



ADVANCED

General Certificate of Education

20XX

Environmental Technology

Unit A21: Technologies for a sustainable future

Time allowed 2 hours

Please answer all questions

3 The waste management hierarchy (figure 2.1 highlights the preferred options that society has identified for dealing with its waste.

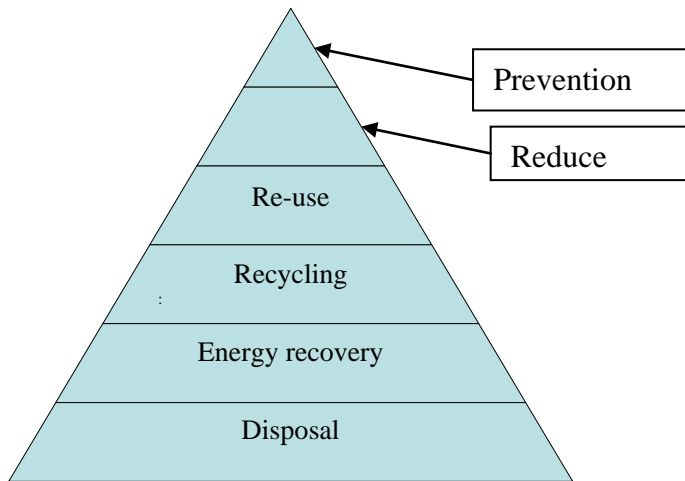


Figure 2.1

(a) Identify and briefly explain two examples of technical processes that are associated with waste recycling at a Materials Recycling Centre (MRF).

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.....[4]

(b) Anaerobic digestion and incineration are both processes through which energy can be recovered from waste.

(i) What is meant by the term “energy recovery”?

.....
.....[2]

(ii) Discuss one advantage and one disadvantage of using incineration as a method of municipal waste treatment?

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.....[2]

(c) With reference to figure 2.1 comment on how the waste management hierarchy affects the availability of material for incineration?

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.....[3]

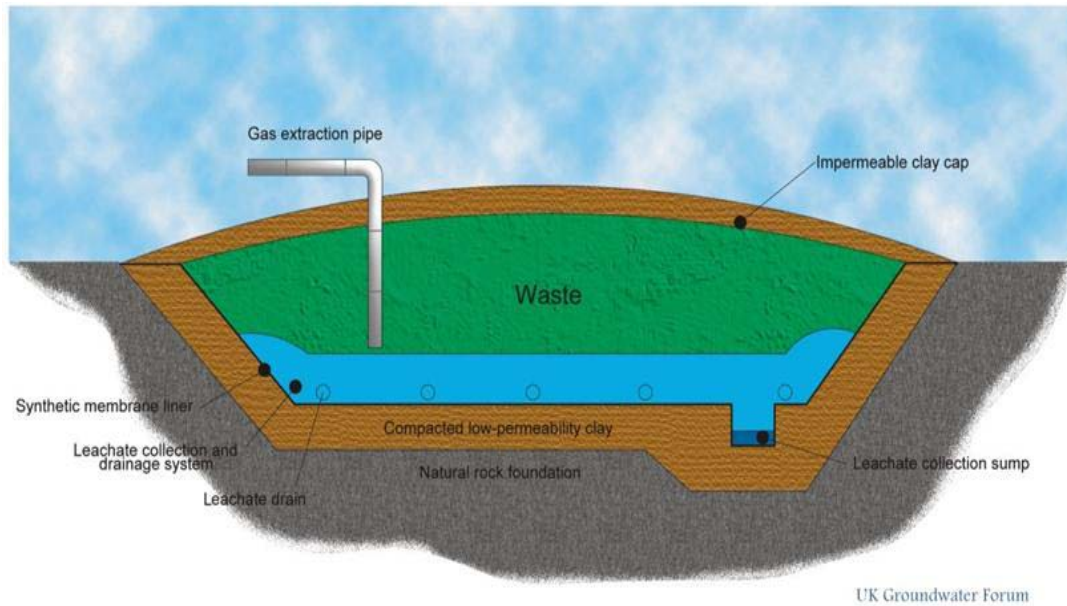
[11]

4 Waste deposited in a landfill site will decompose over many years. During this time leachate and methane gas are produced.

