# 1.2 Systems, feedback and models

Name: _____ Class: _____ Date: _____ **Total: 18 marks**

**KEY WORDS** storage • flow • transformation • negative feedback • positive feedback • tipping point • albedo

## Objective

Build the skills to answer exam questions on **systems** : storages and flows, open and closed systems, **feedback** , **tipping points** and the strengths and limits of **models** .

**You must be able to:**

- draw and read systems diagrams with storages and flows
- tell transfers from transformations, and open, closed and isolated systems apart
- explain negative and positive feedback, equilibrium and tipping points
- evaluate the use of models

## 1 Key knowledge and worked examples

### Systems

A **system** is a set of parts that work together. In a **systems diagram**, boxes are **storages** (stocks) and arrows are **flows**; the width of an arrow can show the size of the flow.

| flow | what changes | example |
|---|---|---|
| **transfer** | the place only | water flowing down a river |
| **transformation** | the form, state or energy | water evaporating; light energy to chemical energy in photosynthesis |

| system | exchanges energy? | exchanges matter? | example |
|---|---|---|---|
| **open** | yes | yes | a forest, a lake |
| **closed** | yes | no (almost) | Earth as a whole |
| **isolated** | no | no | none in nature (the universe, in theory) |



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**Feedback:** a change in the output returns to affect the input.

- **Negative** feedback **reduces** the change, so the system stays near a **steady-state equilibrium**: more prey → more predators → fewer prey.
- **Positive** feedback **increases** the change and moves the system away from equilibrium: warming → less ice → less sunlight reflected (**albedo** falls) → more warming.

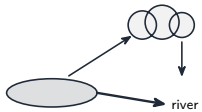
A **tipping point** is a critical threshold: past it, positive feedback drives the system to a new state that is hard to reverse, e.g. coral reefs to algae, or rainforest to savanna.

A **model** simplifies reality. Strengths: easier to understand, can predict, can test "what if". Limits: leaves things out, depends on its assumptions and data, so predictions are uncertain.

**Answer shapes:** for feedback, write the loop as a chain of arrows and say whether it ends by **reducing** or **increasing** the first change.

## 2 Practice

**2.1** Distinguish between a transfer and a transformation, with **one** example of each from the water cycle. [2]




**2.2** Classify each as an open, closed or isolated system, with a reason: (i) a pond; (ii) planet Earth; (iii) a sealed jar of pond water with plants, kept in the light. [3]




**2.3** For each loop, state whether it is negative or positive feedback, and explain. (i) A deer population grows, so food runs short. (ii) Permafrost thaws and releases methane, which warms the climate further. [3]

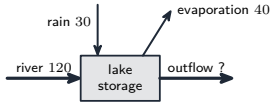


## 3 Exam-style questions

**3.1** The diagram shows a simple lake system.

(a) Identify **one** transformation in the diagram. [1]

(b) The inflows are 120 and 30 units a day; evaporation is 40 units a day. The lake level is steady. Calculate the river outflow. [2]




(c) State what would happen to the storage if the outflow fell to 80 units a day. [1]

**3.2** Arctic sea ice reflects most of the sunlight that reaches it; open sea absorbs most of it.

(a) Explain how the loss of sea ice is an example of positive feedback. [3]




(b) Explain what is meant by a tipping point, using the sea ice as an example. [2]

(c) State **one** limitation of a climate model used to predict when the Arctic will be ice-free in summer. [1]



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