L-Università ta' Malta

MATSEC
Examinations Board

Marking Scheme

IM Environmental Science

Main Session 2024

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PAPER I

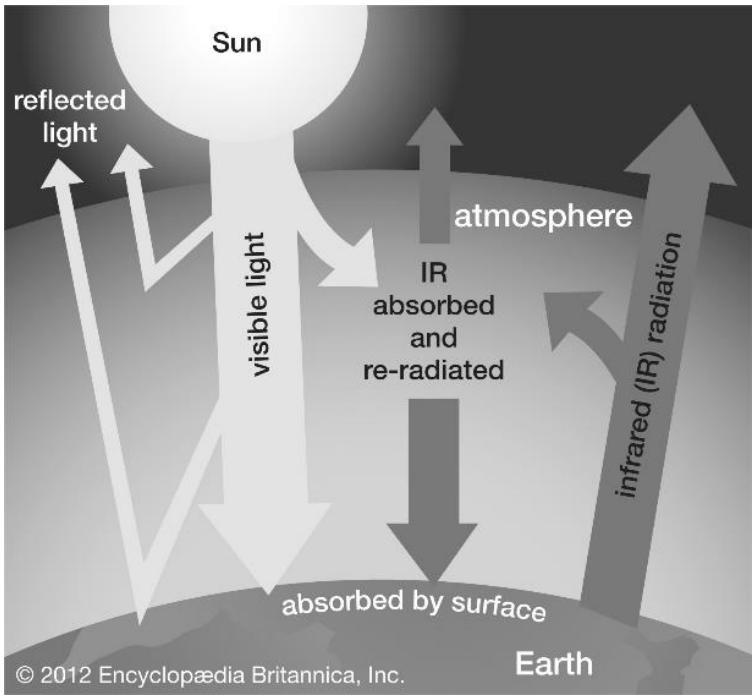
Question No			Suggested Answers		Marks
1	a		True A divergent boundary occurs when two tectonic plates move away from each other. Earthquakes are common and magma (molten rock) rises from the Earth's mantle to the surface, solidifying to create new oceanic crust.		2
	b		**False** Sedimentary rock is formed as a result of accumulation and compression of rock debris. Igneous rock is formed when hot molten rock (magma) cools down and solidifies.		2
	c		**False** The Richter scale is used to rate the magnitude of an earthquake, that is the amount of energy released during an earthquake. The Mercalli scale measures quake damage.		2
	d		**False** When two continental plates collide, the crust is bunched up and a mountain range is formed.		2
	e		**True** Malta is entirely sedimentary rock, mostly calcium carbonate rock deposited from marine life and therefore biogenic. The landmass of Malta rose out of the Mediterranean due to geologic forces.		2
				Total:	**10**
2	a		The hydrosphere is the total amount of water on a planet. The hydrosphere includes water that is on the surface of the planet, underground, and in the air.		2
	b		Thermocline. Photic zone. Perched aquifer. Infiltration. Abyssal zone. Mean sea-level aquifer. Abyssal zone.	1 mark each	7
				Total:	**9**
3	a		Sustainable agriculture is the production of food using techniques that protect the environment, public health, human communities, and animal welfare. This form of		2

			agriculture enables us to produce healthy food without compromising future generations' ability to do the same.		
	b	i	Alternation of land use: growing different crops in succession in the same field. It reduces pest problems because it breaks pest reproductive cycles as the act of changing crops does not guarantee pests a steady food supply. A crop rotation cycle usually includes legumes that replenish plant nutrients thus reducing the need for chemical fertilizers.		2
		ii	Terracing: a method of farming where sloped land is divided into a series of flat platforms, resembling steps. These platforms help prevent soil erosion by slowing down the flow of water and retaining moisture, allowing crops to be grown more effectively on steep terrain.		2
		iii	Biological pest control involves using natural predators, parasites, or pathogens to manage pest populations and minimize crop damage. This method avoids the use of synthetic pesticides, promoting ecological balance and reducing harm to the environment.		2
				Total:	**8**
4	a		Biofuels are fuels produced from renewable biological resources, such as plant oils, animal fats, and biomass. They can be used in place of conventional petroleum-based fuels in vehicles, power plants, and other applications. Biofuels can reduce air pollution by emitting fewer greenhouse gases and pollutants compared to fossil fuels.		4
	b		The catalytic converter converts harmful pollutants such as carbon monoxide, hydrocarbons, and nitrogen oxides into harmless gases, such as carbon dioxide, water vapour, and nitrogen.		2
	c		Flue gas desulfurisation (FGD) is a process that removes sulfur dioxide from the exhaust gases of power plants and other industrial facilities. Sulfur dioxide is a major component of acid rain, which can damage forests, crops, and aquatic ecosystems. Controlling its removal is essential in managing air pollution.		4

