Exam Papers Practice

1.3 Energy & Equilibria

Mark Schemes

Course	SL IB Environmental Systems & Societies (ESS)
Section	1. Foundations of ESS
Topic	1.3 Energy & Equilibria
Difficulty	Medium

To be used by all students preparing for
SL IB Environmental Systems & Societies (ESS)
Students of other boards may also find this useful

1a

Indicative Content
The resilience of an ecosystem is influenced by the following factors: Any **four** from the following: • Greater species diversity increases resilience/stability by providing a wider range of functional roles and genetic variation within the ecosystem; [1 mark] • Greater interactions/interdependencies among species in a complex food web increase the resilience/stability of the ecosystem; [1 mark] • Keystone species play a crucial role in maintaining the structure/functioning of the ecosystem, increasing its resilience/stability; [1 mark] • Greater availability of key resources such as nutrients/water/sunlight increases ecosystem resilience/stability by sustaining populations/energy flow within the system; [1 mark] • Larger ecosystems tend to have greater resilience/stability due to their capacity to support larger populations/withstand disturbances; [1 mark] • Robust negative feedback mechanisms regulate ecosystem processes and help increase ecosystem resilience/stability; [1 mark] • Human activities that degrade the structure/diversity/abundance of an ecosystem can reduce its resilience and make it more vulnerable to disturbances/more unstable; [1 mark] • Ecosystems that maintain a stable/balanced state / steady-state equilibrium / have consistent inputs and outputs are more resilient (to disturbances); [1 mark] • Ecosystems that are close to tipping points (where small changes can result in significant and potentially irreversible shifts) have lower resilience/stability; [1 mark] • Ecosystems that have evolved with specific disturbance regimes, (e.g. fire/flood/storm adapted ecosystems) have adaptations/processes that allow them to bounce back/restore their structure/function after a disturbance, resulting in increased resilience/stability; [1 mark]

- High ecosystem connectivity (interaction/exchange of resources/species/ecological processes between different components of an ecosystem / between multiple ecosystems) increases resilience/stability by allowing flow of energy/nutrients/species across different habitats (facilitating ecological processes e.g. seed dispersal/recolonisation/genetic exchange); [1 mark]

Model Answer	Commentary
Firstly, greater diversity of components and species within the ecosystem enhances its resilience by providing a wider range of adaptive strategies and increasing its ability to recover from disturbances [1 mark]. Secondly, the complexity of interactions and the presence of well-developed food webs contribute to resilience by creating intricate relationships that promote stability and facilitate energy flow [1 mark]. Additionally, the establishment of keystone species, which exert a significant influence on ecosystem structure and function, enhances resilience by maintaining biodiversity and supporting ecosystem processes [1 mark]. Lastly, ecosystems with larger storages and more abundant resources, such as nutrients, water, sunlight, and biomass, exhibit higher resilience as they can sustain populations and withstand disturbances [1 mark].	The command 'outline' requires you to give a brief account or summary For each factor you give, you must also make it clear whether this factor increases or decreases ecosystem resilience in order to gain the mark The converse of each statement given in the mark scheme would be accepted Using terms such as 'firstly', 'secondly' and 'lastly' can help to structure your answer and indicate to the examiner that you have given a sufficient number of factors to gain all 4 marks

1b

Indicative Content
Larger populations can effect ecosystem resilience in the following ways: Any **two** from the following: • Larger populations provide increased storage capacity, allowing the ecosystem to withstand disturbances or periods of lower productivity; [1 mark] • Larger populations generally contain greater genetic diversity, which enhances their ability to adapt to changing environmental conditions and recover from disturbances (the presence of new pathogens/diseases); [1 mark] • Larger populations are more resilient / can lose more individuals to disturbances such as disease / habitat fragmentation /random environmental fluctuations, reducing the risk of extinction; [1 mark] • Larger populations of foundation/keystone species play a crucial role in maintaining ecosystem resilience (e.g. corals, kelp, beavers, elephants) as they have a significant/disproportionate influence/impact on the structure/functioning of ecosystems; [1 mark] • Larger populations of invasive species can outcompete native species, leading to a reduction in biodiversity and disrupting ecosystem processes, decreasing ecosystem resilience; [1 mark] • Larger populations of a single dominating species can be too highly specialised and reliant on specific environmental conditions, resulting in lower ecosystem resilience (compared to many smaller populations of various species, which have greater biodiversity / functional diversity); [1 mark]

2a

Indicative Content	Commentary
An ecological tipping point is: Any **two** from the following: • A critical threshold within an ecological system/ecosystem; [1 mark] • ...past which any further small change in the ecological system/ecosystem will have significant knock-on effects / cause the ecological system/ecosystem to move away from its average state (away from the equilibrium); [1 mark] • (Tipping points) represent the point beyond which serious, irreversible damage and change can occur to ecological systems/ecosystems; [1 mark] • (Tipping points) represent the minimum amount of change within an ecological system/ecosystem that will destabilise it, causing it to reach a new equilibrium or new stable state; [1 mark]	A tipping point happens when a changing process goes to a point where it cannot be reversed For example, when a glass of water tips over, the spilt water can't be put back in the glass The question specifically refers to **ecological** tipping points, so you must make sure you reference ecological systems or ecosystems in your answer in order to gain the marks