(a) Explain the environmental problems associated with the production of leachate and methane in older traditional landfill sites.

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.....
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.....[2]

(b) The figure below shows a modern landfill site



www.groundwateruk.org/Image-Gallery.aspx

Describe the function of each of the following features

(i) Synthetic membrane liner

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(ii) Leachate collection and drainage system

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(iii) Impermeable clay cap

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(iv) Gas extraction pipe

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(v) Compacted low permeability clay

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[10 marks]

[12]

5 (a) Define what is meant by **Bioremediation** and state 2 pollutants that this technology can be used to treat.

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.....[3]

(b) Technological developments can some times have disadvantages.
Discuss any one disadvantage of **Biorefining**.

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.....[2]

(c) Discuss the role that Genetic Engineering has to play in Bioremediation and (Phytoremediation).

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.....[4]

[9]

(b) Name two other types of Hydrogen Fuel Cells and state the name of the common electrolyte used in each one.

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.....[4]

(c) Hydrogen Fuel Cells require a source of Hydrogen as a fuel. List two methods of bulk Hydrogen production currently used.

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.....[2]

[12]

7(a) (i) What is meant by the term 'new vehicle technologies' when used in the context of futuristic transport systems?

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.....[3]

(ii) Describe the infrastructure changes that would be required to allow any one new vehicle technology to work effectively.

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.....[4]

(b) With reference to Biofuels explain why they should be promoted as substitute fuels for private and commercial transport.

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.....[5]

[12]

Mark Scheme

Section A

Q1 reference to any 3 from

Energy & Carbon Dioxide

Dwelling emission rate, fabric energy efficiency, energy display devices, drying space, energy labelled white goods, external lighting, low and zero C technologies, Cycle storage, home office.

Materials

Environmental of materials, responsible sourcing of building materials, responsible sourcing of materials for finishing elements

Waste

Storage of non-recyclable and recyclable household waste, construction site waste management, composting

Health & well-being

Day lighting, sound insulation, private space, lifetime homes

Ecology

Ecological value of site, ecological enhancement, protection of ecological features, change in ecological value of site, building footprint

[6 marks]

Total marks 6

Q2

(i)

Ecological footprints refer to;

“The total number of hectares required to provide an area with all of its needs. It includes farmland for food, fuel and water resources as well as the amount of land required to dispose of its waste and absorb its CO₂.”

This figure can be compared to the actual size of the city and it may be determined if the city is living beyond its environmental means. Individual footprints may be calculated in a similar way e.g.

Carbon Footprint

This is a subset of ecological footprint. It is a measure of the total amount of CO₂ emission that enters the atmosphere as a result of power generation and fuel consumption. It includes what we use in our everyday lives as well as what is used in the making of products we use.

Ecological and carbon footprints are used to evaluate sustainability and allow international comparisons to be made

Local councils incorporate both ecological and carbon footprints analysis in the planning of new developments.

An understanding of this for

[4marks]

(ii) To be inserted (OPL Living)

Total marks 8

Q3 (a) Any two from

Bag splitter [1] – to shred bags to allow better separation of waste [1]

Trommel screen [1] – to mix / break down and screen out small pieces – brings to a more uniform size [1]

Electro-magnet [1]– to extract iron and steel [1]

Eddy current separator [1]– to separate alloys [1]

Air classifier [1]– separate plastics by density [1]

Optical identification (e.g. Infra-red or Ultra violet) [1]– separation by optical properties [1]

[4 marks]

(b) (i) Definition of energy recovery

Waste materials often contain chemical energy as a result of their molecular structure. Combustion or oxidation causes this energy to be released as the material is decomposed. This energy is released in the form of heat and as such can be used to form steam, which can subsequently be used to drive turbines to produce electricity.

