

Name: \_\_\_\_\_

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Class: \_\_\_\_\_

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**IB ESS**

# **1.2 Systems and Models**

## **Significant Ideas:**

A systems approach can help in the study of complex environmental issues

The use of systems and models simplifies interactions but may provide a more holistic view without reducing issues to single processes

## What is a system

1.

a) Compare reductionist and systems approaches to scientific research.

A reductionist approach divides systems into parts or components and each part is studied separately. But a system can also be studied as a whole, with patterns and processes described for the whole system. This is the holistic approach.

b) Describe what is meant by the term "emergent properties".

An emergent property is a property which a complex system have, but which the individual members do not have. It also means → "whole is greater than the sum of its parts." Sodium and chlorine both are harmful but sodium chloride is edible.

2. There are several components that are present for most systems. Match the words below with the descriptions

Flow

Input

Output

Storages

Boundary

storages	The stock of matter or energy within a system.
Flow	The movement of matter or energy from one storage to another, or into/out of the system.
boundary	The designated area separating the system from its surroundings.
input	Matter or energy entering the system.
output	Matter or energy exiting the system.

3. Flows can be categorized into two distinct types, depending on whether the matter/energy is changed or just moved. State and describe what they are. (read pg 19 & 20)

Type of flow: Transfers

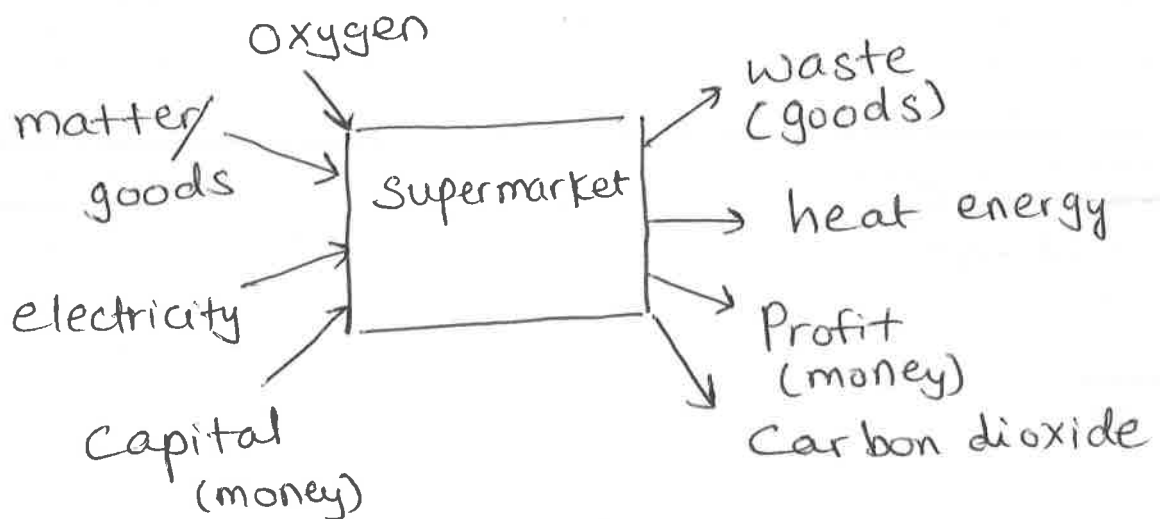
Transfers occur when energy or matter flows and changes location but does not change its state or chemical composition. e.g. water moving from a river to a sea.

Type of flow: Transformations

Transformations occur when energy or matter flows and changes its state or chemical composition. e.g. energy to energy (light energy to heat energy by a bulb).

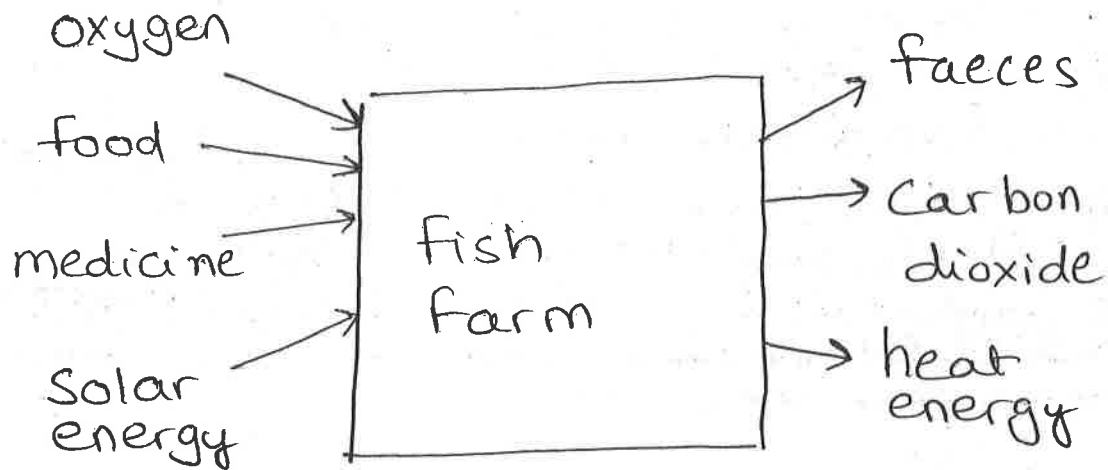
4. Draw a systems diagram to represent:

a) A supermarket



b) A fish farm

(The fish are in the ocean but contained within the farm by a net until caught and sold. They are provided with food and medicine, and produce waste products, sometimes polluting the surrounding water. Bacteria/pathogens will also feed on the food and may cause infections in the fish.)