2b

Indicative Content	Commentary
Feedback loops play the following roles in the dynamics of alternate stable states and the occurrence of tipping points: Any **four** from the following:	The command word 'explain' requires you to give a detailed account,

• Negative feedback loops occur when the output of a process counteracts/reverses that process; [1 mark] • ...preventing (significant) change/deviation and maintaining the system in equilibrium / stable state; [1 mark] • ...which helps to avoid tipping points / alternate states; [1 mark] • Positive feedback loops occur when the output of a process reinforces/amplifies/speeds up that process; [1 mark] • ...leading to increased changes/deviations and pushing the system away from its equilibrium / stable state; [1 mark] • ...which drives a system towards a tipping point; [1 mark] • ...causing the system to transition to a new equilibrium / alternate stable state / to undergo significant transformations; [1 mark]	including reasons or causes Pulling out key terms from the question (such as 'alternate stable states' and 'tipping points') and using them in your own answer is always a good idea as it helps you ensure that you hit the necessary marking points This also demonstrates to the examiner that your answer is directly relevant to the question being asked

3a

Indicative Content
As solar energy flows through producers, the first law of thermodynamics is demonstrated as follows: Any **two** from the following: • The first law of thermodynamics regards the conservation of energy **OR** in transformations, energy is conserved **OR** energy is neither created nor destroyed (in transformations); [1 mark]

- (This is demonstrated in the food chain as) all chemical energy (within the producers) is derived from light/solar energy / is converted through photosynthesis; [1 mark]
- (However) no new energy is generated/created **OR** the chemical energy (in producers) is eventually converted into heat energy / is not destroyed; [1 mark]
- The energy entering primary producers is equal to the energy stored in their biomass **AND** the energy dissipated as heat; [1 mark]

Model Answer	Commentary
The first law of thermodynamics states that energy is conserved and not created or destroyed in transformations. In the food chain, all chemical energy originates from light energy through the process of photosynthesis in producers [1 mark]. Although chemical energy is converted into heat energy through metabolic processes, no new energy is "created" or "destroyed" [1 mark].	The command word 'describe' requires you to give a detailed account More important than just learning the first and second laws of thermodynamics, you need to learn **how these laws can be applied** to natural systems and ecosystems (mainly with a focus on how they apply to food chains, food webs, and trophic levels)

3b

Indicative Content
The second law of thermodynamics applies to the food chain as follows: Any **two** from the following: • The second law of thermodynamics states that the entropy/disorder of a system increases over time **OR** conversions/transformations in energy are not 100% efficient; [1 mark] • This means available energy is lost to the environment/atmosphere between trophic levels; [1 mark]

- This energy is lost (from the food chain/ecosystem) as heat from (cell/cellular) respiration/metabolism/metabolic processes; [1 mark]
- (Only around) 10% of the available energy is passed on **OR** (around) 90% of the available energy is lost between trophic levels / ecological efficiency is (very) limited / energy transfer is (very) inefficient; [1 mark]
- (In addition) not all parts of the grass/mouse are consumed/absorbed (by the mouse/owl); [1 mark]

Model Answer	Commentary
The second law of thermodynamics applies to this food chain by demonstrating the increase in entropy and the inefficiency of energy conversions. As energy flows through the trophic levels, there is a loss of available energy to the environment, resulting in reduced energy transfer between levels [1 mark]. This loss occurs as heat during cell respiration and results in approximately 10% of the available chemical energy being passed on to the next trophic level [1 mark].	The command word 'explain' requires you to give a detailed account, including reasons or causes It can be a good idea to refer to specific organisms in the food chain in your answer, as this demonstrate to the examiner that your answer directly relates to the example/scenario/data given in the question

4a

Indicative Content
The process of ozone destruction and reformation exemplifies negative feedback in the following way: Any **three** from the following: • Ultraviolet/UV radiation (from the Sun) interacts with ozone / O_3 (molecules), some of which absorb the energy / dissociate / break apart, resulting in the formation of an oxygen molecule / O_2 and a free oxygen atom / O; [1 mark]

- These (free) oxygen atoms can then react with other oxygen molecules / O_2 to (re)form ozone / O_3; [1 mark]
- The regenerated ozone helps absorb/filter UV radiation, limiting dissociation of oxygen / O_2 **OR** reduces the production of oxygen atoms **OR** slows down the destruction process; [1 mark]
- This cyclical process of destruction and reformation (acts as a negative feedback loop that) maintains a relatively stable concentration of ozone in the atmosphere/stratosphere **OR** creates a dynamic equilibrium in the atmosphere/stratosphere, where there is a continuous cycle of ozone molecules being broken apart and reformed **OR** ensures that the rate of the forward reaction equals the rate of the backward reaction in the system **OR** ensures that the concentrations of the reactants and products remains relatively constant; [1 mark]

Indicative Content