Teacher Resource Bank

GCE Environmental Studies

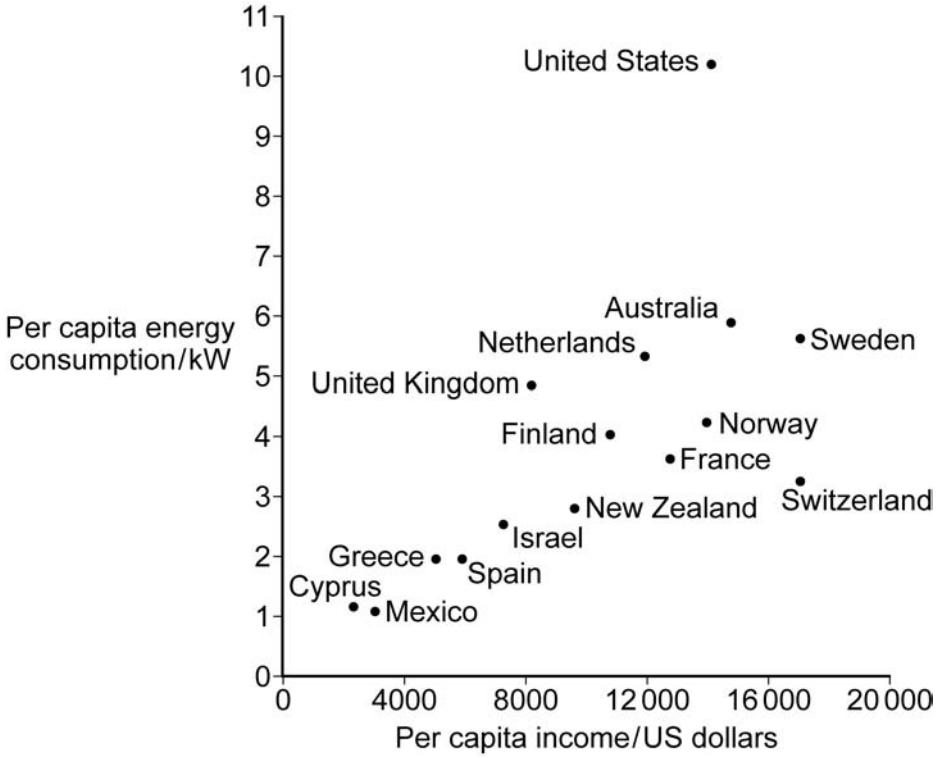
ENVS3 Sample Questions and Mark Schemes

Topic 1: Energy

Energy Use

1 The per capita energy consumption in a country is affected by its level of affluence.

1 (a) The graph shows the relationship between income and energy consumption in a range of countries.



1 (a) (i) Describe the trend shown in the graph.

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(1 mark)

1 (a) (ii) Explain the relationship between income and energy consumption shown in the graph.

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(2 marks)

1 (a) (iii) Suggest why some countries have a position on the graph which is well away from the general trend.

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(3 marks)

1 (b) Suggest how the wealth of a country may affect the choice of energy resource which is used.

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(1 mark)

1 (c) Explain how the level of energy use in more wealthy countries can have an impact on the development and environment of less wealthy countries.

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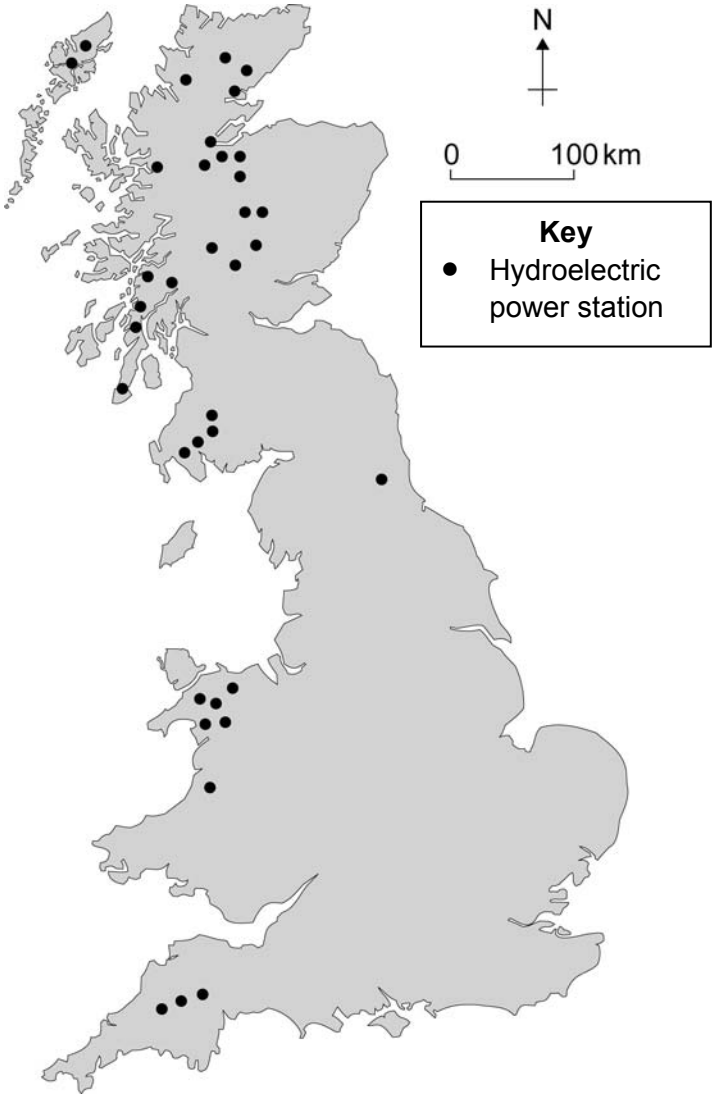
(3 marks)

10

Renewable Energy Resources

2 The map shows the locations of hydroelectric power stations in England, Wales and Scotland.



Suggest **three** locational factors which should be considered when choosing a site for a hydroelectric power station.

1.....

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(1 mark)

2.....

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(1 mark)

3 .....

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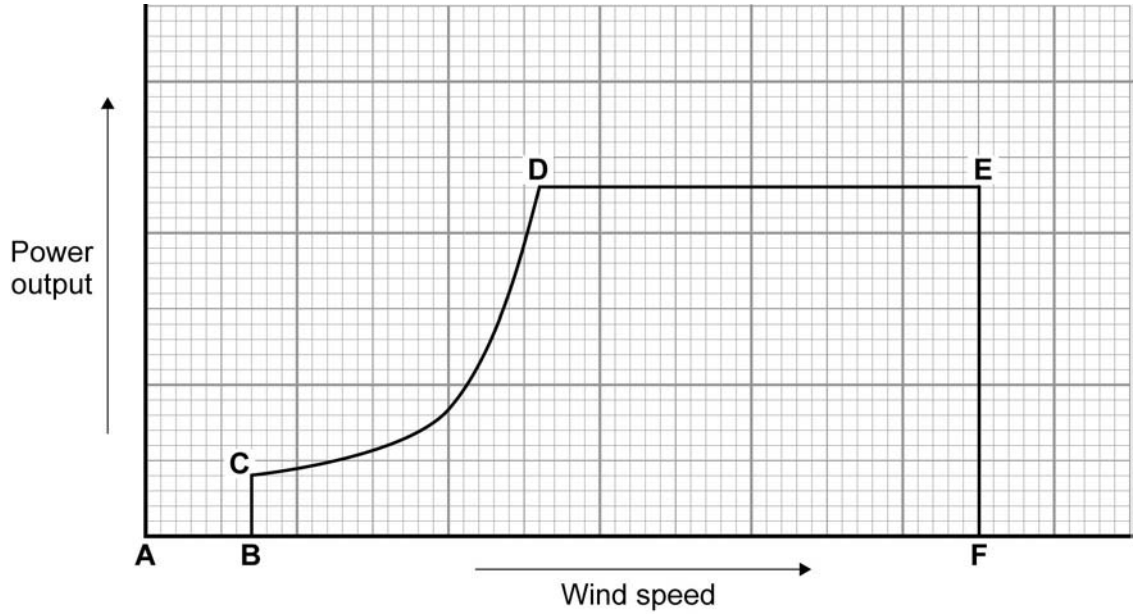
(1 mark)

3

3 The power output from an aerogenerator is not proportional to wind speed.

The diagram shows the variations in power output from a typical aerogenerator.



3 (a) Explain the changes in power output shown for:

3 (a) (i) **D-E**;

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(1 mark)

3 (a) (ii) **E-F**.

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(1 mark)

3 (b) The table shows the effect of changing wind speed and blade diameter on the electrical output (Watts) of one design of aerogenerator.

Blade diameter/ meters	**Wind speed/kilometres per hour**					
	8	16	24	32	40	48
0.6	0.6	4.8	16.0	38.4	73.0	128.0
1.2	2.4	19.2	64.0	153.6	292.0	512.0
1.8	5.0	40.0	140.0	320.0	660.0	1120.0
2.4	9.6	76.8	256.0	614.4	1168.0	2048.0
3.0	15.0	120.0	400.0	960.0	1840.0	3200.0
3.6	20.0	160.0	560.0	1280.0	2640.0	4480.0
4.8	38.4	307.2	1024.0	2457.6	4672.0	8192.0
6.0	60.0	480.0	1600.0	3840.0	7360.0	12 800.0
7.2	80.0	640.0	2240.0	5120.0	10 560.0	17 920.0

3 (b) (i) How does the power output of the aerogenerator change if the blade diameter is doubled?

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(1 mark)

3 (b) (ii) How does the power output of the aerogenerator change if the wind speed doubles?

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(1 mark)

3 (c) Name **two** other renewable energy resources which harness naturally occurring kinetic energy.

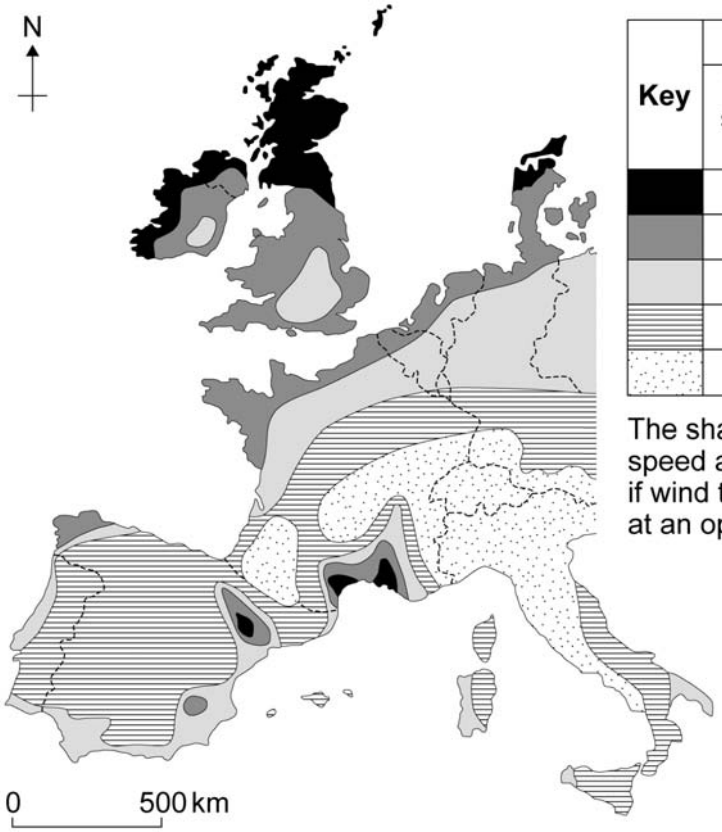
1 .....

2 .....

(2 marks)

6

4 The potential for using wind power is affected by wind strength and its reliability. The map shows the wind speed and power at different locations.



