Name: _____

Date: _____

Class: _____

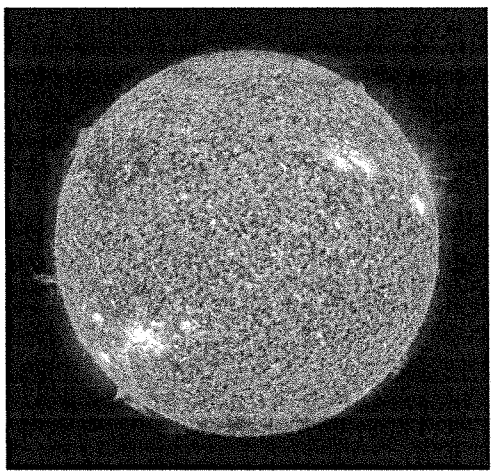
IB ESS

2.3 Flows of Energy and Matter

Significant ideas:

Ecosystems are linked together by energy and matter flows.

The Sun's energy drives these flows and humans are impacting the flows of energy and matter both locally and globally.

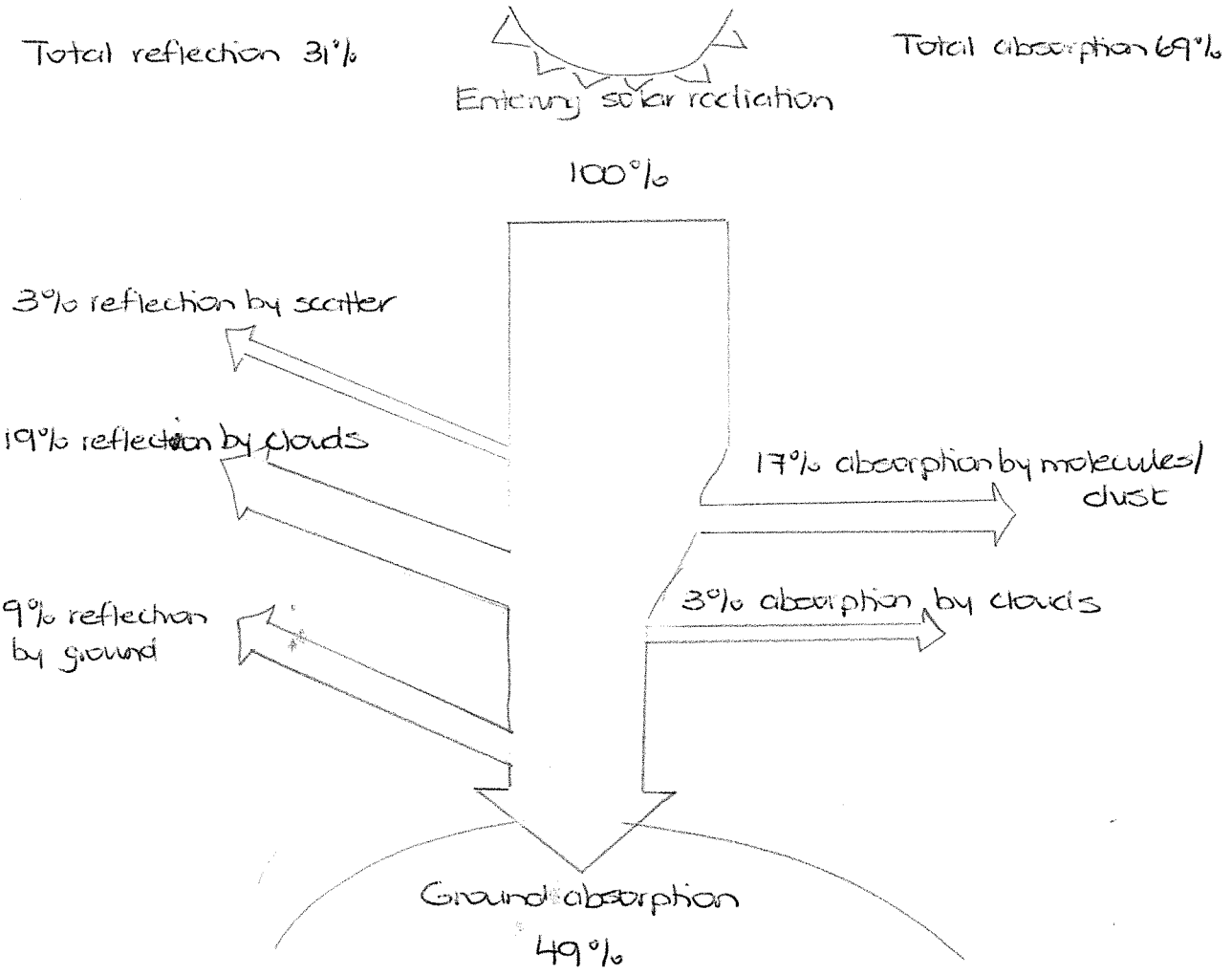


Energy Transfers

1. Draw a diagram to summarise the transfers and transformations of solar energy that occur as it reaches the Earth. Use the details listed below:

Ref: Davis + Nagle

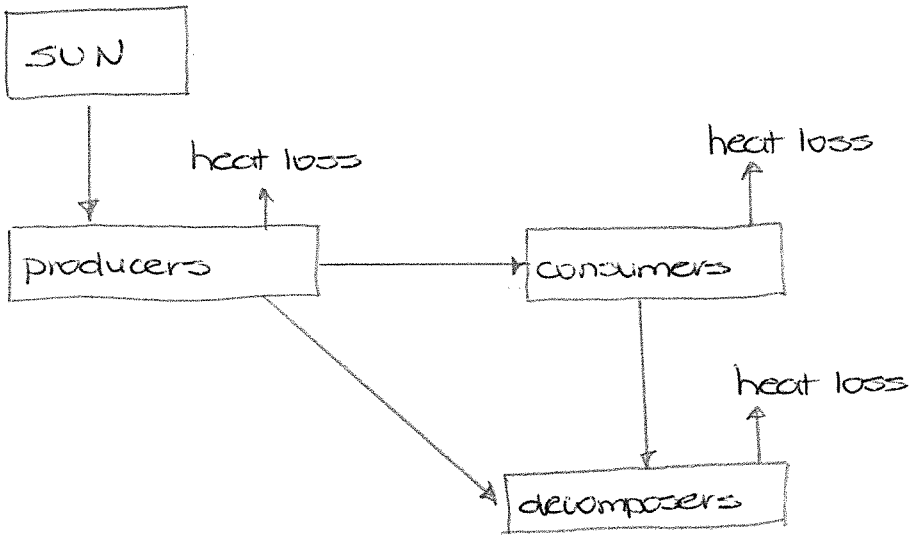
3% reflection by scatter	17% absorption by molecules/dust
19% reflection by clouds	3% absorption by clouds
9% reflection by ground	49% absorption by the ground



2. Roughly what percentage of the Sun's radiation is available to plants for photosynthesis?

1 %

3. Draw a systems diagram to summarise the pathways of energy through an ecosystem.



Productivity

1. The sentences below each describe one of the phrases in the box. Write the correct phrase below each sentence.

Net primary productivity ***Gross primary productivity***
Net secondary productivity ***Gross secondary productivity***
Maximum sustainable yield

The total amount of stuff (energy or biomass) that's taken in and assimilated by a consumer. An example is all the food that an animal takes in, subtracting what it releases as faeces.

Gross secondary productivity

The total amount of energy/matter assimilated by a producer (e.g. a plant), before it gets used by the plant for respiration.

Gross primary productivity

The food that an animal consumes, with fecal losses AND respiration subtracted. This is basically what is available to the next trophic level.

Net secondary productivity

The amount of energy/biomass that a producer takes in that it actually keeps (and doesn't use for respiration).

Net primary productivity

This is equivalent to NPP or NSP (depending on the context). It's basically the amount of "useful" stuff that is produced by a system.

Maximum sustainable yield

2. Complete the table below summarizing the details of productivity:

Productivity type	Abbr.	Calculation	Units
Net primary productivity	NPP	GPP - R	$g.m^{-2}yr^{-1}$
Gross secondary productivity	GSP	Food eaten – fecal loss	$g.m^{-2}yr^{-1}$
net secondary productivity	NSP	GSP - R	$g\ m^{-2}yr^{-1}$

