Is the greenhouse effect happening outside today?
A classroom discussion to consolidate understanding about the greenhouse effect

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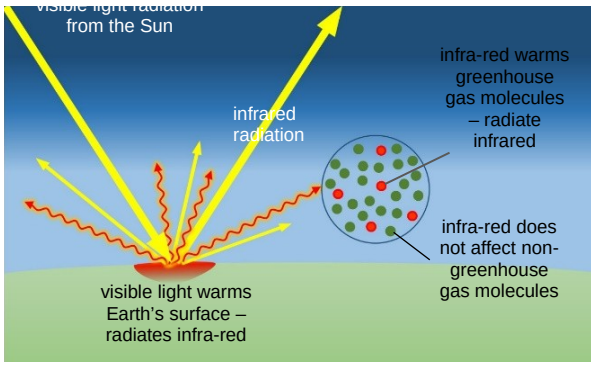

Diagram, Chris King, drawing, Tanja Reinhardt

Ask your pupils, 'Is the greenhouse effect happening outside the window today?' Help them to respond through the following discussion.

Q. Is there visible light outside?
A. Yes, because we can see – there is daylight.

Q. Is the visible light reflecting off the ground and other objects outside?
A. Yes, because otherwise we would not be able to see these things.

Q. Is some of the visible light that is hitting these surfaces being absorbed?
A. Yes, because different colours and textures of outdoor surface reflect different amounts of light (the albedo effect) but some is always absorbed.

Q. Is some of the absorbed visible light being re-emitted as infra-red radiation?
A. Yes since, when visible light is absorbed, some is always re-emitted as infra-red radiation, or heat.

Q. Are there some greenhouse gases in the air outside?
A. Yes, Earth's atmosphere contains different amounts of water vapour most of the time, together with about 0.04% carbon dioxide, 0.0002% methane and traces of nitrous oxide and ozone.

Q. Will the greenhouse gases be absorbing the heat re-emitted by the Earth?
A. Yes, greenhouse gas molecules absorb any heat they receive.

Q. Will the greenhouse gases then be re-emitting infra-red radiation as heat to warm the atmosphere and the Earth?
A. Yes, greenhouse gas molecules that absorb heat, then re-emit it.

Q. So, is the greenhouse effect happening outside today?
A. YES, because all the things which cause the greenhouse effect are happening outside now – as in the diagram.

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The back up

Title: Is the greenhouse effect happening outside today?

Subtitle: A classroom discussion to consolidate understanding about the greenhouse effect.

Topic: A discussion to reinforce learning and to counter misconceptions about the greenhouse effect.

Age range of pupils: 11 years upwards

Time needed to complete activity: 10 minutes

Pupil learning outcomes: Pupils can:
- explain that the greenhouse effect involves visible radiation from the Sun being absorbed and re-emitted by the Earth's surface as infra-red radiation, which is then absorbed by greenhouse gas molecules and re-emitted to warm the atmosphere;
- explain that this effect happens throughout the atmosphere, since greenhouse gas molecules are distributed through the atmosphere.

Context:
Many people wrongly think that the greenhouse effect occurs because there is a layer of greenhouse gases in the sky that act like a pane of glass in a greenhouse, trapping the heat that

originally came as visible light from the Sun. This view is often reinforced by misleading animations and diagrams on the internet and diagrams in textbooks and elsewhere.

This activity has been devised to help pupils to realise that there is no 'layer in the sky' but that the greenhouse effect processes happen throughout the atmosphere.

The greenhouse effect is necessary for life on this planet. Without it, it is likely that we would be experiencing a 'Snowball Earth' scenario, with the Earth frozen from pole to pole. The issue today is not that the greenhouse effect exists, but that measurements show that the amount of greenhouse gases in the atmosphere is increasing, resulting in an 'enhanced greenhouse effect'. Almost all scientists are convinced that this enhanced effect is caused by human activity, such as the burning of fossil fuels and deforestation of large regions, and that this is resulting in climate change.

Note that the greenhouse effect continues into the night-time, because objects that have received visible light during the day emit infrared radiation day and night.

Following up the activity:
Ask the class to search on the internet and in textbooks for diagrams and animations which wrongly show that the greenhouse effect is caused by a layer of greenhouse gases high in the atmosphere reflecting heat back to the surface – then to discuss them.

Underlying principles:

- The greenhouse effect is caused by visible radiation from the Sun being absorbed by the Earth's surface and then re-radiated as infrared radiation or heat. This in turn is absorbed by molecules of the greenhouse gases, which then re-radiate heat, warming the atmosphere and the Earth's surface.
- The greenhouse effect processes happen throughout the atmosphere.
- Increased amounts of greenhouse gases in the atmosphere may be causing an 'enhanced greenhouse effect' resulting in climate change.
- Almost all scientists consider that the measured increases of greenhouse gases in the atmosphere are being caused by human activity.

Thinking skill development:
Pupils need to construct their own model of how the greenhouse effect occurs before applying it through bridging to the local area. Misleading textbook diagrams and other sources can cause cognitive conflict.

Resource list:

- none

Useful links:
https://www.bgs.ac.uk/discovering-geology/climate-change/how-does-the-greenhouse-effect-work/

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