Key	Open plain		Coast	
	Wind speed ms^{-1}	Power wm^{-2}	Wind speed ms^{-1}	Power wm^{-2}
	>7.5	>500	>8.5	>700
	7.0	400	7.5	500
	6.0	250	6.5	325
	5.0	150	5.5	200
	<4.5	<100	<5.0	<150

The shaded regions show average wind speed and the power each would produce if wind turbines were placed on the land at an optimum density.

4 (a) Suggest **three** reasons why the windiest areas are not always chosen for the location of wind farms.

1 .....

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2 .....

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3 .....

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(3 marks)

4 (b) Outline **two** reasons why it may be difficult to replace fossil fuels with wind power.

1 .....

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2 .....

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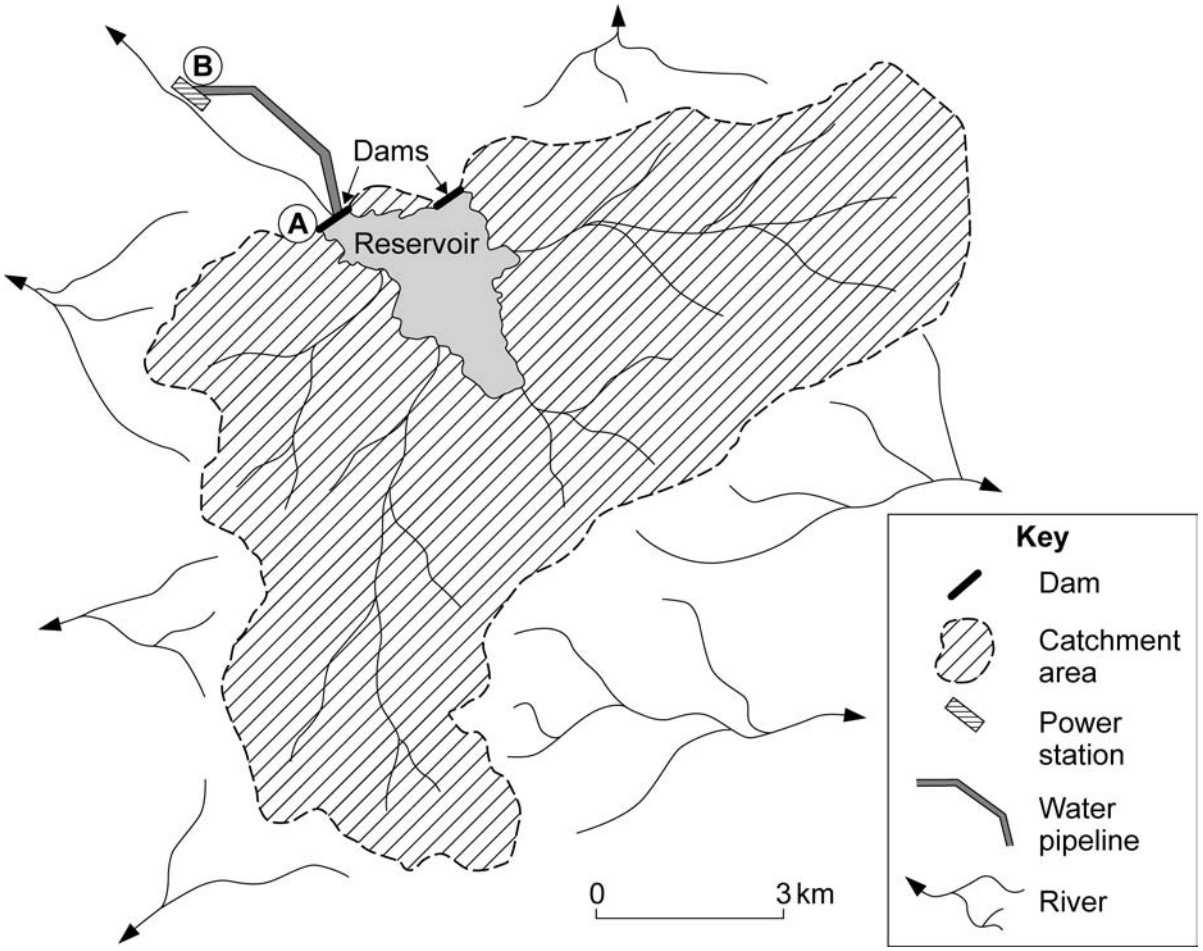
(2 marks)

5

5 (a) The map shows a hydroelectric power (HEP) scheme in Wales.



5 (a) (i) Explain what is meant by the term *catchment area*.

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(1 mark)

5 (a) (ii) Name a factor other than the size of the catchment area which affects the amount of water collected by the reservoir.

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(1 mark)

5 (a) (iii) Explain why the drop in height between points **A** and **B** should be as large as possible.

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(1 mark)

5 (b) Outline how **two** land uses within a catchment area may cause problems for a reservoir which is to be used for public water supply.

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2 .....

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(4 marks)

5 (c) Compare the usefulness of HEP and solar power in meeting the daily demand for domestic electricity.

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(3 marks)

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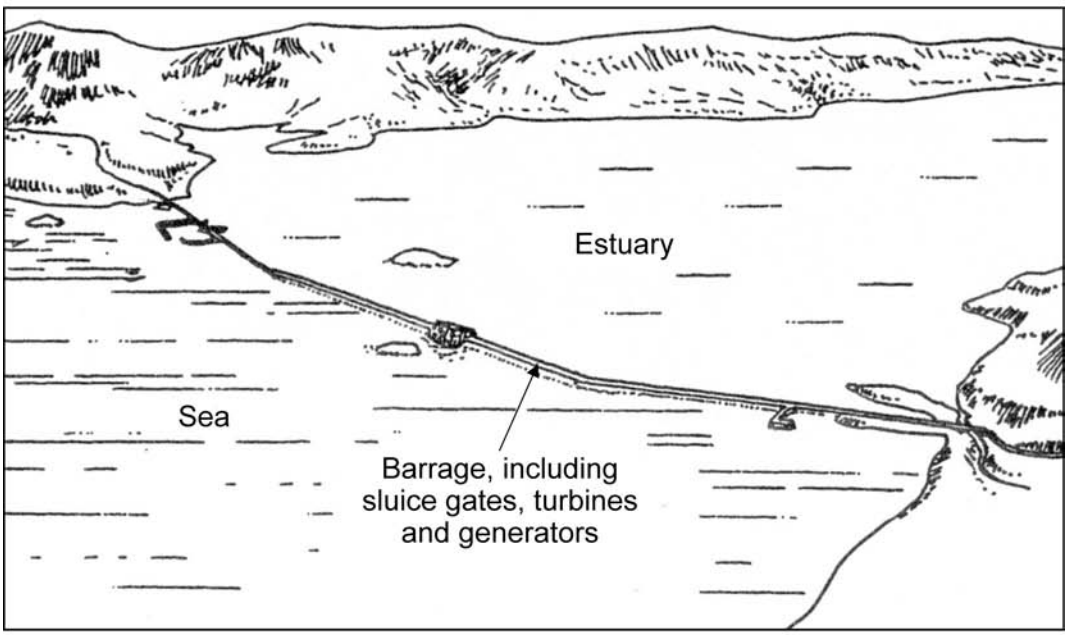
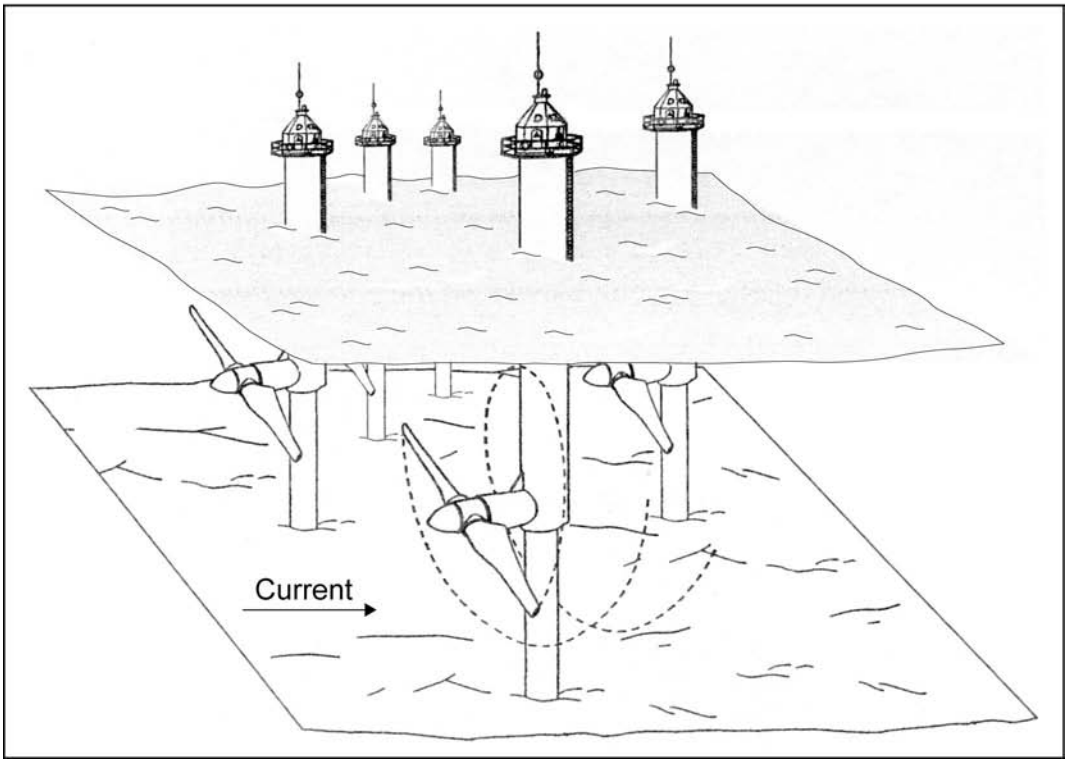
6 (a) The diagrams show two different methods of harnessing the energy of flowing water in tidal areas of the sea.

Scheme A
Part of a proposed tidal power scheme



Scheme B
In-stream tide turbine



Explain which of the two schemes would:

6 (a) (i) provide a high energy output

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(2 marks)

6 (a) (ii) have a low environmental impact.

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(2 marks)

6 (b) Name **two** other renewable energy resources which harness the kinetic energy of moving water.

1 .....

2 .....

(2 marks)

6 (c) Outline **two** reasons why it is difficult to use renewable energy resources to replace fossil fuels.

1 .....

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2 .....