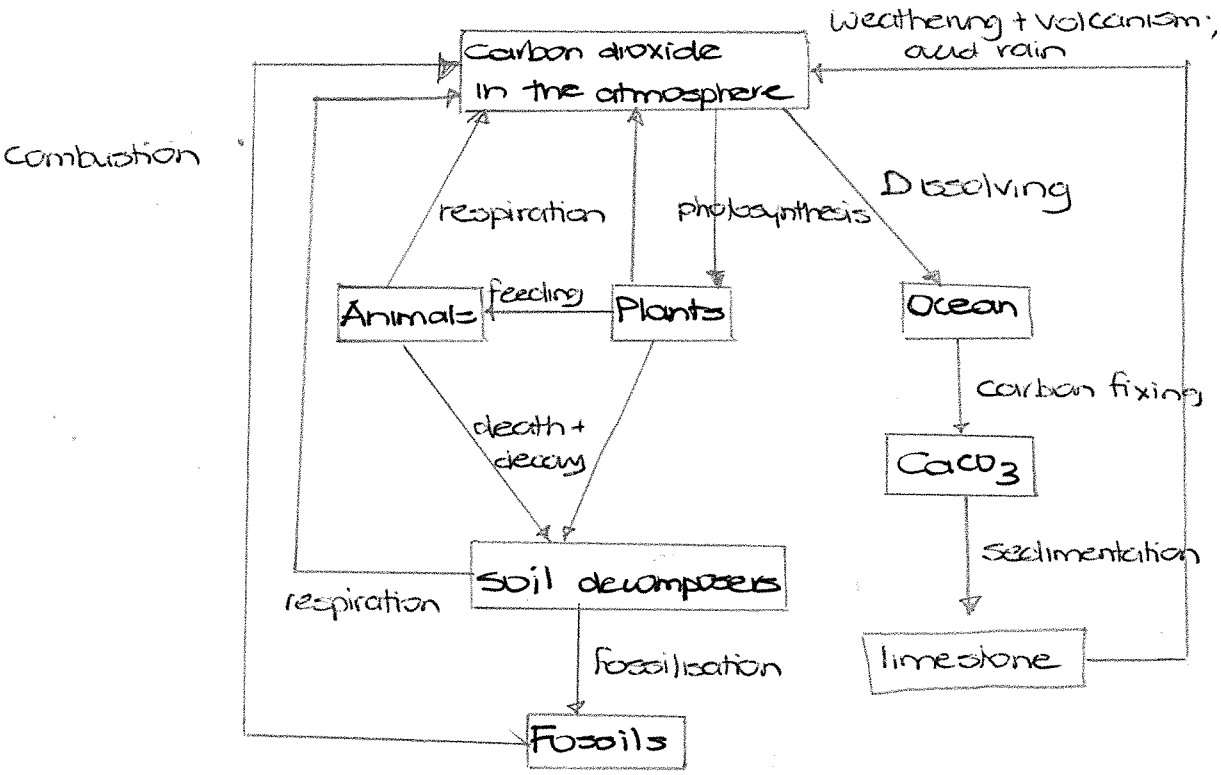
The Carbon Cycle

1.

a) Complete the table to list the flows and storages in the carbon cycle.

Storages	Flows
Producers Consumers Decomposers Fossils + sediments Atmosphere Oceans Soil	Photosynthesis Respiration Feeding Death + decomposition Fossilization Combustion Dissolving sedimentation

b) Draw a systems diagram to represent the carbon cycle. Include all storages and flows.



