Name: _____

Date: _____

Class: _____

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.

Reductionist approach divides systems into parts or components which are studied separately. But a system can also be studied as a whole, with patterns, processes and interactions described for the whole system. This is a more holistic, but much more complex, approach

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

Property which complex systems have but which the individual components do not have. Results from a systems approach as the interactions between the components are what make up the emergent properties

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

Flow *Input* *Output* *Storages* *Boundary*

storage	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.

Type of flow: Transfers

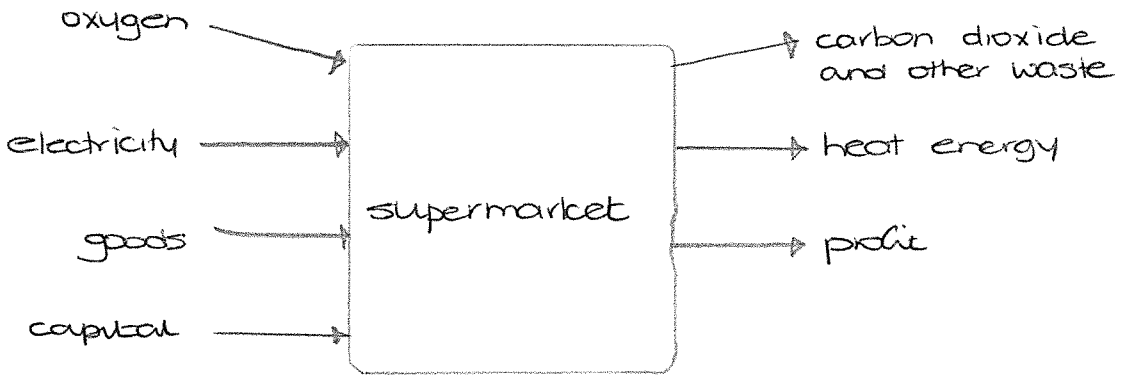
occurs when energy or matter flows/moves and changes location but does not change its state or chemical composition
e.g. rain falling into a lake, fall of leaves to ground

Type of flow: Transformations

occurs when energy or matter flows and changes its state or chemical composition
e.g. light energy to stored/potential energy in photosynthesis

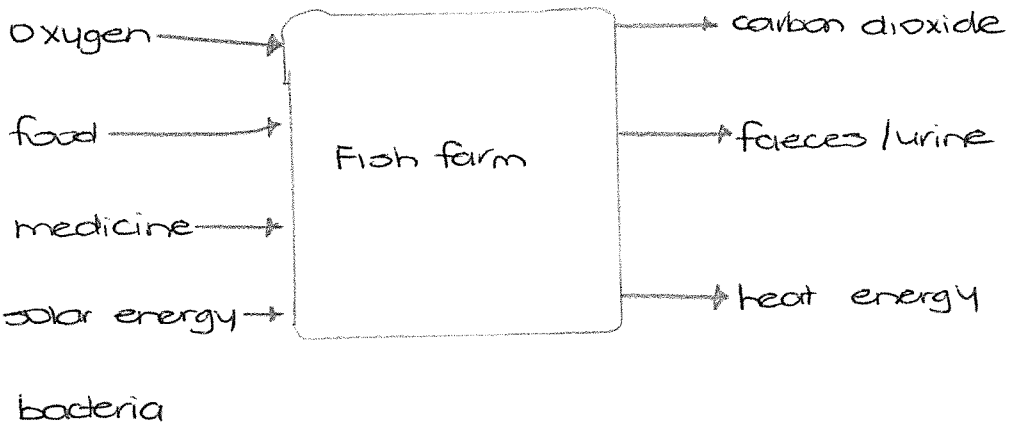
4. Draw a systems diagram to represent:

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

exchange energy and matter with their environments

They are organic (living) eg. ecosystems, people

Closed system

exchange energy but not matter with their environment

Examples are atoms, molecules and mechanical systems.