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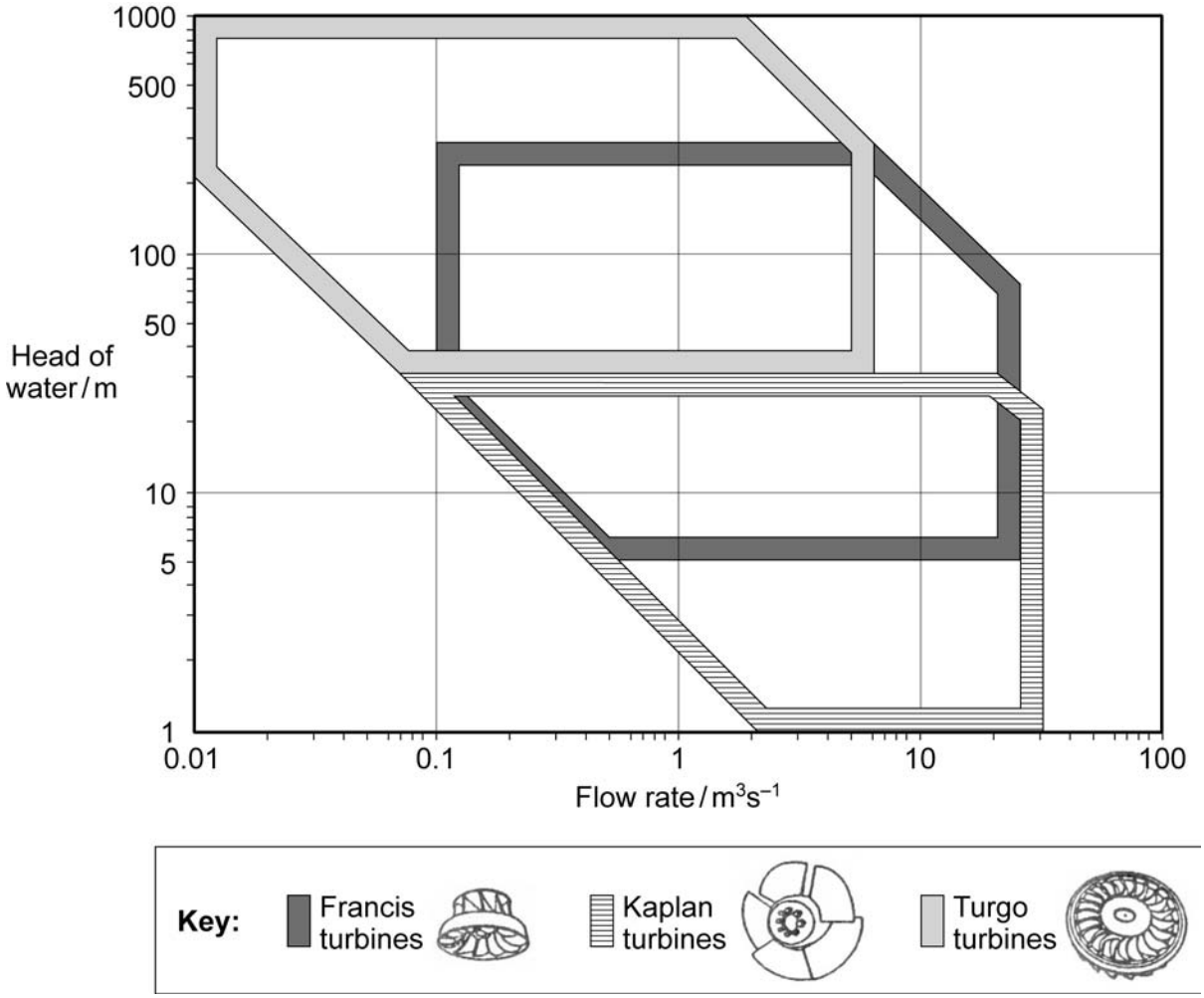
(4 marks)

10

7 Hydroelectric power is a well established renewable energy resource. The type of turbine used depends on the flow rate and height drop of the water.

The graph shows the types of turbine which can be used under different conditions of flow rate and height drop (head of water).



7 (a) (i) Shade the area on the graph where the flow rate and height drop are suitable for Turgo turbines **only**.

(1 mark)

7 (a) (ii) What type of turbine should be used if the flow rate is 10 m^3s^{-1} and the height drop is 100 m?

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(1 mark)

7 (a) (iii) Which **two** types of turbine could **never** be used under the same conditions?

…… and ……..

(1 mark)

7 (b) Explain why hydroelectric power can be described as indirect solar power.

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(2 marks)

7 (c) Describe how pumped storage hydroelectric power stations can be used to match electricity supplies to demand.

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(2 marks)

7 (d) Explain how the following features make it difficult to replace fossil fuels with renewable energy resources.

7 (d) (i) The amount of energy per kg of fuel (energy density)

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(1 mark)

7 (d) (ii) Intermittency of supplies

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(1 mark)

7 (d) (iii) Type of energy available for use

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(1 mark)

10

Secondary Fuels/Energy Storage

8 At some time in the future fossil fuels will be used less.

8 (a) Use the following characteristics to explain why biofuels are more suitable than direct solar power as replacements for fossil fuels.

8 (a) (i) Ease of storage

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(1 mark)

8 (a) (ii) Energy density

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(1 mark)

8 (a) (iii) Suitability as a vehicle fuel

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(1 mark)

8 (b) (i) Explain why demand for electricity fluctuates during any 24-hour period.

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(3 marks)

8 (b) (ii) Explain how energy-storage schemes can be used to balance fluctuations in demand for, and supplies of, electricity.

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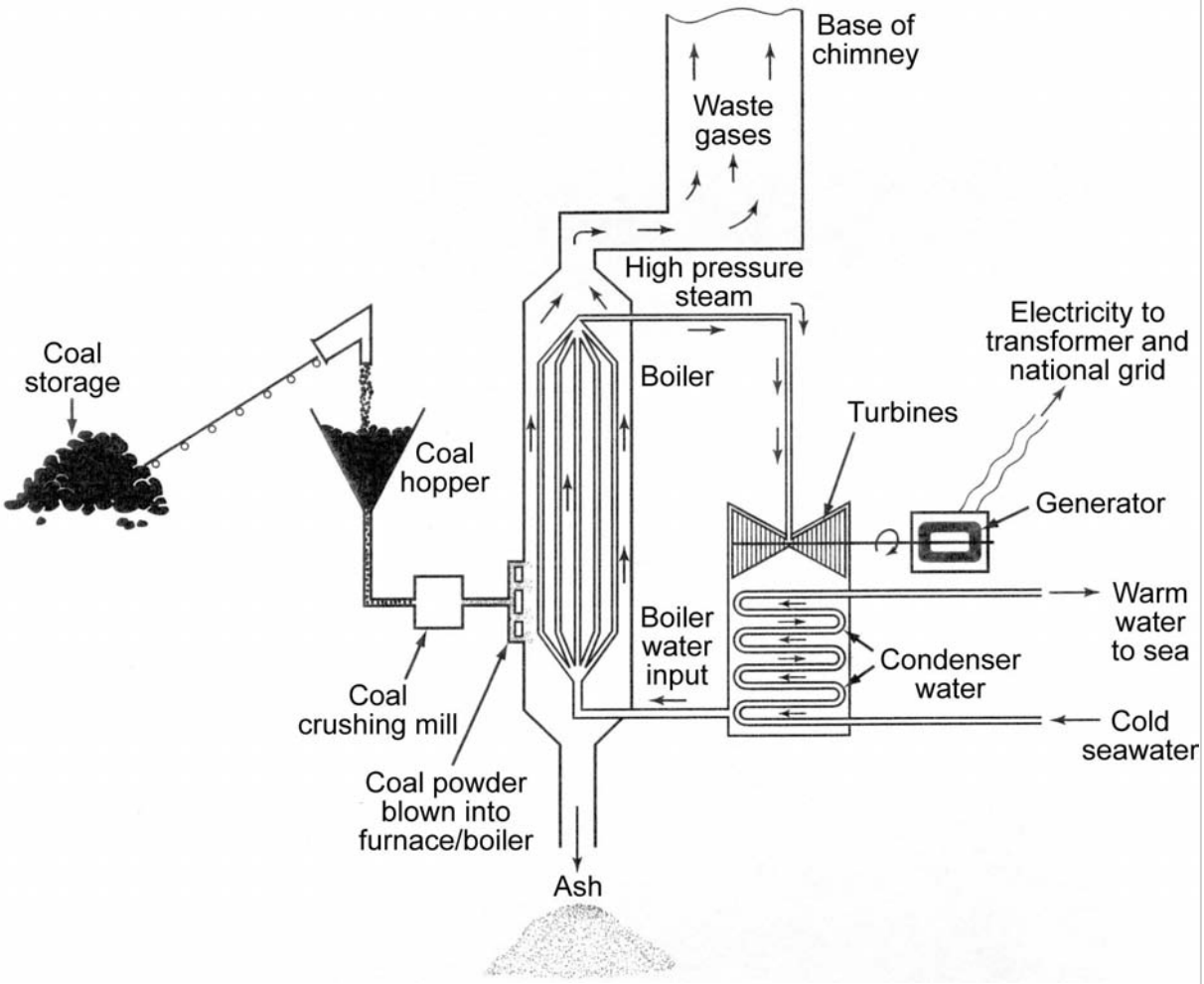
(7 marks)

13

9 The diagram shows the main uses of water in a coal-fired power station.



9 Outline the purposes of the following features of the power station.

9 (a) Turbines .....

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(2 marks)

9 (b) Condenser.....

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(2 marks)

4

Future Energy Supplies

10 At some time in the future fossil fuels will be used less.

Outline **three** reasons why fossil fuels will be used less in the future other than the atmospheric pollution they cause.

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(2 marks)

2 .....

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(2 marks)

3 .....

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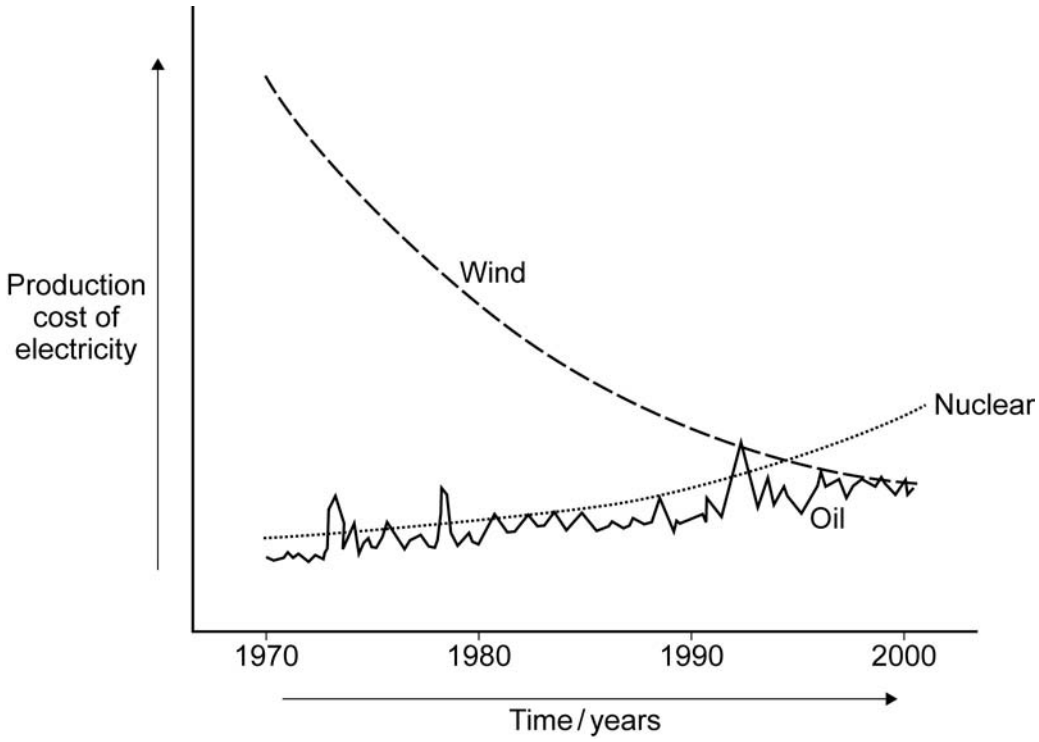
(2 marks)

6

11 The graph shows the changing costs of producing electricity from three energy resources.



11 (a) Describe the trend in the production cost of electricity generated by oil.

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(1 mark)

11 (b) Explain:

11 (b) (i) the increasing cost of electricity generated by nuclear power

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(1 mark)

11 (b) (ii) the declining cost of electricity generated by wind power.

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(1 mark)

11 (c) Outline **one** method that can be used to increase the total amount of oil recovered from an oilfield.

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(2 marks)

11 (d) Describe how locational, technological and environmental factors may influence the energy resources which are used in different parts of the world.

Credit will be given for your understanding of the relationship between different areas of the subject, also for the organisation and presentation of the essay and for grammar, punctuation and spelling.