	d		An electrostatic precipitator (ESP) is a device designed to remove particulate matter (dust and ash) from industrial exhaust gases. It works by using electrically charged plates to attract and capture particulate matter. This technology aids in reducing air pollution by effectively trapping harmful pollutants before their release into the environment.		4
	e		More efficient engines burn fuel more cleanly, producing fewer emissions of pollutants such as carbon dioxide, nitrogen oxides, and particulate matter. This contributes to overall pollution control and environmental conservation.		2
	f		Legislation sets pollution control guidelines and emission standards, while enforcement ensures compliance, promoting responsible behaviour and minimizing pollution impact on the environment.		2
				Total:	**18**
5	a		**Industrial smog** is a type of air pollution that is primarily caused by coal combustion and is rich in sulphur dioxide, nitrogen oxides and smoke particles. When SO_2 and NO_x react with water vapour in the atmosphere, they form sulfuric acid and nitric acid. These acids then combine with other pollutants, such as particulate matter, to create a thick, hazy fog.		3
	b		The main sources of industrial smog include coal-fired power plants, industrial boilers, and metal extraction processes.		1
	c		Photochemical smog forms through chemical reactions initiated by sunlight, which leads to the production of harmful pollutants. It also increases the rate at which these reactions occur, leading to the rapid accumulation of the pollutants in the atmosphere.		2
	d		Ozone and other harmful pollutants such as nitrogen oxides (NOx) and volatile organic compounds (VOCs). These pollutants are formed through complex reactions involving sunlight and precursor pollutants emitted from various sources like vehicles, industrial processes, and combustion activities.		2

	e		Respiratory irritation, aggravation of conditions like asthma, and cardiovascular effects. Children and the elderly, are particularly at risk. Prolonged exposure weakens respiratory defences, increasing susceptibility to infections.		2
				Total:	**10**
6	a		Species richness refers to the number of different species present in a particular area or ecosystem. It is a measure of biodiversity and represents the variety of species within a given community or habitat.		2
	b		Community 1 and 2 have the same species richness; because they have the same 4 different species present. Community 1 has a higher species evenness when compared to Community 2; because the 4 different tree species are present in equal amounts /Community 2 is dominated by one tree species so has a lower species evenness when compared to Community 1.		4
	c		**Overgrazing**: occurs when livestock consume vegetation faster than it can regenerate, leading to soil erosion, reduced plant biodiversity, and degradation of grasslands. Sustainable management: rotate pastures / fence off areas / build populations of native grasses. **Logging**: involves the removal of trees, disrupting ecosystems, soil erosion, and reducing wildlife habitats. Sustainable management: determine the maximum number of trees that can be harvested sustainably / use wood substitutes.		4
	d		Steppe → garigue → maquis → woodland Steppe – pioneer stage; Woodland - climax stage	1,1,1,1 ½, ½	5
				Total:	**15**
7			Palaeolithic period. Hunting. Neolithic period. Domestication. Animals. Industrial revolution. Emigrated. Immigrated. Exponential growth. Carrying capacity.	1 mark each	10
				Total:	**10**

SECTION B

Question No			Suggested Answers		Marks
1	a		The greenhouse effect helps to maintain the Earth's atmosphere at the temperatures needed to sustain life. The sun's incoming radiation is mixed (ultraviolet, light and infrared). As the sun is very hot its infrared radiation has a short wavelength. The Earth's surface will absorb this energy and emit it back but with a longer wavelength. The Earth's atmosphere contains gases that absorb some of this thermal radiation and re-radiate it in all directions resulting in a warming effect on the atmosphere. *Accept any diagram that shows the following features:*  *(https://www.britannica.com/science/greenhouse-effect)*	3 3	6
	b		**Troposphere** - Weather occurs in this layer. Temperature decreases with altitude. **Stratosphere** - Temperature increases with altitude, due to the absorption of UV by the ozone layer. **Mesosphere** - Temperature decreases with altitude. **Thermosphere** - Temperature increases with altitude, due to absorption of solar radiation. **Exosphere** - Outermost layer of the atmosphere	1,1 1,1 1,1 1,1 1,1	10
	c		**Weather** refers to the conditions of the atmosphere at any given place and time. This includes the short-term	2	4