## Types of System

1. Systems can be categorized depending on whether or not energy and matter are able to enter/exit the system. Outline what is meant by the following in terms of energy and matter:

Open system

Open Systems exchange matter and energy with their environment. eg. all ecosystems

Closed system

Closed Systems exchange energy <sup>but</sup> not matter with its environment. eg. <sup>the</sup> Earth, Biosphere 2

Isolated system

An isolated system exchanges neither matter nor energy with its surroundings. eg. the universe

2. State whether the following are open, closed or isolated systems.

Type of system	Description
Open	A natural forest ecosystem
Closed	A closed zip-lock bag
Open	A fishbowl
Isolated	An adiabatic* drinks flask (This is only theoretical – not physically possible)

\* "Adiabatic" means it is a perfect insulator – if you put hot tea in it, it would never cool down. Ever.

## Models

1. Define the term "model".

A model is a simplified version of a real thing.

2. There are a number of types of model such as:

- Physical models
- Computer simulations
- Mathematical models (often using computers if they are very complex)
- Diagrams (e.g. systems diagrams)

a) Describe a physical model you have seen or used recently.

A globe. I have used it to find location of countries.

b) If you have ever checked the weather forecast, you have used (or seen the results of) a computer simulation model. Explain why weather forecast tools are considered models.

Weather forecast tools use current observations of weather and processing these data with computer models to forecast the future state of weather.

Current weather observations serve as input to the numerical computer models through a process known as data assimilation to produce outputs of temperature, precipitation, and hundreds of other meteorological elements from the oceans to the top of the atmosphere.

c) Explain why a systems diagram is considered a model.

Systems diagrams are simplified version of a real thing.

3. Models are very useful but also have their limitations and disadvantages.

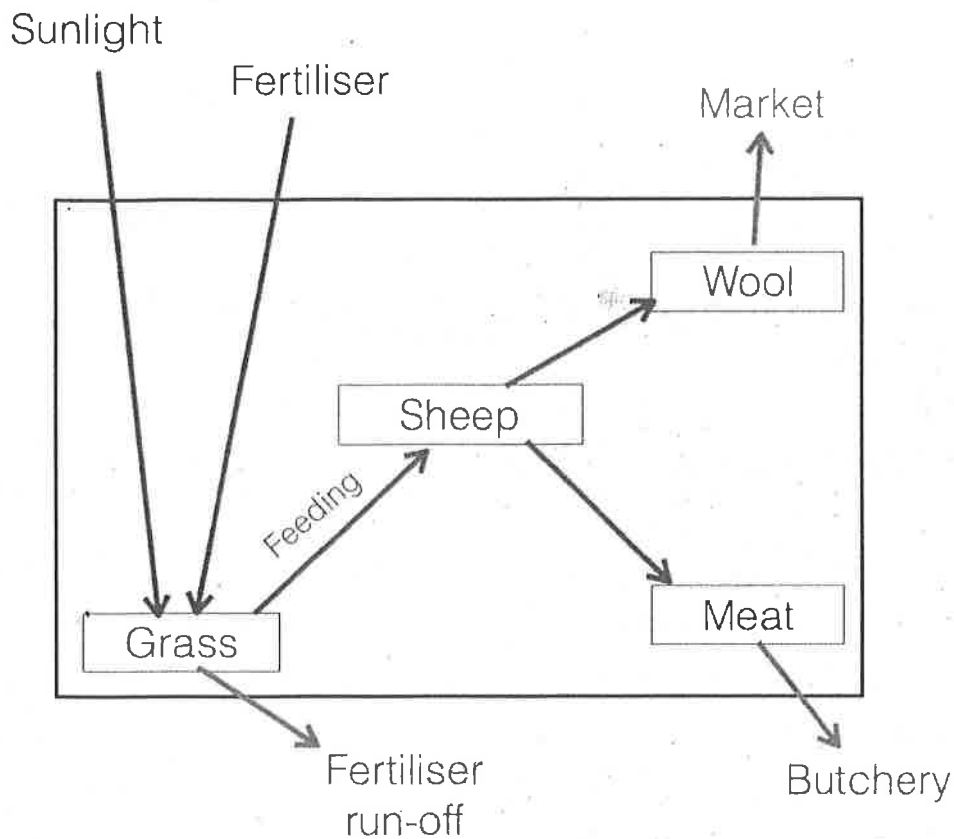
a) Using the table, summarise the advantages and disadvantages of using models. Use the headings to guide your answers

Advantages	
Simplifying a complex reality	Models allow complex systems to be simplified and do not show too much information and so it is easier to see and understand relationship between component parts.
Predicting future changes	They allow predictions to be made about future events e.g. inputs can be changed to see their effects without having to wait for real events.
Identifying patterns	Provides a more holistic view, helping us to see patterns, rather than focussing on individual processes.
Visualising small or large systems	Can be used at a range of scales. Biosphere 2 is a big model, a terrarium in my class is small.
Limitations	
Simplification vs accuracy	Models are simplified with some approximation as environmental factors are very complex or interrelated, it is impossible to take
Specialist knowledge (or lack of)	Models' accuracy depends on the expertise of people making it.
Quality of input data	Models depend on the quality of the data available, and the level. Different inputs will lead to different predictions.

• Models can be manipulated for financial or political gain

... all variables into account. If models are too simple they obscure detail and lose accuracy.

4. Evaluate the following model of a sheep farm system.



### advantages:

- Complex System is simplified
- allows to predict what will happen if there are changes <sup>into</sup> the inputs, outputs, or storages
- Can be applied to other similar situations.

### disadvantages:

- Many assumptions are made, there might be more inputs, outputs and storages. Model might not be accurate
- It doesn't tell you about the size of flows (inputs & outputs)
- Model is oversimplified, no output of energy is shown.
- Size of storage is not given.