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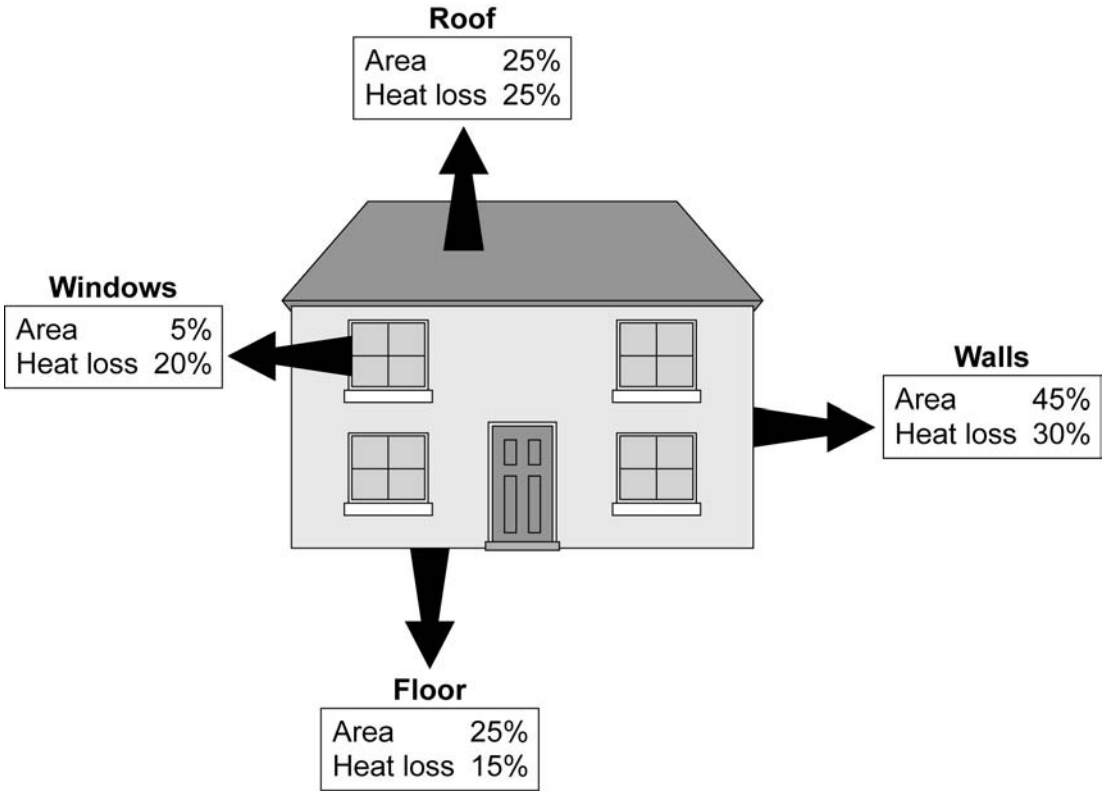
(10 marks)

15

Energy Conservation

12 The diagram shows the percentage of the external area and percentage heat losses from different parts of a house.



12 (a) Explain why the proportion of the total heat lost through the windows is relatively large compared with their area.

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(1 mark)

12 (b) Explain why double glazing reduces the amount of heat lost through a window.

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(2 marks)

12 (c) Name and describe a technique which reduces heat loss through the walls of a house.

Technique .....

Description .....

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(2 marks)

12 (d) Suggest how energy may be saved during food preparation.

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(1 mark)

12 (e) Outline the environmental benefits of satisfying the increasing national demand for energy by encouraging more efficient energy use.

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(8 marks)

12 (f) Suggest why reducing energy consumption in More Economically Developed Countries may benefit people in Less Economically Developed Countries.

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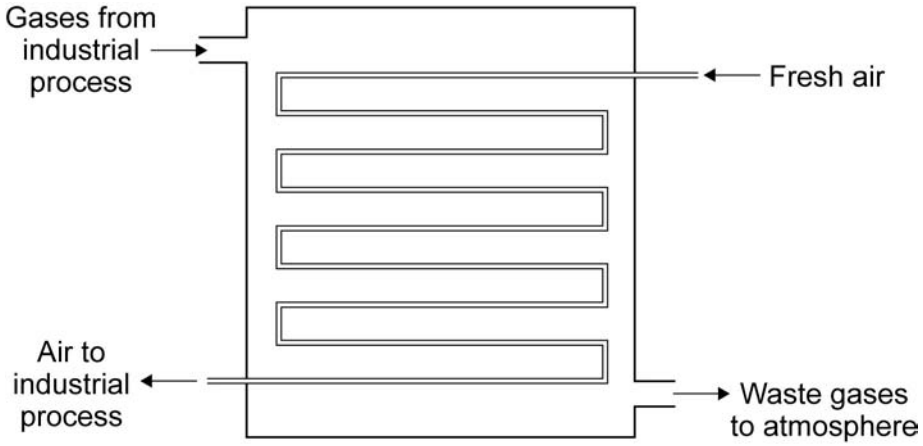
(4 marks)

18

13 The diagram shows a heat exchanger used for industrial heat recovery.



13 (a) (i) Mark an **X** on the diagram to show where the highest temperatures would be found.

(1 mark)

13 (a) (ii) Mark a **Y** on the diagram to show where the lowest temperatures would be found.

(1 mark)

13 (b) Use the diagram to explain how a heat exchanger may be used to reduce the waste of energy in industry.

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(2 marks)

13 (c) Outline **one** way in which the heat exchanger may be designed to increase the efficiency of energy conservation.

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(2 marks)

13 (d) Outline **one** method by which the design of vehicles may reduce fuel consumption.

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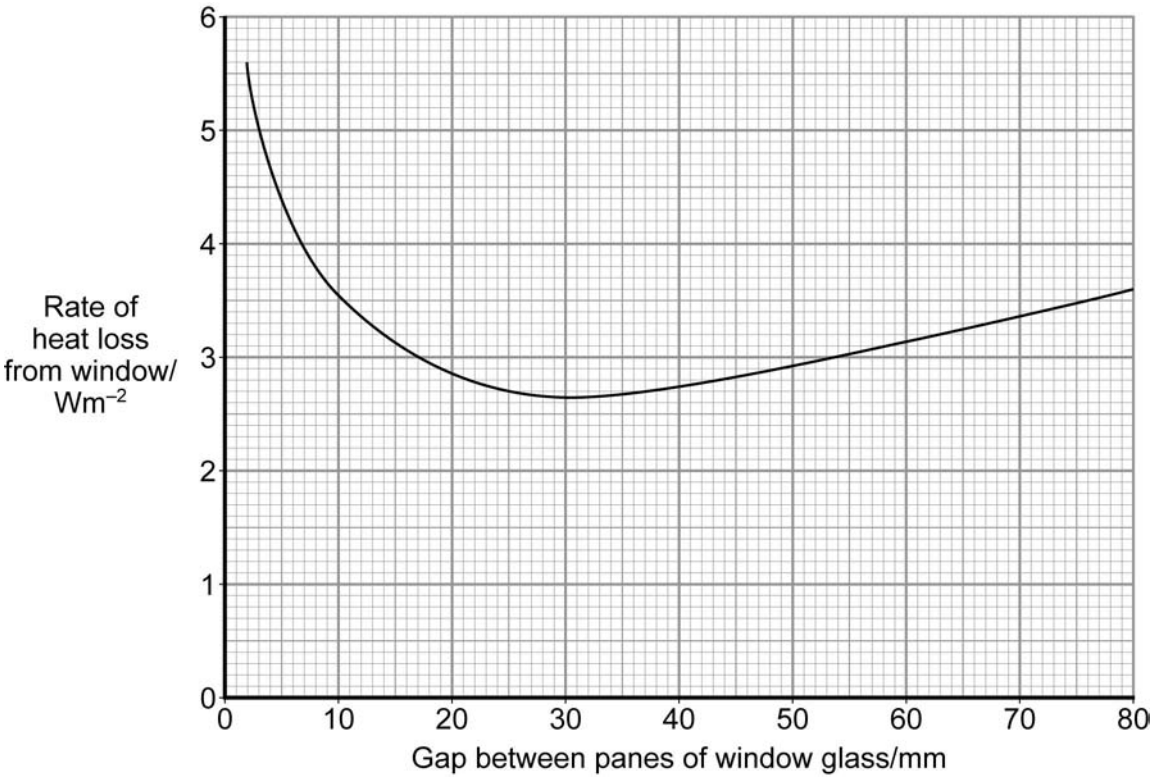
(2 marks)

8

14 The effectiveness of double glazed windows is affected by the size of the gap between the panes of glass.

14 (a) The graph shows the effect of gap size on the rate of heat loss when the outside temperature is 10 °C lower than that inside the house.



Use the graph to estimate the optimum gap for energy conservation.

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(1 mark)

14 (b) Explain how double glazing reduces heat loss through a window.

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(2 marks)

14 (c) The choices made during the design of a house will affect the amount of energy needed to keep it warm.

Explain how the amount of energy needed to heat a house would be affected by:

14 (c) (i) a large surface area to volume ratio

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(1 mark)

14 (c) (ii) a small temperature gradient between the inside and outside

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(1 mark)

14 (c) (iii) being in a windy position.

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(1 mark)

14 (d) Describe the ways in which energy conservation may reduce damage to the environment.

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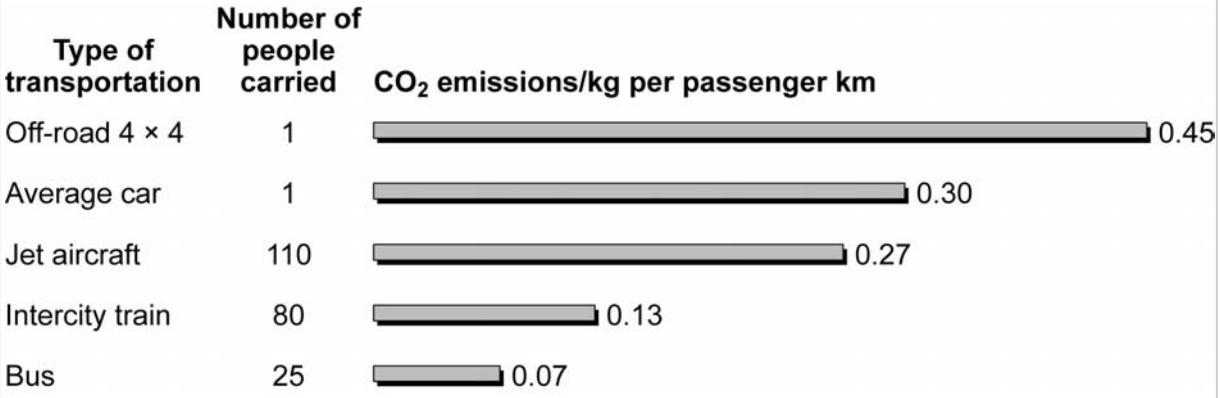
(9 marks)

15

15 The lifetimes of fossil fuels may be extended by using them more efficiently now.

The graph shows the relative energy efficiencies of different passenger transport systems.



15 (a) Calculate the amount of carbon dioxide produced when 300 people travel alone by car for 100 kilometres.

Show your working.

..... kg of CO_2

(2 marks)

15 (b) Suggest a circumstance in which using a bus may be less energy efficient than using cars.

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(1 mark)

15 (c) Outline **two** features of car design which reduce fuel consumption.

1 .....

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2 .....