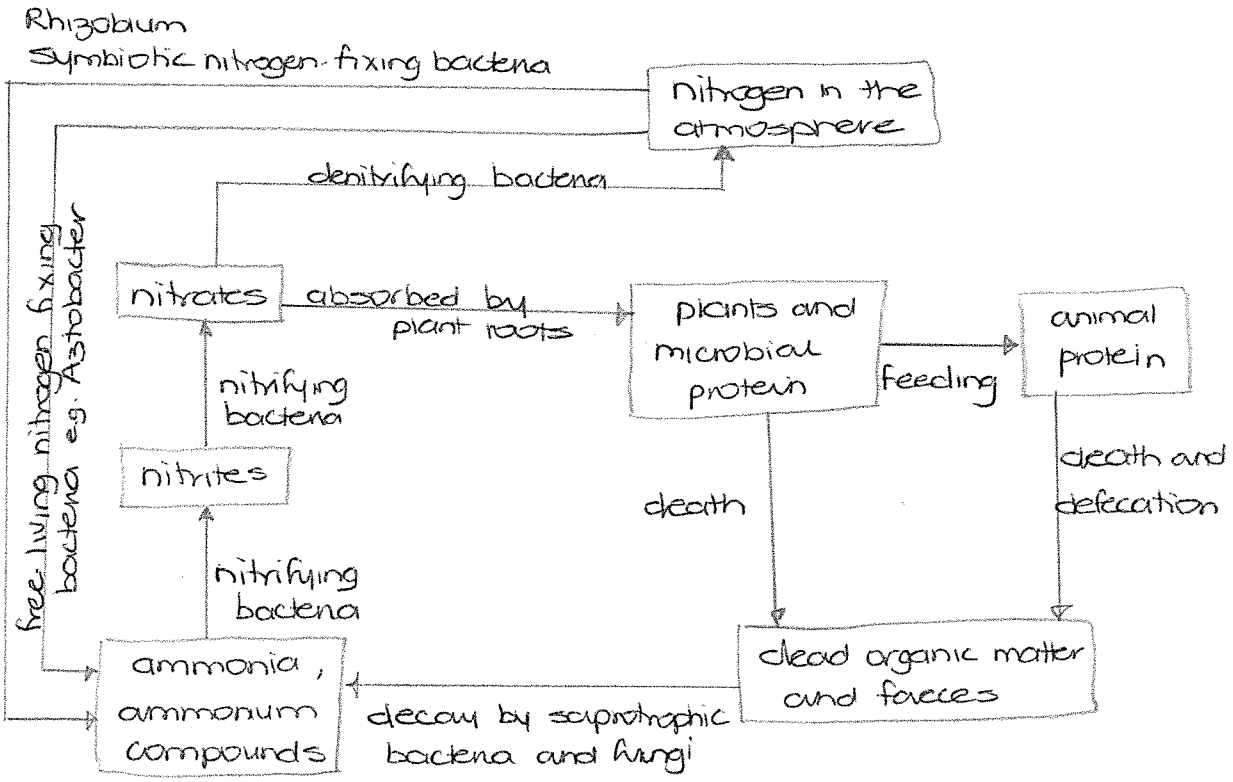
The Nitrogen Cycle

1.

a) Complete the table to list the flows and storages in the nitrogen cycle.

Storages	Flows
Producers - plant protein Consumers - animal protein Soil / organic matter Atmosphere Water Microbes - microbe protein	Nitrogen fixation Nitrification Denitrification Feeding Excretion Death + decomposition

b) Draw a systems diagram to represent the nitrogen cycle. Include all storages and flows.



Human Impacts

1. Outline ways in which humans influence **energy** flows.

Hints:

- Greenhouse gases
- Increased water vapour (clouds are reflective)
- Deforestation
- CFCs, ozone and UV light
- Agriculture: disrupting the natural flow through a food chain/web
- ... (any others you can think of?)

Our use of fossil fuels has allowed us to use the sun's energy that was previously trapped by plants and inaccessible for millions of years. This increased amount of available energy has allowed us to massively increase agricultural output, which has lead to increased population growth. It has also led to many environmental issues such as enhanced greenhouse gas emissions, deforestation (for agricultural land) and disruption of natural cycles.

Fossil fuel combustion has altered the way in which energy from the sun interacts with the atmosphere and the surface of the planet. Increased CO_2 levels and the corresponding increase in temperature (climate change) have led to the reduction in Arctic land + sea ice, reducing the amount of reflected sunlight energy. Changes in the atmosphere through pollution (CFCs, ozone, acid rain) have led to increased interception of radiation from the sun, through changes in reflection by scatter from tiny atmospheric particles and absorption by molecules and dust in the atmosphere.

2. Explain the impact of the industrial revolution on the **carbon** cycle.

This led to increased burning of fossil fuels which increased the amount of CO_2 in the atmosphere, leading to global warming and climate change. Mining and burning of fossil fuels reduced the storages of these non-renewable sources of energy and increased the storage of carbon in the atmosphere. This can lead to increased vegetation growth, increasing storage in biomass.

3. Outline the ways in which the agriculture industry has influenced the **nitrogen** cycle.

Agriculture removes biomass from one area and moves it to another so that the nitrogen compounds cannot be recycled. Often the nitrogen is lost in the sea as sewage. This depletes the area of nitrogen so nitrogen is added by farmers in the form of fertiliser.