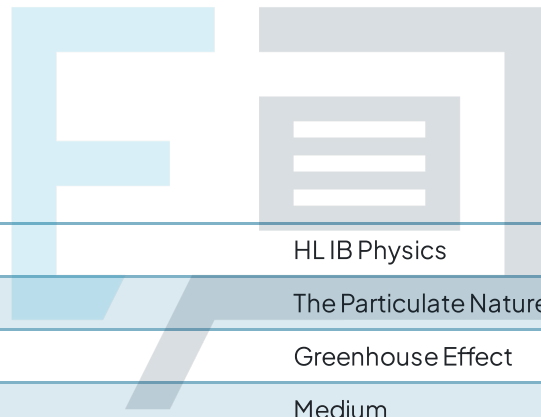




Greenhouse Effect

Mark Schemes



Course	HL IB Physics
Section	The Particulate Nature of Matter
Topic	Greenhouse Effect
Difficulty	Medium

Exam Papers Practice

To be used by all students preparing for HL IB Physics
Students of other boards may also find this useful

1

The correct answer is **C** because:

- Weather conditions can affect the intensity of sunlight that reaches the surface of the Earth
- For example, on a cloudy day, the intensity will be much lower than on a clear day
 - Therefore, statement I is **correct**
- Latitude refers to how far north or south of the equator a location is and therefore, is a key factor in daylight hours and intensity due to the tilt of the Earth
 - Therefore, statement II is **correct**
- The orbit of the Earth is slightly elliptical, so there are very small, but measurable, differences between the intensity received at different times of the year
 - Therefore, statement III is **correct**

Although statement **III** is correct don't get this mixed up with the cause of the seasons. Winter and summer conditions are caused by the tilt of the Earth on its axis. This tilt has a much greater effect on the intensity of the energy received at the surface than being slightly closer at these times of year.

2

The correct answer is **C** because:

- The Solar Constant is not an actual physical constant, but an average value of the amount of solar radiation reaching the upper atmosphere of the Earth
- Since it is measured from outside the atmosphere, the tilt of the Earth has no effect, so statement **II** is incorrect and **B** is incorrect
- The elliptical orbit of the Earth takes it very slightly closer to the Sun at certain times of the year so statement **I** is correct, meaning **D** is not correct
- The Sun does follow an 11-year cycle, meaning that statement **III** is correct, leaving **C** as the right answer

The Sun's cycle causes on very slight variations, as little as 0.1%. In fact, the considerations above only cause the incident radiation to vary by 0.2%. However, even this small effect is taken into account by averaging to get the Solar Constant.

3

The correct answer is **A** because:

- Greenhouse gases contribute to warming because they allow incoming radiation from the Sun to transmit through the atmosphere to the surface of the Earth
 - However, when a proportion of this energy is radiated from the surface as infrared it does not allow all of them transmit and leave the atmosphere
- Infrared radiation corresponds to the energy levels of the greenhouse gases
 - It is absorbed and then re-radiated
- This re-radiation takes place in all directions, containing a large proportion of the heat energy within the atmosphere

4

The correct answer is **C** because:

- Carbon dioxide absorbs infrared radiation then emits it in all directions

A is incorrect as the infrared radiation emitted from the surface at night does not become trapped in any part of the atmosphere (and the troposphere is the lowest layer). It is absorbed and re-radiated

B is incorrect as the upper atmosphere is not heated. Infrared radiation either passes through and out into space, or is absorbed by re-radiated

D is incorrect as some of the radiation either passes through and out into space, so it is not all returned to the Earth's surface



5

The correct answer is **D** because:

- Calculations of the solar constant assume that:
 - Radiation is incident perpendicular to the Earth's surface
 - The Earth is at its mean distance from the Sun

A is incorrect as the Earth is in an elliptical orbit around the Sun and the Sun's output varies during its 11-year sunspot cycle are both reasons why the solar constant's value changes throughout the year and not assumptions made when calculating the solar constant

B is incorrect as radiation is incident on the Earth in one second and on one square meter of its surface are both statements that form part of the solar constant definition

C is incorrect as the assumptions of the solar constant are:

- radiation is incident perpendicular and not parallel to the Earth's surface
- the Earth is at its mean and not maximum distance from the Sun

It is really important that you learn the definition, assumptions and the reasons why the solar constant changes to make answering more complex questions easier.

Exam Papers Practice

The solar constant is defined as:

The amount of solar radiation across all wavelengths that is incident in one second on one square metre at the mean distance of the Earth from the Sun

The value of the solar constant varies year-round because:

- The Earth is in an **elliptical orbit** around the Sun, meaning at certain times of year the Earth is closer to the Sun, and at other times of year it is further away
- The **Sun's output varies** by about 0.1% during its 11-year sunspot cycle



Calculations of the solar constant assume that:

- This radiation is incident on a **plane perpendicular** to the Earth's surface
- The Earth is at its **mean distance** from the Sun

6

The correct answer is **C** because:

- Ozone absorbs nearly 100% of ultraviolet radiation
- It is the ozone that restricts most of the outgoing infrared radiation from leaving the Earth's atmosphere
- The absorption spectrum for ozone looks different to other absorption spectra with dark lines in the ultraviolet wavelengths and in the outgoing infrared radiation

A is incorrect as this is the absorption spectra for water vapour and not for ozone

B is incorrect as this is the absorption spectra for carbon dioxide and not for ozone

D is incorrect as this is the absorption spectra for the whole atmosphere and not just for ozone

It is important to know the differences between the absorption spectra; specifically the wavelengths of radiation absorbed by each type of greenhouse gas. Whilst you do not need to memorise this diagram you will need to be able to interpret it to answer questions on greenhouse gases in your examination.