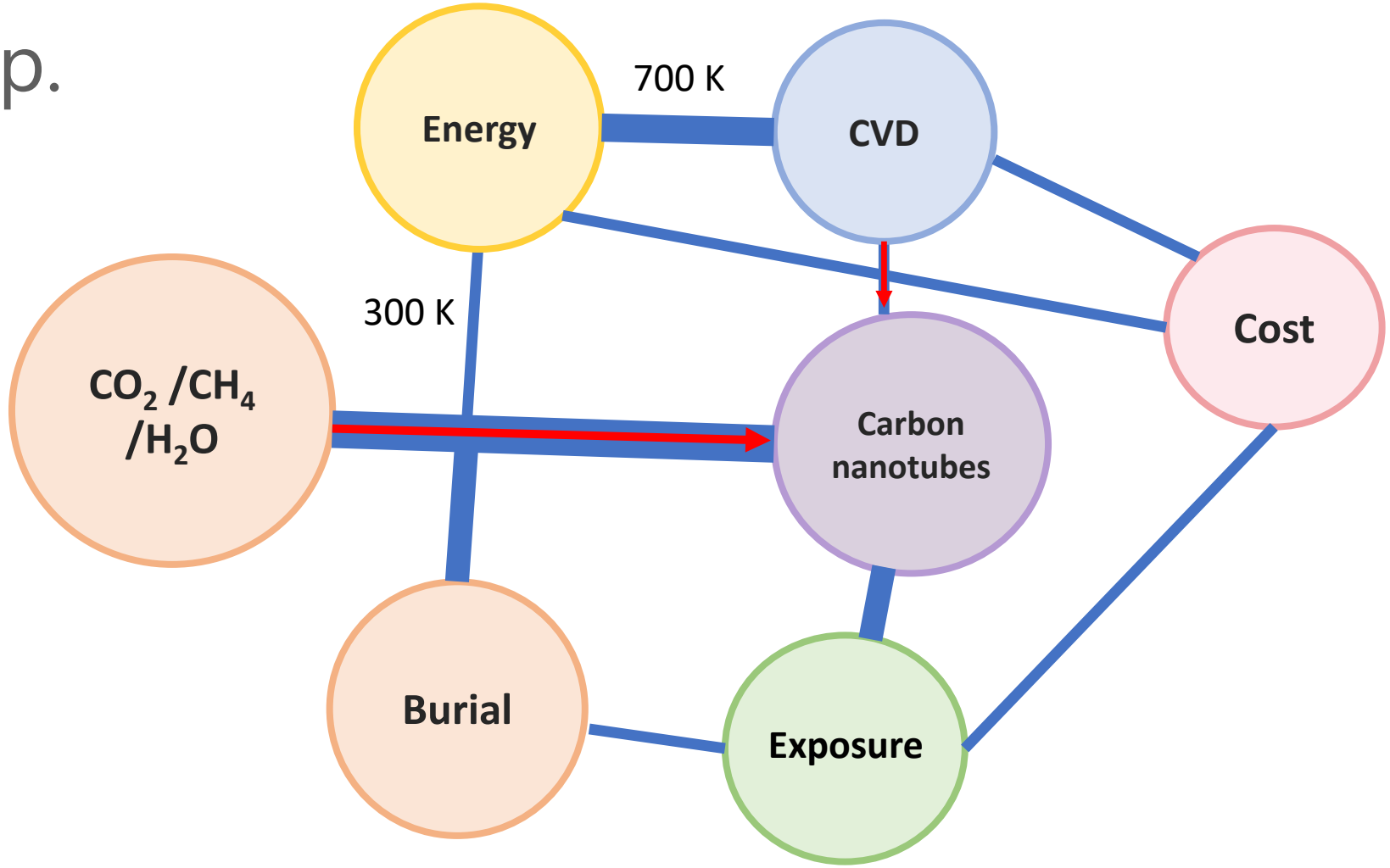
- **TIME.** 1-2 hrs independent + 20 mins flipped classroom.

Nuclear fuel reprocessing.



Network Map.

Simulation, greenhouse gas diffusion onto carbon nanotubes.



Activity 3, Network Map: Learning Outcomes.

- Identify missing and necessary information to solve chemistry sustainability problems.
- Prioritise information.
- Interpersonal, teamwork and communication – peer learning.
- Critical thinking, analysis, developing strategies.

Conclusion, feedback, next steps.

FRAMEWORK	PEDEGOGY	DIGITAL MAP TOOLS	TIMINGS
Easy and quick to start working with.	Interdisciplinary skills, handle complexity, flipped learning.	Can be too complicated.	Flexible.
Develop examples in specific chemistry topics.	Further define learning outcomes / skills.	Source easy to use tools and create a user guide.	Embed in any chemistry, undergraduate or post graduate course.

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