Isolated system

Neither energy nor matter is exchanged with their environment

Do not exist naturally but an example could be the universe.

Exchange takes place at the boundary of the system

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 simplified version of reality. Can be used to understand how systems work and predict how they will respond to change.

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.

Aquaponics system to show the nitrogen cycle

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.

Environmental factors are very complex with many interrelated components and it may be impossible to take all variables into account. many assumptions need to be made. Relies on expertise.

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

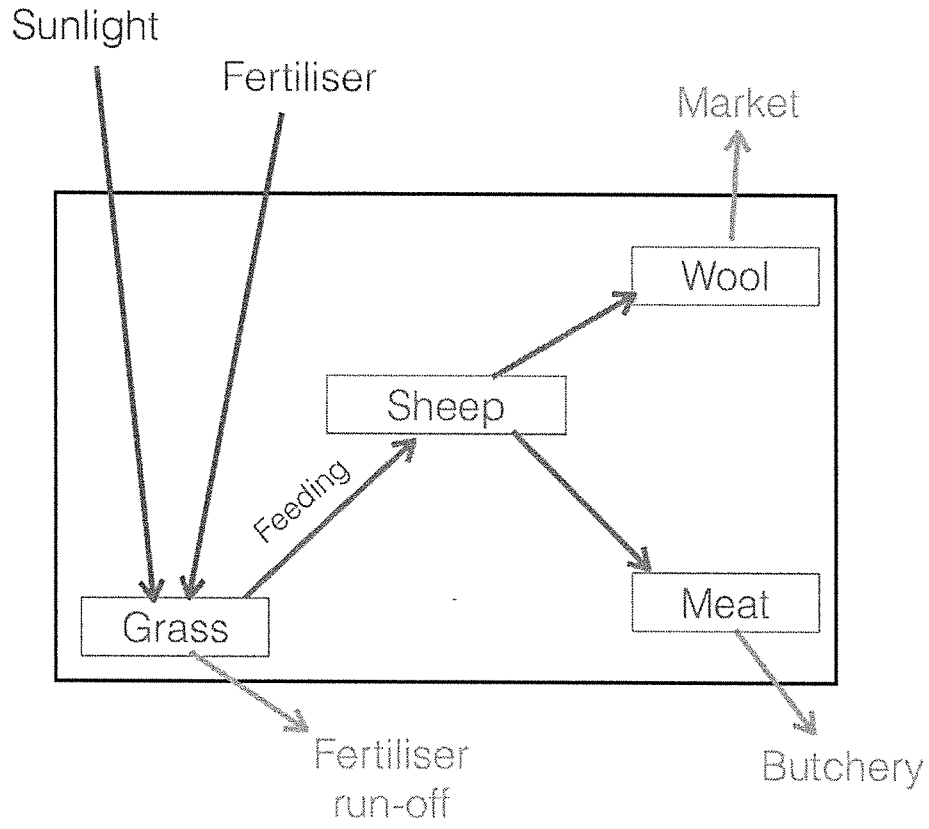
They are a simplified version of a much more complex reality.

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 They do not show too much (all) the information so it is easier to see and understand the most important component
Predicting future changes Inputs can be changed to examine the outputs without waiting for natural change.
Identifying patterns Can be observed / run / manipulated several times under controlled conditions.
Visualising small or large systems Can be used at a range of scales from Biosphere 2 to terrarium
Limitations
Simplification vs accuracy Not all variables can be included so the interrelated factors are lost in some cases.
Specialist knowledge (or lack of) Interpretation of the model depends on the expertise of the people making them for accuracy.
Quality of input data The more accurate and detailed the data the more reliable the model. Models can be manipulated

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



Advantages	Disadvantages
• complex system simplified	• many missing variables
• can predict changes	• size of inputs not shown
• can be applied to other systems	• size of outputs not shown
• major variables identified	• does not consider variable nature of flows.
	• Energy only shown as input