香 港 大 學
THE UNIVERSITY OF HONG KONG

Enhancing learning and teaching of mathematics and science in Hong Kong – A reflection based on the TIMSS 2019 results

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About me

Background

- Science education researcher
- Chemistry teacher educator

Research interest

- Chemistry education
- Modelling-based teaching and learning

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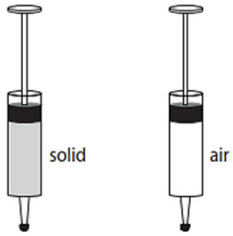
Let's start with what we know

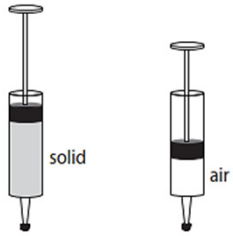
- Which ideas of particle theory are useful to answer these two questions?

Tim filled two syringes with equal volumes of a solid and air and sealed the ends so that none of the materials could escape.



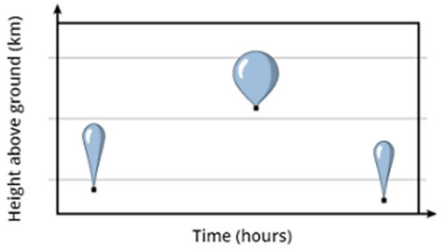
1

He pressed the plungers of the syringes and observed the following:



Explain his observations in terms of particle spacing in solids and in gases.

The diagram shows the height above the ground of a helium-filled weather balloon during a period of several hours.



2

What causes the balloon to become bigger as its height above the ground increases?

A Gravity decreases.

B Atmospheric pressure decreases.

C The balloon is heated by the Sun.

D The balloon absorbs air.

What can we tell about particle theory from these questions?

- It explains very diverse phenomena

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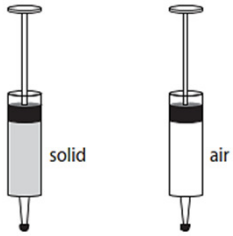

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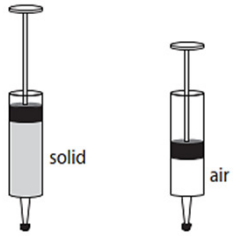

Girl: 25.0%
Boy: 25.9%

Explain his observations in terms of particle spacing in solids and in gases.

Physics

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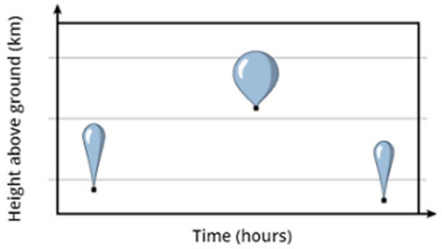

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What causes the balloon to become bigger as its height above the ground increases?

A Gravity decreases. 16.5%

*B Atmospheric pressure decreases. 49.5%

C The balloon is heated by the Sun. 14.6%

D The balloon absorbs air. 17.6%

Earth Science

How are these questions related to our junior science curriculum?

- One of the learning targets:
  recognise the connections and overarching coherence across different disciplines of science with unifying concepts
- One of the unifying concepts: Evidence and models

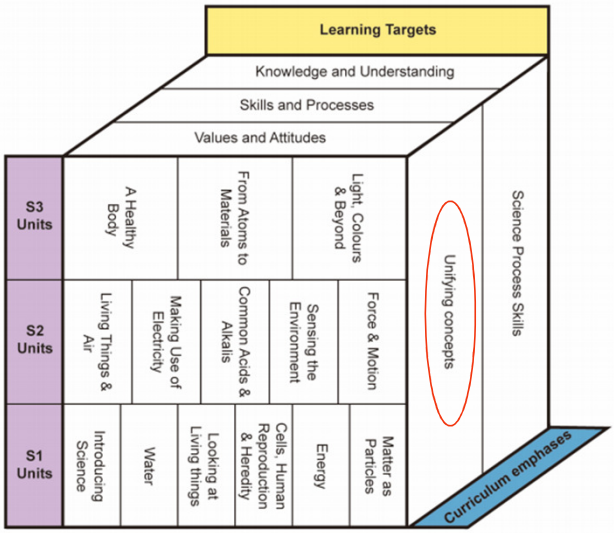

Figure 2 Diagrammatic Representation of the Science (S1-3) Curriculum Framework

Purposes of models

Evidence and models	Scientists use evidence and models to understand, explain and/or predict scientific phenomena. • Evidence consists of observations and data on which scientific explanations can be constructed and predictions can be made. • Models are representations that are taken to illustrate real systems, objects, concepts or events. They can be used to explain, predict and study how real objects work. Models can be physical, conceptual, or mathematical.

sets of ideas externalised as

Multimodal

Which ideas of the particle theory are needed?

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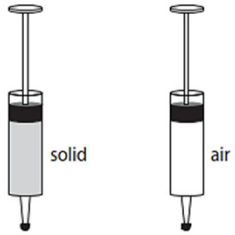

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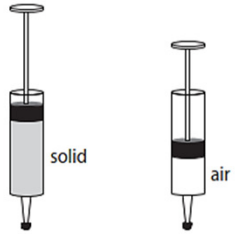

Girl: 25.0%
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Explain his observations in terms of particle spacing in solids and in gases.