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(4 marks)

7

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Mark scheme – Topic 1: Energy

Instructions: ; = 1 mark / = alternative response A = accept R = reject

Energy Use

Question 1

1	(a)	(i)	Positive correlation/as one rises so does the other**;**	1
1	(a)	(ii)	Ability to afford energy-using devices**;** greater use of materials requiring energy during production**;** energy use in energy industry infrastructure**;** example if device/material/feature of infrastructure**;**	MAX 2
1	(a)	(iii)	Climate difference requiring more energy use**;** climate difference requiring less energy use**;** level of industrialisation**;** type of industry**;** greater distances requiring more transport energy use**;** low cost encouraging waste**;** conservation ethic/efficiency of use**;** indigenous supplies**;** relevant use of country to illustrate**;**	MAX 3
1	(b)		(Richer/poorer) can/can't afford more expensive/desirable/new technologies**;**	1
1	(c)		Relative shortage increases prices**;** inability to afford energy**;** restricted fuel choice**;** example of restricted fuel choice**;** example of environmental impact of fuel choice**;** example of effect on any development activity**;** transfer of money to LEDCs**;** transfer of pollution/GCC/radiation pollution**;**	MAX 3

Total marks = 10

Renewable Energy Resources

Question 2

Impermeable rocks/no faults to prevent water loss**;**
stable geology/no slip planes/slope failures**;**
narrow exit to large-volume valley for dam**;**
close to consumers/areas of demand**;**
climate with low evaporation rate**;**
suitable topography to give large volume with small surface area**;**
large catchment area to collect large volume of water**;**
adequate/high/regular rainfall/supply/river flow**;**
river sediment load/soil erosion**;**
specified land use conflict**;**
ease of access for construction/maintenance**;**
steep gradient/high head**;** MAX 3

Total marks = 3

Question 3

3	(a)	**D** – **E** turbine/generator operating at optimum output**;**		1
		E – **F** braked/stopped (to prevent damage)**;**		1
3	(b)	(i)	× 4**;** [**R** Increases]	1
3	(b)	(ii)	× 8**;**	1
3	(c)	Tidal power**;** HEP**;** wave power**;** ocean currents**;** [**R** solar/geothermal/biofuels/wind]		MAX 2

Total marks = 6

Question 4

4	(a)	Aesthetics**;** noise**;** radio interference**;** wildlife impact/habitat destruction**;** designated protected areas**;** named land use conflicts**;** topography**;** damage risk in very high winds**;** higher local construction costs/maintenance costs/difficulties**;** distance from area of demand**;**	MAX 3
4	(b)	Lower energy density/large number of aerogenerators needed/ (dispersed over) large area of land**;** need for storage**;** existing vehicles use chemical energy/liquid fuels**;** variable supply/unreliable**;** public opposition**;**	MAX 2

Total marks = 5

Question 5

5	(a)	(i)	Area that collects rainfall/precipitation for a river or reservoir or other water body**;**	1
5	(a)	(ii)	Evaporation/precipitation/infiltration rate/abstraction above reservoir/effluent inputs/land use/geology re porous/permeable/ amount/type of vegetation**;** [**R** position of reservoir]	1
5	(a)	(iii)	Increase potential energy/kinetic energy/flow rate/velocity/ force**;** [**R** head of water]	1
5	(b)		2 examples of land use – agriculture/forestry/industry/housing/ recreation/other**;;** [**A** activities on the reservoir]	
			2 appropriate different problems caused – fertilisers/pesticides/ turbidity/industrial pollutants/sewage/reduced volume/ sedimentation**;;**	4
5	(c)		Correct relative predictability**;** correct relative output controllability**;** correct relative reliability**;** ability to store**;** comment on fluctuating demand**;** who buys the equipment (public/private/corporate)**;** level of technological development**;**	MAX 3

Total marks = 10

Question 6

6 (a) (i) Barrage scheme/(**A**)**;**
greater head/water velocity/water pressure/force/greater volume/all water flows past turbines/barrage full width of estuary**;** 2

6 (a) (ii) Instream turbine/(**B**)**;**
no barrier to wildlife/change in tide height/(significant)silting/ current flow rate/current flow route/less sea bed affected/less habitat damage/less visual impact/no effect on drainage of surrounding land**;** 2

6 (b) Hydroelectric power/HEP/pumped storage HEP/water mill**;**
wave power**;** 2
[**A** named example of technology]
[**R** dam]

6 (c) Suitable reason**;**
explanation**;**
eg
intermittency**;**
output not predictable**;**

unreliability**;**
not always available (when required)**;**

energy density**;**
low output per unit fuel/appliance/high cost per unit output**;**

energy form**;**
not in required form/liquid fuel/chemical energy**;**

storability**;**
reason why storage is difficult eg form of energy which can't be stored**;**

state of development of technology**;**
description of specific technological difficulty/high development costs**;**

geographical/location limitations specific example**;**
eg areas with low wind velocity/rainfall/insolation/rock temperatures/tidal range**;**

public acceptability**;**
specific acceptability problem eg aesthetics of windfarms**;**

output of individual appliances/need for large number of appliances**;**
specific example eg wind turbines/solar panels**;** 2 + 2 4
[**R** 'less energy' without justification]

Total marks = 10

Question 7

7	**(**a)	(i)	Correct area shaded**;**	1
7	(a)	(ii)	Francis**;**	1
7	(a)	(iii)	Turgo and Kaplan**;**	1
7	(b)		Sunlight absorbed and converted to heat**;** evaporation**;** potential energy**;** pressure differences produce winds**;**	MAX 2
			[**R** water cycle driven by the sun (need processes)]	
7	(c)		Surplus electricity/low (energy) demand allows water to be pumped up/moved from bottom to top reservoir**;** high (energy) demand, water flows down/potential energy transformed**;**	2
7	(d)	(i)	Lower energy density of named renewable energy resources/ high energy density of fossil fuels**;** storage/weight/transport difficulties/quantity needed of named renewable energy resource**;**	MAX 1
7	(d)	(ii)	Mismatch to demand from named (intermittent) renewable energy resource/fossil fuels always available**;**	MAX 1
7	(d)	(iii)	Named required energy type not available from named renewable energy resource**;**	MAX 1

Total marks = 10

Secondary Fuels/Energy Storage

Question 8

8 (a) (i) Biofuels are chemical energy solar power is light/chemical energy can be stored/light cannot be stored/biofuels can be stored/solar power cannot be stored**;**

8 (a) (ii) Biofuels have a high energy density/solar power has a low energy density**;**

8 (a) (iii) Biofuels can be converted easily to liquid fuels, solar power cannot/biofuels similar to petrol/solar power cannot be used at night**;**

1 for each characteristic MAX 3

8 (b) (i) Temperature changes**;**
changes in industrial use**;**
changes in domestic use**;**
meals/breaks**;**
lighting**;** MAX 3

8 (b) (ii) Electrolysis/splitting of water**;**
production of hydrogen**;**
easily stored under pressure or absorbed onto surfaces/ metal hydrides/metal mesh/matrix**;**
energy released on combustion**;**
production of electricity in fuel cell**;**

Surplus electricity used to pump water uphill**;**
rapid response/no electricity wasted by slow response**;**
potential energy stored**;**
conversion of electricity by turbines/generators**;**
rapid response**;**
meet peak demands/demand which couldn't be met by other electricity generators**;**

Example of fluctuating supply eg wind, solar**;**
supply > demand at times**;**
surplus energy is stored**;**
used when demand> supply**;**
peak shaving**;**

Use of batteries/cells**;**
chemical energy stored**;**
small scale use**;**
rapid response**;**
remote/mobile uses**;**

Up to 5 marks from each example MAX 7

Total marks = 13

Question 9

9 (a) Turbines**:**
absorb/convert kinetic energy of steam/high pressure of steam**;**
(to KE of) generator**;** 2

9 (b) Condenser**:**
convert steam to water**;**
by absorbing heat/cools down steam**;**
so it can be re-used/recycled/not wasted**;** MAX 2

Total marks = 4

Future Energy Supplies

Question 10

Alternative resources will become available**;**
reason why this will replace fossil fuel**;**
OR
reduction in reserves/resource available**;**
non-renewable resources**;**
rate of reformation too slow/slower than rate of use**;**
OR
technological difficulties/too difficult to extract**;**
resource too deep/viscous/in fine-grained rock/dispersed**;**
OR
economic difficulties**;**
extraction cost above sale value/cheaper alternative energy supplies**;**
OR
environmental problems**;**
habitat damage on extraction/less polluting alternatives**;**
OR
improved efficiency of (fuel burning) technology**;**
reduces quantity needed for given output**;**

Up to 2 for each MAX 6

Total marks = 6

Question 11

11 (a) Slow/fluctuating <u>increase</u>**;** 1

11 (b) (i) (Increasing) costs of storage/fuel extraction/resource supplies/ safety procedures/waste disposal**;** 1

11 (b) (ii) Reduced manufacturing costs/economies of scale/ number manufactured/turbine size/more efficient design/ technology**;** 1

11 (c) Use of pump/nodding donkey**;**
increased pressure difference**;**
OR
secondary recovery**;**
increased pressure**;**
water/natural gas injection**;**
OR
tertiary recovery**;**
reduced viscosity**;**
solvents/steam/bacteria/detergents/hot water**;** MAX 2

11 (d) *Quality of Written Communication is assessed in this answer.*

Two main approaches**:**
- descriptions of locational, technological and environmental factors with areas and resources to illustrate
- named energy resources with description of factors influencing their use

Up to **4** named energy resources**;;;;**
coal, oil, natural gas, tar sands, oil shales, nuclear power, solar, wind, biofuels, wave, ocean current, tidal, geothermal

Up to **3** named locational factors**;;;**
description of availability of resource
eg fossil fuel deposits
windy/sunny/rough sea areas with reasons
distance to area of demand
cooling water
geological stability
rock permeability
precipitation
evaporation rate
water flow rate
large (construction) site
high tidal range
volcanic activity/hot rocks near surface
topography

Up to **3** named technological factors**;;;**
costs/ability to afford
level of development/complexity of technology
infrastructure eg electricity grid, technical support

Up to **3** named environmental factors**;;;**
specific land use conflict
specific pollutants
sulfur dioxide
smoke
noise
aesthetics
hot water MAX 8

Quality of Written Communication

Mark	Descriptor
2	All material is logically presented in clear, scientific English and continuous prose. Technical terminology has been used effectively and accurately throughout. At least half a page of material is presented.
1	Account is logical and generally presented in clear, scientific English. Technical terminology has been used effectively and is usually accurate. Some minor errors. At least half a page of material is presented.
0	The account is generally poorly constructed and often fails to use an appropriate scientific style to express ideas.