[2 marks]

(ii) advantages: any one from

Does not require same amount of space as land fill [1]

Can be used to release energy [1]

Reduces mass of waste [1]

Disadvantages: any one from

Concern over gaseous pollutants (e.g. dioxins) [1]

Location – aesthetics [1]

[2 marks]

(c) The waste management hierarchy indicates that prevention, re-use, recycling are more desirable than incineration [1]. As a consequence it is better to re-use and recycle wastes [1]. This may reduce the total volume of waste requiring disposal [1] as well ensuring valuable products such as metal/aluminium are recycled rather than destroyed [1]

[3 marks]

Total marks 11

Q4 (a)

Production of methane – greenhouse gas, contributes to global warming [1]

Leachate – may contain poisonous by products/pollutants which will contaminate surrounding land/water systems [1]

[2 marks]

(b) *Synthetic membrane liner* - to prevent waste/leachate from coming into contact with outside soil and groundwater.[2]

Leachate collection and drainage system – any water that percolates through the waste may collect potential pollutants from waste (leachate), this is collected and then removed for treatment and discharge [2]

Impermeable clay cap -collects any gas and seals the landfill from influx of rainwater [2]

Gas extraction pipe - methane produced can be flared- off or used as a fuel [2]

Compacted low permeability clay - prevents the easy flow of water through the waste and minimises the volume used to store the waste [2]

[10 marks]

Total marks 12

Q5

(a) Bioremediation – the use of micro organisms in the treatment of environmental pollution/waste [1]

Any two from

Oil spills [1], chlorinated pesticides [1], heavy metals [1], diesel oil [1], PCB's [1]

[3 marks]

(b) Any one from

The biorefining crop used may occupy land needed for food production;[1]

The land used for the biorefining process may be cleared from natural forest thereby contributing to deforestation;[1]

Biorefining (in context of metallurgical extraction) is very slow [1]

Credit given for any discussion of issues caused by deforestation such as increased soil erosion, landslides, etc; and/or reference to time scale required to see a return on initial investment

[2 marks]

(c) Any two from

Fungi, bacteria or plant species with biorefining potential can have properties enhanced by genetic engineering;[1]

Genes can be introduced from other organisms into the host species to improve the efficacy of the host;[1]

The host may have its biochemical pathways altered, or have enzymes modified by altering the enzyme active site which will enhance bioremediation/phytoremediation capability;[1]

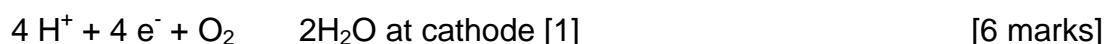
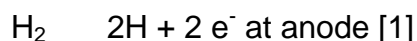
[4 marks]

Total 9 marks

Q6 (a) Award 4 for

Hydrogen is introduced which is then oxidised/chemically split into H^+ ions and electrons (at the anode) [1]. Protons migrate through the PEM, [1] electrons follow a conductive path between electrodes/follow a circuit/ between electrodes either side of the PEM [1] protons and electron then re-combine at cathode to form water and heat [1]

1 mark for each correct equation



(b) Any Three from:

Alkaline [1] – Potassium Hydroxide solution soaked in an inert matrix; [1]
Phosphoric Acid [1]– Liquid Phosphoric Acid (soaked in an inert matrix);[1]
Molten Carbonate [1]– Molten carbonate salt of lithium, sodium, or potassium soaked in an inert matrix;[1]
Solid Oxide [1]– Non-porous ceramic electrolyte.[1] [4 marks]

(c) any two from

Steam reforming of fossil fuels [1]
Electrolysis of water using high pressure and high temperature [1]
Photocatalytic splitting of water [1] [2 marks]

Total marks 12

Q7(a) (i) Any two from

New vehicle technology applies to the increase use of technology to overcome some of the current environmental inefficiencies of vehicles [1]. New vehicle technologies aim to develop and accelerate the deployment of clean and efficient vehicle technology [1] as well promote renewable fuels [1]. Together they will reduce our demand for petroleum products [1] and will make our transport vehicle more sustainable [1].