- Matters are made up of particles
- Particle spacing
  - Do we need to focus on regular/irregular arrangement of particles?
  - What is the aim?
    - Explain why there is a decrease in volume when air is compressed

Identify the set of ideas with reference to the aim of the model.

Which ideas of the particle theory are needed?

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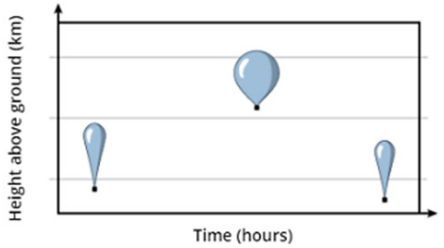

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- Matters are made up of particles
- Particle spacing
  - Number of particles per unit area
- Particle movement (Brownian motion?)
- Particle collision with the surface of the balloon

Identify the knowledge boundary.

How can we promote student conceptual understanding of particle theory by engaging them in model construction?

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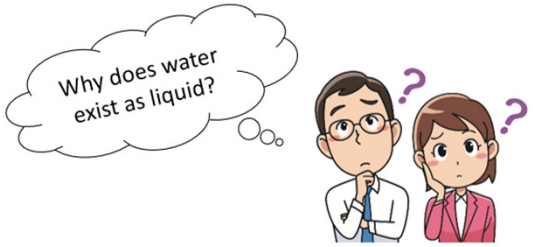
Working with students' generated representations- 1



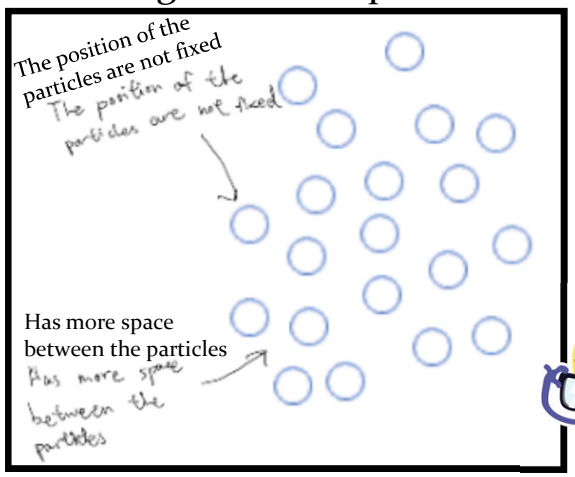
Can you try constructing a model to explain why water exists as liquid?

You may choose to use these particles and drag them into place:

- Why do you choose small/ large/ both particles in your model?
- Why you arrange them in such a way?

Students are asked to drag and drop given particles to construct their representations

Student's generated representation



Let's comment on this representation.

Evaluate their representation

Make inference on their models

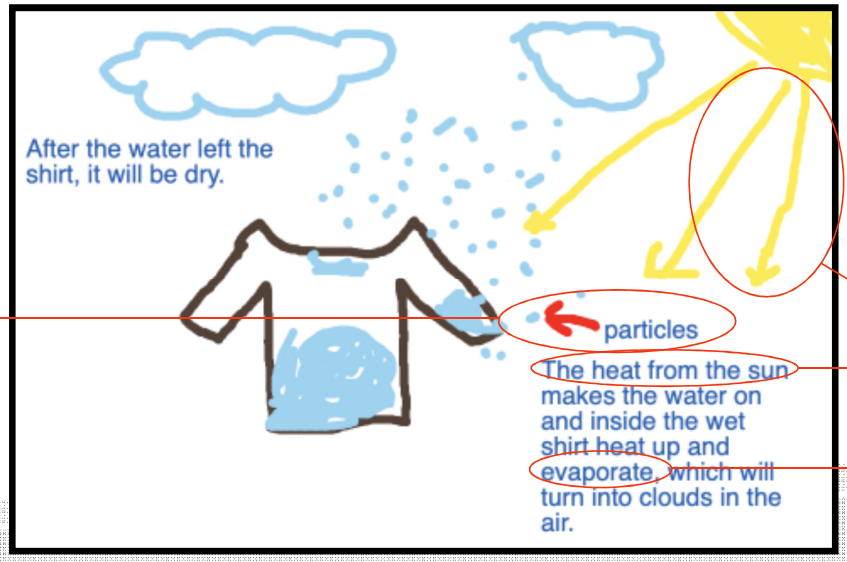
- What **can be** explained?
  Irregular shape
- What **cannot be** explained?
  Incompressibility

Emphasize on correct answerism

Emphasize on students' achievement and improvement

Working with students' generated representations- 2

Explain why wet clothes can be dried under sunlight.
You may have to think about:
1. What are the ideas involved in your explanation?
2. How these ideas are related to the phenomenon?
3. How are these ideas linked?



Matter is made up of particle

Energy transfer

???
Missing: Movement of particles

Student's generated representation

Reflect on our teaching and learning

- Scaffold students' development of models
  - Identify the sets of ideas involved and develop them **gradually**
  - Make use of evidence
    - Common to students
    - Given as observations, data, etc.
    - Collect through inquiry
- Use multimodal instruction to support students' expression of models
- Value students' ideas
- Recognise and praise students' achievement and improvement

Thank you

Go to Part 3