MAX 2

Total marks = 15

Energy Conservation

Question 12

12 (a) Higher thermal conductivity/transmittance/lower thermal resistance/ lower U value/easier passage of heat**;**
[**R** thicker/thinner/draughts] 1

12 (b) Reduced thermal conductivity/increased thermal resistance/ better insulation**;**
trapped layer of air/air between two sheets of glass**;**
no convection currents**;**
[**R** vacuum] MAX 2

12 (c) Cavity-wall insulation**;**
gap/space filled with a poor conductor/good insulator**;**
foam/polystyrene beads/sheet/mineral wool/material with air pockets**;**
[**R** cavity with no explanation]
OR
layer of material added internally/externally**;**
poor conductor/good insulator**;**
mineral wool/polystyrene**;**
OR
aluminium foil**;**
reflects radiant energy back into the building**;** MAX 2

12 (d) Eat food which doesn't require as much cooking**;**
do not use excessive amounts of water when boiling food**;**
use ring on cooker of appropriate size for pan**;**
keep lid on pan when heating**;**
insulated/hay boxes to reduce heat losses**;**
use microwave rather than conventional cooker**;**
bulk cooking**;**

pan central on ring**;**
steamer/pressure cooker**;**

other suitable example**;**
[**R** turn off when not needed] MAX 1

12 (e) Longer life-spans/reduced use of non-renewable energy resources**;**
up to 3 distinct examples of reduced environmental impact of energy harnessing/extraction/using**;**
less land dedicated to energy production**;**
power stations/equipment**;**
mining/fuel supply**;**
reduced use of materials in construction**;**
reduced pollution in production**;**
reduced pollution in use**;**

1 mark for each
+ 1 mark for scientific explanation or example × 4 MAX 8
[**A** clear explanation without benefit]

12 (f) Reduced demand may reduce price to LEDCs could afford more**;**
reduced demand would increase proportion of global supplies available to LEDCs**;**
increased supplies in LEDCs would allow socially beneficial developments**;**
example of such a development**;**
reduced use would reduce pollution**;**
eg Global Climate Change**;** MAX 4

Total marks = 18

Question 13

13 (a) (i) **X** on 'Gases from industrial process' in heat exchanger**;** 1

13 (a) (ii) **Y** on 'Fresh air' on pipe**;** 1

13 (b) Heat transfer/conduction**;**
from (outgoing) wastes to (incoming) air (for use)**;**
recycling/reuse of heat energy**;**
reduced demand for 'new' energy/fuel use**;** MAX 2

13 (c) Any method
eg increased length/long pipes**;**
increase surface area**;**
OR
thinner pipes**;**
increased rate of conduction**;**
OR
thermal insulation**;**
reduce heat losses (to surroundings)**;**
[**R** if around pipe]
OR
pipes made of better thermal conductor/example**;**
more efficient/rapid heat transfer**;**
OR
counter – current flow**;**
increased temperature gradient**;**
increased rate of heat transfer**;** MAX 2

13 (d) Any suitable example**:**
1 mark for method, 1 mark for expansion
eg aerodynamics**;**
reduced friction/drag**;**
OR
better engine temperature control**;**
more efficient fuel combustion**;**
OR
ignition control/electronic ignition/fuel injection**;**
more efficient combustion**;**
OR
optimum size of engine**;**
[**R** smaller]
correct power : weight ratio/avoid unnecessary fuel use**;**
OR
no use of unnecessary energy-using equipment**;**
air conditioning/4WD/other suitable eg**;**
OR
lower weight/lighter construction materials**;**
less fuel/energy required**;** MAX 2
[**A** 'more efficient engine' for 1 mark only]

Total marks = 8

Question 14

14 (a) 30 – 33**;** 1

14 (b) Reduced convection**;**
warm (room) air not in contact with cold glass**;**
air is a poor conductor/good insulator**;**
some filled with a poorer conductor/argon/vacuum**;** MAX 2

14 (c) (i) Increased losses/more energy needed/more air in contact**;** 1

14 (c) (ii) Reduced losses/less energy needed/ reduced rate of heat flow**;** 1

14 (c) (iii) Increased losses/more energy needed/warmed air removed/
cold air enters/increased temperature gradient**;** 1

14 (d) Reduced (habitat) damage from extraction of energy resource**;**
less transport of resources/equipment**;**
less pollution in equipment manufacture**;**
less pollution in use**;**
CO_2**;**
SO_x**;**
NO_x**;**
CO**;**
less waste**;**
aesthetics**;**
noise**;**
equipment siting**;**
dust**;**
smoke**;**
turbid drainage water**;**
other valid point**;** MAX 9
[**R** conservation methods]
up to 2 for expansion of each problem**;;**

Total marks = 15

Question 15

15 (a) $0.30 \times 300 \times 100$**;**
= 9000 kg**;** 2

15 (b) Empty bus/few passengers**;** 1
[**A** specific method of improved car fuel efficiency]

15 (c) Any suitable design feature with explanation**:**
aerodynamics/streamlining**;**
reduce drag/friction/air resistance**;**
OR
specific fuel combustion design/electronic ignition/more cylinders/
more valves/more spark plugs/combustion chamber shape**;**
optimum spark timing/combustion efficiency**;**
OR
specific fuel delivery design/fuel injection/air-fuel ratio control/
lean burn engine**;**
correct amount of fuel delivered**;**
OR
thermostatic cooling**;**
prevent over-cooling**;**
OR
specific wheel design/wheel size/tyre deformation**;**
rotational energy use/friction**;**
OR
hybrid fuels**;**
energy recovery/electricity**;**
OR
named fuel choice**;**
reason for reduced fuel consumption**;**
OR
smaller engine size**;**
less energy to move engine parts/lighter moving parts**;**
OR
lighter mass**;**
less KE needed**;**
OR
optimum engine : road speed ratio**;**
more gears/automatic/cruise control**;**
OR
fewer energy – consuming devices**;**
air conditioning**;**
OR
not 4×4/one pair of wheels driven**;**
reduced friction/lighter moving parts**;** 2 + 2 MAX 4
[**R** car usage/driving description, catalytic converters]

Total marks = 7

Topic 2: Pollution

General Properties of Pollutants

1 Use examples to explain the following terms, as applied to pollution.

1 (a) Persistence

.....

.....

.....

.....

(2 marks)

1 (b) Bio-magnification

.....

.....

.....

.....

(2 marks)

4

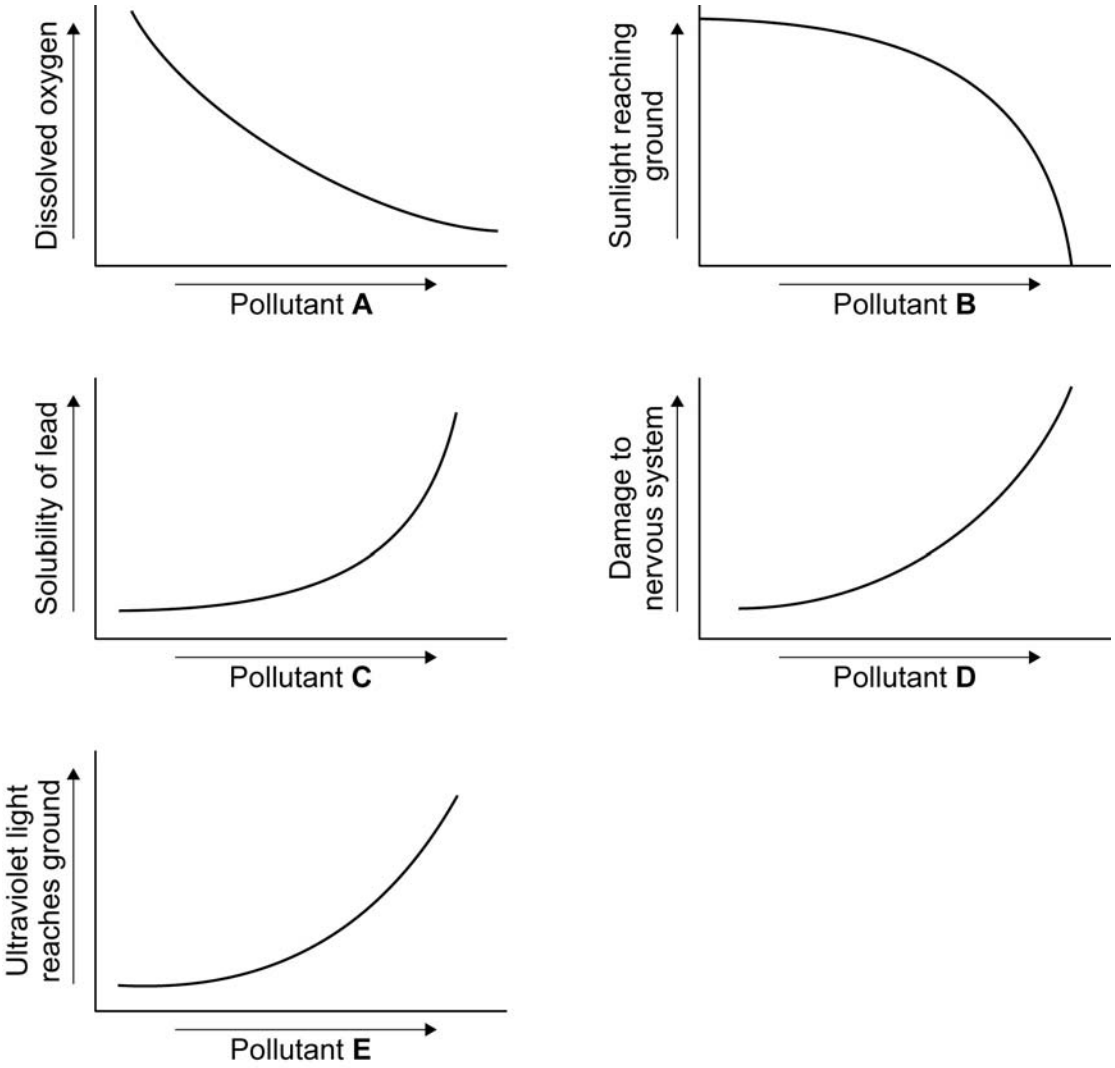
2 Discuss how the properties of different pollutants affect the ways in which they harm the environment.

Credit will be given for your understanding of the relationship between different areas of the subject, also for the organisation and presentation of the essay and for grammar, punctuation and spelling.

(20 marks)

20

3 The graphs illustrate the properties of selected pollutants.



Suggest pollutants which show the properties illustrated by each graph.

Pollutant **A** .....

Pollutant **B** .....

Pollutant **C** .....

Pollutant **D** .....

Pollutant **E** .....

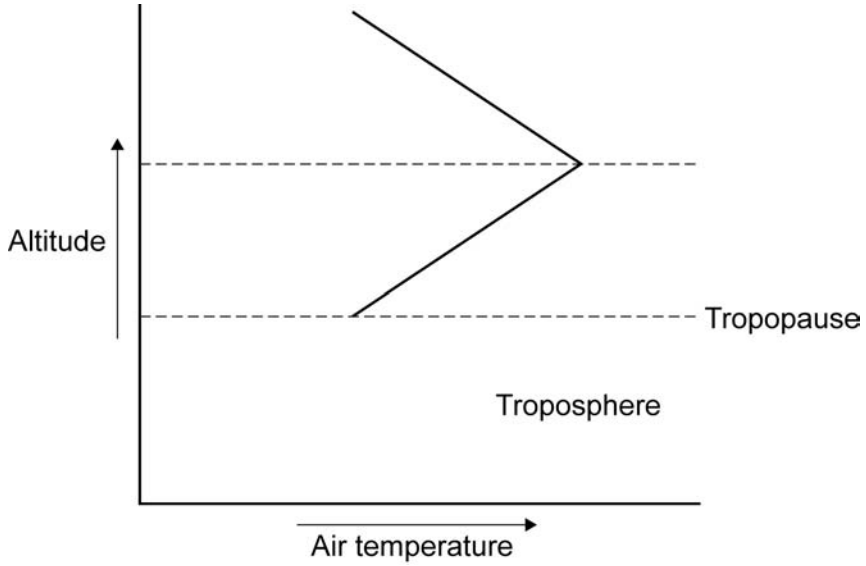
(5 marks)

5

Atmospheric Pollution

4 (a) On the axes below, sketch a line to show the relationship between air temperature and altitude during a temperature inversion in the troposphere.

(2 marks)



4 (b) Add a label to the graph to show the stratosphere.

(1 mark)

4 (c) Explain why a temperature inversion can trap pollutants close to ground level.

.....

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.....

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(2 marks)

4 (d) Describe how catalytic converters in vehicle exhausts help prevent photochemical smogs.