One example from

Hydrogen fuelled vehicles/bio fuelled vehicles/electric vehicles/hybrid vehicles vehicle shape & aerodynamics. [3 marks]

(ii) Award [2] for stating infrastructural change and [2] for detail and focus.

Electric vehicles will need an extensive infrastructure planned and developed that will allow drivers plug in their vehicles. Purely electric vehicles are totally reliant on their battery pack so they will be confined to short commutes if the network of charging stations isn't developed. Candidate may choose any of the technologies mentioned in the spec but answer must focus on the infrastructure changes required to meet the change. [4 marks]

(b) Allow [4] or [5] for clear understanding and explanation of any 2 of the above points.

Benefits of Biofuels:

- Doesn't require any radical changes to switch to the use of biofuels- unlike the difficulties in switching to other renewable energy sources such as solar and wind power.
- Are cheaper than fossil fuels. Many governments are now offering tax incentives to buy greener cars that run on biofuels (ethanol being one example).
- Are considered 'carbon neutral' by some people. This is because the carbon dioxide they release when burnt is equal to the amount that the plants absorbed out of the atmosphere. Therefore, they don't contribute to global warming. However, it does require some fuel to power the machinery on the farms where biofuels are produced. Still, they are better than fossil fuels! Research suggests that they reduce carbon emissions by 50-60%.
- Reduce dependence on foreign oils. Oil fluctuates in price rapidly, so changing to biofuels will help buffer against the change.
- Emit less particulate pollution than other fuels, especially diesel.
- Are renewable sources of energy as you can just keep producing more.
- Ethanol is very inexpensive to produce.
- Can help prevent engine knocking.

[5 marks]

Total marks 12

Q8

To be inserted

Section B

Sample question 1

1. This answer requires extended writing covering the various elements of the spec which deals with the development of sustainable rural communities. Application of independent energy solutions e.g. biomass, agricultural waste treatment, wind power and small scale district heating solutions are mentioned in the spec and may be mentioned in the answer. Similarly the use of local water supplies, small scale waste management solutions and the social economic and environmental benefits of local food should be included in the answer. Use of the resource is necessary as is an evaluative component if both of these elements are missing it is sub optimal.

Response	Mark
Level 3 There is good detail here .The candidate addresses all aspects of the question and has made some use of the resource .A range of examples and considerations are included and a full understanding of the issues involved in the establishment of sustainable rural communities is evident. Answer is written in good English.	[11-15]
Level 2 This is still a good answer but the candidate has provided less depth and detail .One aspect of the question is omitted either resource use or evaluative component.	[6 -10]
Level 1 The sub optimal situation described above is at this level. Otherwise, a level 1 answer will most likely be lacking in relevant accurate detail. There may also be grammatical errors.	[1-5]
Response not worthy of credit	[0]

Sample question 2

2.

Marks should come equally from (a) and (b) to a max of seven marks from either section.

- (a) Soil in the site is ploughed/turned and levelled;
Alpine Pennygrass seeds are sown on the soil;
Plants grow and absorb contaminant from soil into plant tissue;
Contaminant is therefore sequestered (absorbed) from site soil;
Plant is harvested and removed from site thereby taking contaminant with it;

Traditional organic fertilisers may be added to promote plant growth, which will in turn absorb more contaminant;
This process is repeated until soil contaminant levels are at or below desired levels;
Contaminated plant tissue can be further processed or even extracted and purified for commercial gain;
Brownfield site soil is now deemed to be free of significant contaminant levels and so development can continue.

(b) plants can act as hyperaccumulators;
To remove cadmium, nickel, zinc, arsenic, selenium, copper, uranium, lead or chromium for example;
Plants can accumulate several thousand times the level of these metals that would be toxic to most plants;
The slag heap/mine tailings can be treated on site (in situ), or removed off site (more expensive due to transport costs);
The tailings are then inoculated with the biorefining species (which may have already been genetically modified);
After at least one growing season, the plant ??
This leachate can then be collected and the metal extracted from it;
If the plant is processed downstream then the sequestered metal can be concentrated/extracted and used.