			changes in temperature, pressure, humidity, cloud cover, wind direction and speed in the troposphere. **Climate** is the average weather conditions, like general patterns of atmospheric conditions, seasonal variations and weather extremes in a region over a period of thirty years or more.	2	
				Total:	**20**
2	a		**Biotic resources**: a living or once living component of a community; Examples: animals/ plants/ fossil fuels *(Accept any relevant examples)* **Abiotic resources**: non-living physical and chemical elements obtained from the lithosphere, hydrosphere or atmosphere; Examples: water/ air/ sunlight/ minerals *(Accept any relevant examples)*		4
	b		**Landfilling** can lead to soil pollution and leachate seepage, contaminating groundwater and surface water resources. Additionally, they can emit greenhouse gases such as methane, contributing to air pollution and climate change. Sustainable management: Implementing landfill liners, leachate collection systems, and methane capture technologies can reduce soil and water contamination from landfills. Recycling and waste reduction initiatives can also divert waste from landfills, reducing the need for landfill expansion. **Construction**: causes soil erosion, habitat fragmentation, and loss of natural vegetation. Clearing land for construction disrupts ecosystems and increases the risk of soil compaction and sedimentation in water bodies. Sustainable management: adopting sustainable construction practices (e.g. erosion control measures, habitat restoration, and green building standards); conducting environmental impact assessments; adhering to land-use planning regulations.	2 1 2 1	6

	c		**Wind:** Kinetic energy in the wind is converted to mechanical power in the turbines. A generator converts this mechanical power into electricity. **Wave:** Wave energy is converted to kinetic energy in turbines placed around the coast. The waves come in and provide the up and down motion which is used to drive the generator. **Solar:** The sun's energy is used either directly as thermal energy (heat) or using photovoltaic cells in solar panels and transparent photovoltaic glass to generate electricity. **Biomass:** Biomass is organic material that comes from plants and animals. A biomass-fired power plant produces electricity and heat by burning biomass in a boiler. The boiler heats up the water to steam which turns the turbines.	2 marks each	6
	d		It has a small carbon footprint compared to alternatives like fossil fuels. It is key to combating climate change and reaching net zero. They produce solid waste which stays dangerously radioactive for thousands of years. The risk of major accidents.	2 2	4
				Total:	**20**
3	a		Solar radiation variations. Volcanic activity.		2
	b		**Burning Fossil Fuels:** Combustion of fossil fuels (coal, oil, and natural gas) for energy and transportation. Impact: Releases greenhouse gases (CO_2, CH_4) into the atmosphere, contributing to the enhanced greenhouse effect and global warming. **Deforestation:** Clearing large areas of forests for agriculture, logging, or urban development. Impact: Reduces the number of trees that absorb carbon dioxide, leading to increased atmospheric CO_2 levels. Loss of biodiversity and disruption of ecosystems also occur.		6

			Industrial Processes: Manufacturing and industrial activities that release greenhouse gases and other pollutants. Impact: Contributes to elevated levels of greenhouse gases and air pollutants, leading to climate change and air quality issues.		
	c		Transitioning to renewable energy. Afforestation.		2
	d		Livestock Digestion: Enteric fermentation in the digestive systems of ruminant animals, such as cattle. Rice Paddies: Microbial activity in waterlogged rice paddies produces methane during anaerobic conditions. Climate Change: Increased concentrations of methane in the atmosphere contribute to climate change by enhancing the greenhouse effect. Air Quality Issues: Methane emissions can lead to the formation of ground-level ozone, contributing to air pollution.		6
	e		Rising temperatures contribute to sea-level rise, posing threats to coastal communities and ecosystems worldwide. Extreme weather events, intensified by global warming, result in increased frequency and severity of storms, floods, and droughts, impacting human societies through infrastructure damage, displacement, and loss of life.		4
				Total:	**20**
4	a		Thermal pollution results from the discharge of heated water into water bodies, often stemming from industrial processes or power plants. Elevated temperatures can disrupt aquatic ecosystems by reducing dissolved oxygen levels, adversely affecting fish and other aquatic organisms.		4
	b		Mining activities can lead to acid drainage, wherein rainwater or surface water meets rocks containing sulfide minerals, leading to a chemical reaction that forms sulfuric acid.		4