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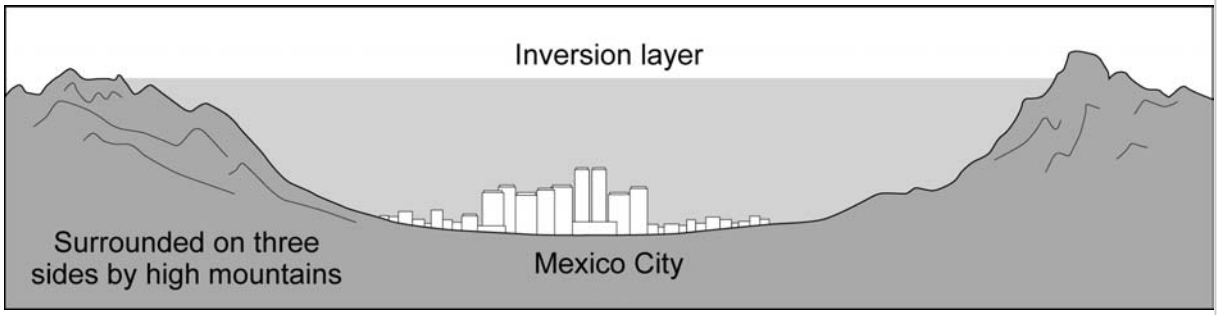
(2 marks)

7

5 The diagram shows Mexico City where the topography, climate and pollution combine to produce photochemical smogs.



5 (a) (i) Name the **three** main pollutant gases which react during photochemical smogs to produce Peroxy Acetyl Nitrates (PANs).

Pollutant 1 .....

Pollutant 2 .....

Pollutant 3 .....

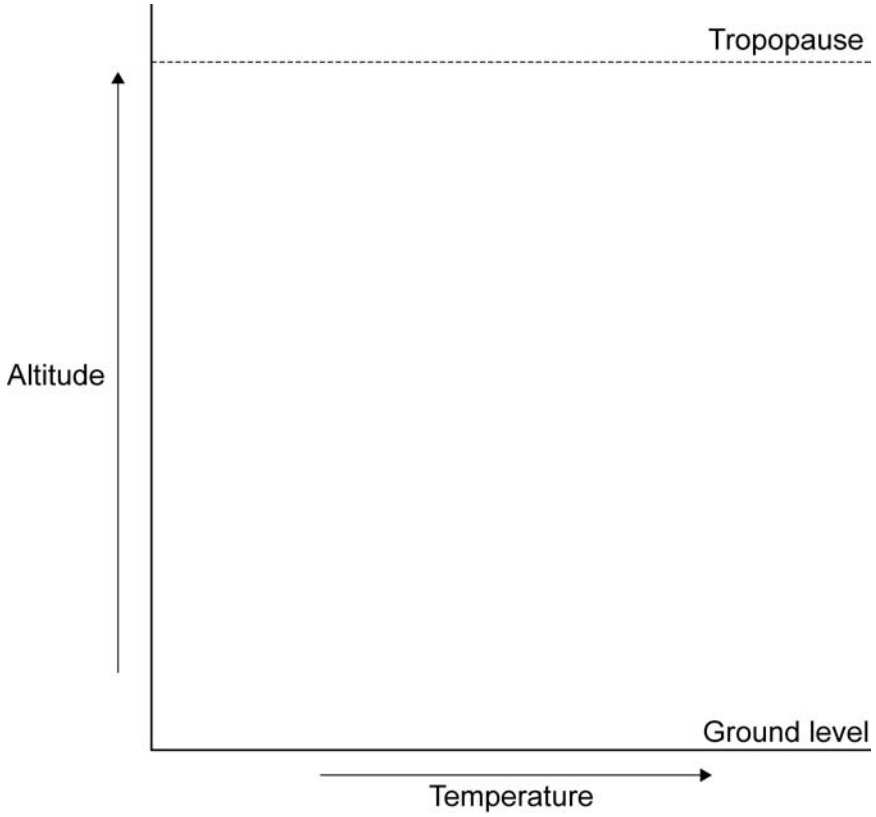
(1 mark)

5 (a) (ii) What is the source of the energy which causes the chemical reactions during a photochemical smog?

.....

(1 mark)

5 (b) (i) Draw a line on the diagram to show the temperature changes with increasing altitude during a temperature inversion.



(1 mark)

5 (b) (ii) Explain how a temperature inversion may trap pollutants close to ground level and prevent their dispersal.

.....

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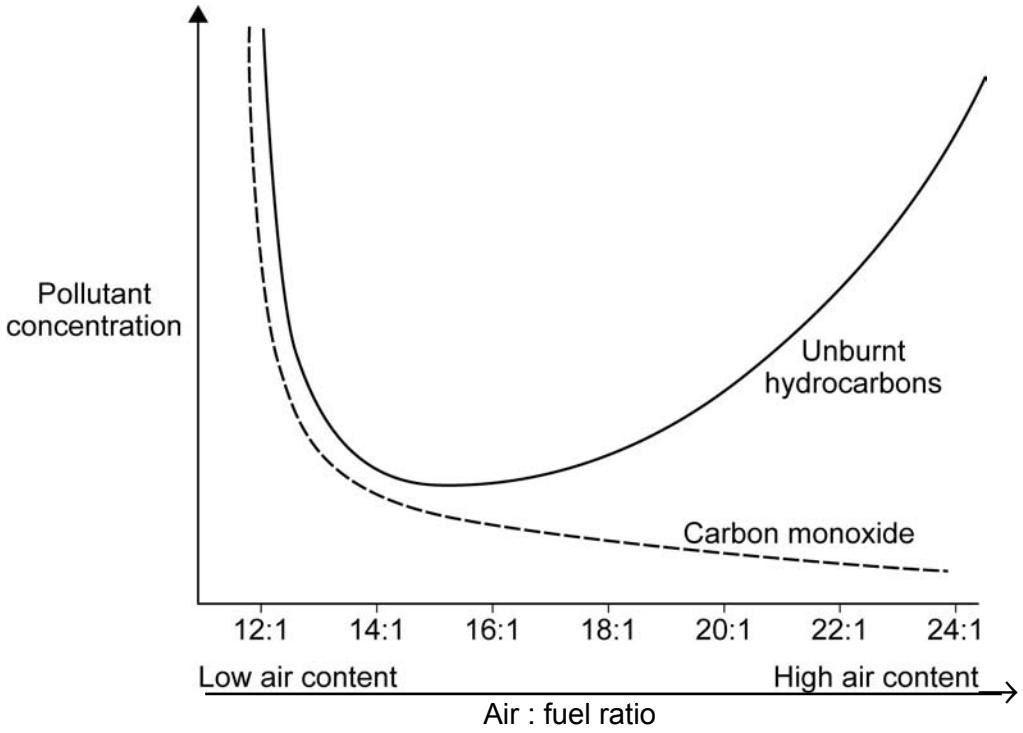
(3 marks)

6

6 The graph shows the relationship between the air : fuel ratio and the production of pollutants by vehicle engines.



6 (a) Estimate the optimum air : fuel ratio to minimise pollution by carbon monoxide and unburnt hydrocarbons.

Optimum air : fuel ratio = ... :1

(1 mark)

6 (b) Describe how oxides of nitrogen are involved in the production of photochemical smogs.

.....

.....

.....

.....

(2 marks)

6 (c) Describe **one** method used to reduce emissions of oxides of nitrogen from road vehicles.

.....

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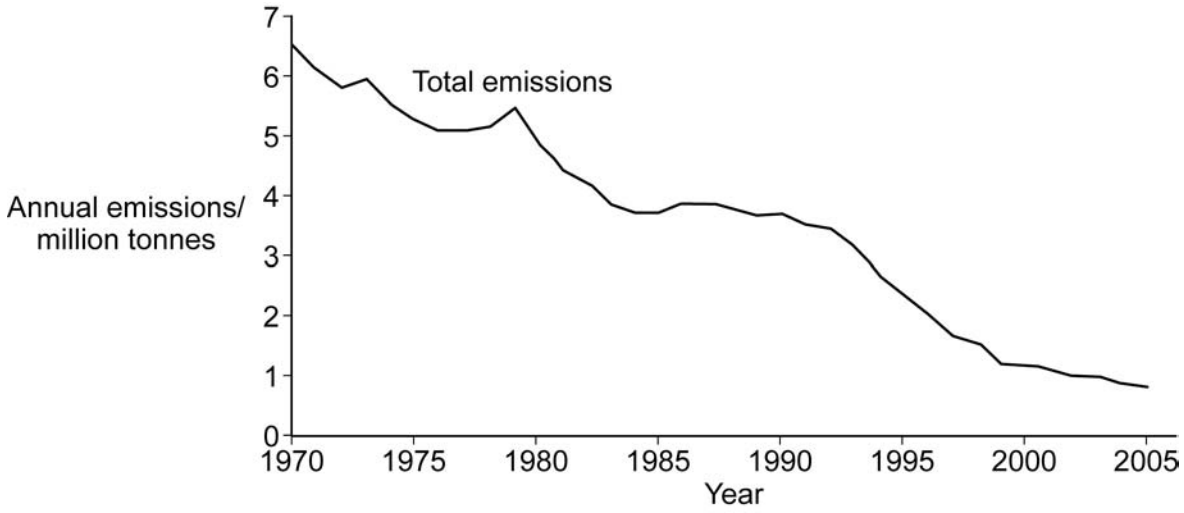
.....

(2 marks)

5

7 The graph shows the emissions of sulfur dioxide in the UK.



7 (a) Outline two ways in which sulfur dioxide emissions have been reduced.

1 .....

.....

2 .....

.....

(2 marks)

7 (b) Describe an effect of acid rain on:

7 (b) (i) living organisms

.....

.....

.....

.....

(2 marks)

7 (b) (ii) non-living objects.

.....

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(2 marks)

7 (c) Describe how living organisms may be used to produce a biotic index to monitor acid pollution.

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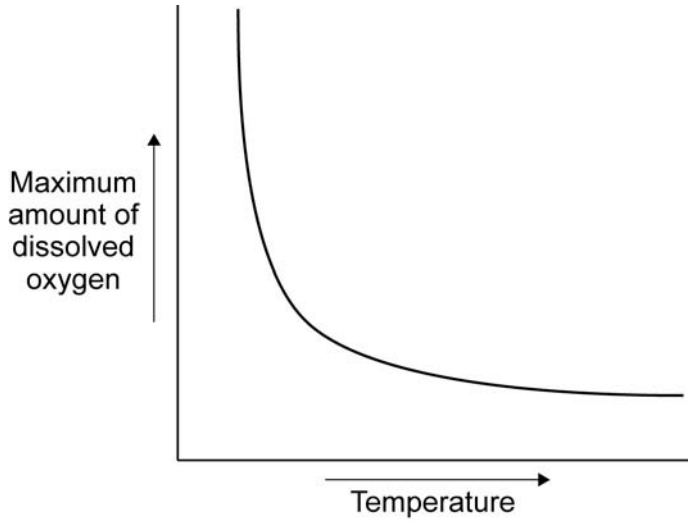
(4 marks)

10

Water Pollution

8 The graph shows the relationship between temperature and dissolved oxygen in water which is saturated with oxygen.



8 (a) Explain the significance for aquatic life of the relationship between dissolved oxygen and temperature shown in the graph.

.....

.....

.....

.....

.....

.....

(3 marks)

8 (b) Outline a method used in power stations to reduce the temperature of effluent water.