			This acid then leaches into water bodies, causing environmental harm by lowering pH levels and releasing toxic metals from the rocks into the surrounding ecosystem. This acidic discharge poses a significant threat to water quality, harming aquatic life and degrading surrounding ecosystems.		
	c		Acid rain is a consequence of air pollution, where sulfur dioxide (SO_2) and nitrogen oxides (NO_x) released from burning fossil fuels combine with atmospheric moisture to form acidic precipitation. Acid rain has detrimental effects on aquatic ecosystems, causing soil acidification and harming fish and other aquatic organisms.		4
	d		**Lead (Pb):** Commonly found in industrial discharges, lead exposure can lead to developmental issues in children and neurological problems in adults. **Mercury (Hg):** Released from industrial processes, coal combustion, and mining, mercury can accumulate in fish, posing severe health risks, especially to those who consume contaminated seafood.		4
	e		Bioaccumulation and biomagnification are both processes that involve the accumulation of substances in organisms. **Bioaccumulation** refers to the gradual accumulation of a substance, such as a pollutant, in the tissues of organisms over time, often from exposure through ingestion or absorption. **Biomagnification** occurs when the concentration of a substance increases at higher trophic levels in a food chain or food web. As predators consume prey containing accumulated substances, the concentration of the substance becomes more concentrated at each higher trophic level.		4
				Total:	**20**

5	a		All the different species living together in an area; with their abiotic environment		2
	b		**Overfishing** when fish are harvested from the ocean at a rate faster than they can reproduce leading to declines in fish populations, disruption of marine ecosystems, and loss of biodiversity. **Destructive fishing practices** such as bottom trawling and blast fishing, can cause significant damage to marine habitats and non-target species. Setting catch limits and quotas for fish species helps prevent overfishing by regulating the amount of fish that can be harvested ensuring fish populations remain at sustainable levels.		5
	c		Conservation biology is a branch in science that focuses on the promotion of sustainable practices to safeguard and restore the natural environment.		2
	d		Rdum tal-Madonna Marine Protected Area. Create safe havens for marine species by restricting human activities such as fishing, mining, and development within their boundaries allowing marine populations to recover and thrive. By preserving habitats, such as coral reefs and seagrass beds, they support the complex interactions among species, promoting biodiversity.		5
	e		Restoration ecology - The practice of renewing and restoring, degraded, damaged, or destroyed ecosystems in the environment, by active human intervention and action. 1. Research & restoration: Conduct research to develop tailored restoration strategies. 2. Identify keystone species & key factors: Identify critical species and processes crucial for ecosystem health. 3. Reclamation & bioremediation: Reclaim polluted land and detoxify soil using bioremediation methods. 4. Direct & non-intervention restoration: Implement direct intervention or allow natural processes for ecosystem recovery.		6
				Total:	**20**

6	a		A food web is a complex network of interrelated food chains within an ecosystem, showing the flow of energy and nutrients as organisms consume and are consumed by other organisms.		2
	b		**Grazer food chains** primarily involve the transfer of energy and nutrients from producers to herbivores forming a linear pathway of energy flow. **Decomposer food chains** involve the breakdown of organic matter by decomposers which then release nutrients back into the ecosystem for uptake by producers.		2
	c		primary consumer: pillbug/bacteria/crickets top carnivore: cat/ bird secondary consumer: cat/bird		3
	d		leaves → snails → bird → cat correct direction of arrows correct number (trophic levels) and position of organisms (present in home gardens)		5
	e		Biotic factor: hunting - decreases the top carnivore and thus increase in the secondary consumers (decreasing the primary consumer). Abiotic factor: drought – producers die out due to no rain affecting the rest of the food chain.		4
	f		It diverts organic waste from landfills. It reduces waste volume and minimizes methane emissions.		4
				Total:	**20**