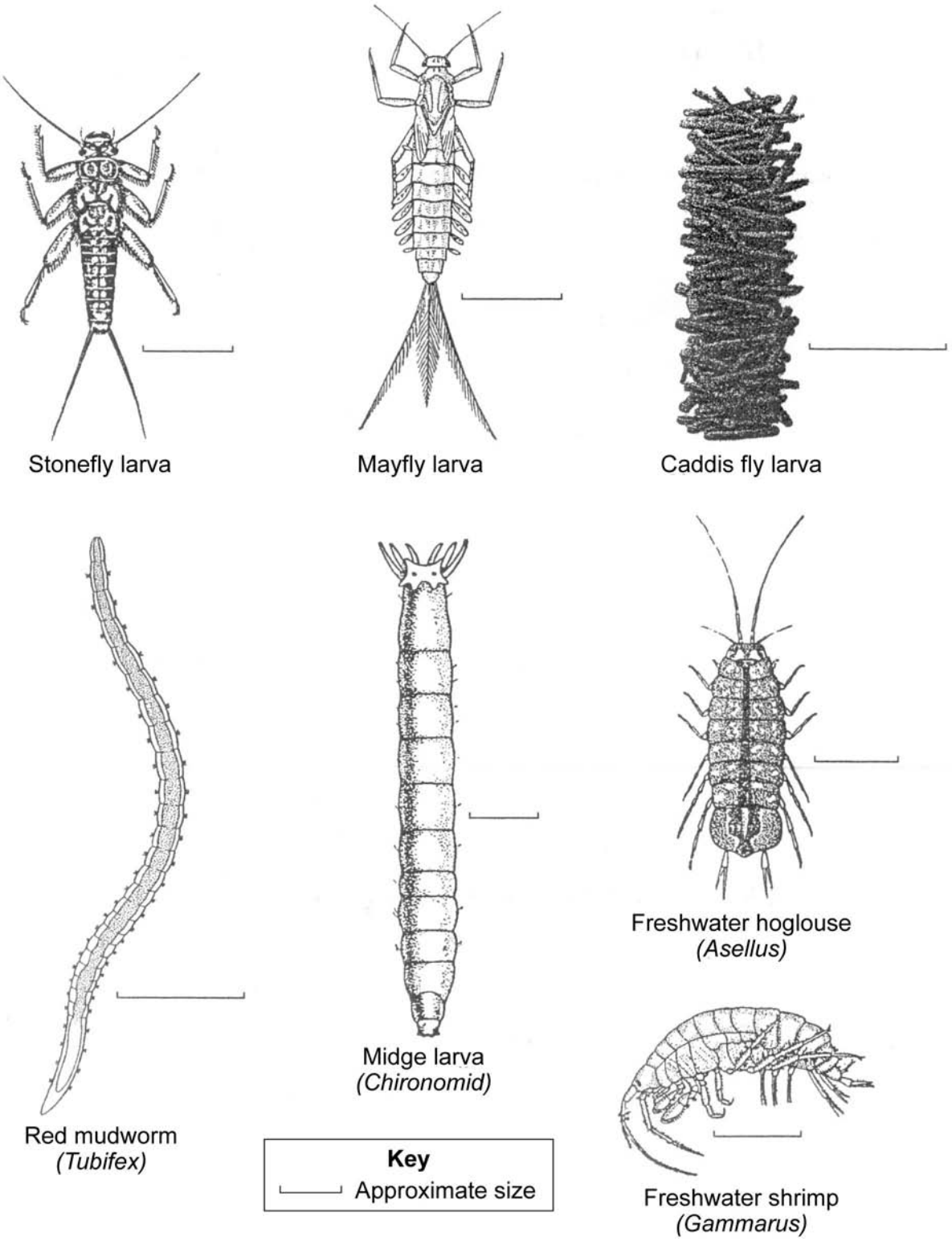
.....

.....

(1 mark)

4

9 The diagram shows some of the species used in a Biotic Index to monitor aquatic pollution.



9 (a) Describe the general features which make species suitable to be used in a Biotic Index.

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(4 marks)

9 (b) Suggest why using a Biotic Index may be preferred to measuring pollutants directly.

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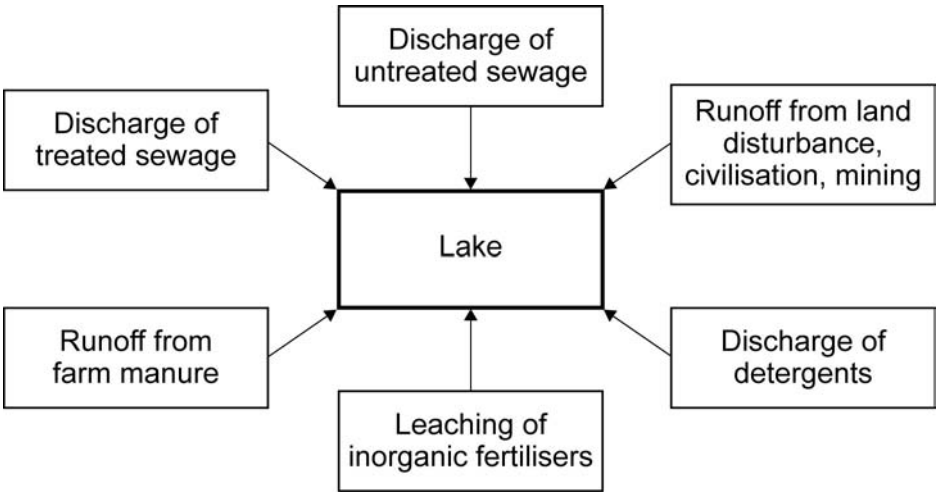
(2 marks)

6

10 The diagram shows some of the causes of the eutrophication of a lake.



Describe how inorganic nutrients entering a lake may lead to it becoming deoxygenated.

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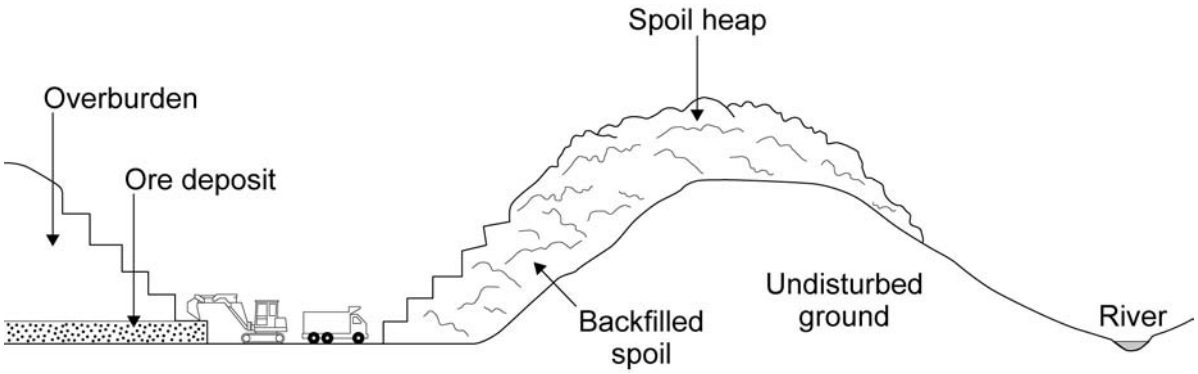
.....

(4 marks)

4

11 Mining of metal ores has many environmental impacts.

The diagram shows a mine from which metal ore is extracted.



11 (a) Explain why the drainage water from metal mine spoil heaps is often acidic.

.....

.....

.....

.....

(2 marks)

11 (b) Describe the effect that acidic drainage water may have on the wildlife in a river.

.....

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.....

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(2 marks)

11 (c) Explain how the geology of an area affects the severity of acid pollution problems.

.....

.....

.....

.....

(2 marks)

11 (d) Outline **one** advantage and **one** disadvantage to a company of spending money on pollution-control equipment.

Advantage .....

.....

.....

.....

Disadvantage .....

.....

.....

.....

(4 marks)

11 (e) Describe the techniques used to reduce the problems caused by waste water from mines.

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

14

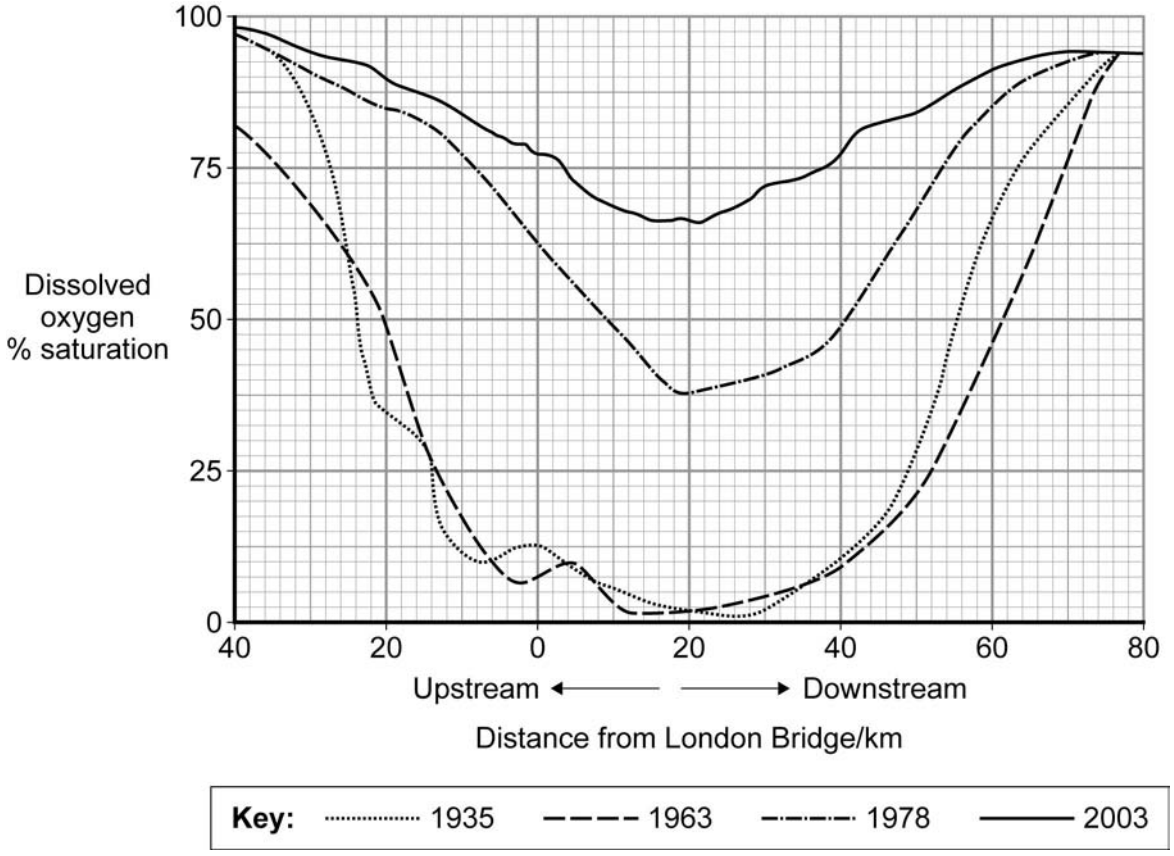
12 Describe how effluents containing organic and inorganic nutrients cause water pollution and outline the methods used to control these problems.

Credit will be given for your understanding of the relationship between different areas of the subject, also for the organisation and presentation of the essay and for grammar, punctuation and spelling.

(20 marks)

20

13 The graph shows the dissolved oxygen levels in the River Thames in four selected years.



13 (a) (i) Estimate the length of the river that had dissolved oxygen levels below 50% in 1963.

..... km

(1 mark)

13 (a) (ii) By how much did the dissolved oxygen % saturation level increase at London Bridge between 1935 and 2003?

..... %

(1 mark)

13 (b) Describe how organic matter in sewage causes the deoxygenation of rivers.

.....

.....

(1 mark)

13 (c) Explain the effect that low oxygen levels have on the biodiversity of aquatic ecosystems.

.....

.....

.....

.....

(2 marks)

13 (d) Describe how the inorganic nutrients present in sewage effluent may also cause the deoxygenation of rivers.

.....

.....

.....

.....

(2 marks)

13 (e) (i) Explain why an increase in water temperature may also affect the dissolved oxygen levels.

.....

.....

.....

.....

(2 marks)

13 (e) (ii) Which industry is the major source of hot water effluents?

.....

(1 mark)

10

Heavy Metals

14 Read the article about mercury pollution and then answer the questions that follow.

A research chemist was investigating the role of mercury in causing cancer. She was studying the organic mercury compound methyl mercury. The researcher took reasonable precautions: wearing safety glasses and latex gloves, working in a fume cupboard and using small quantities. The methyl mercury was supplied in sealed glass tubes which were cooled in iced water to reduce its volatility. The researcher transferred a small sample for testing and put the rest in a storage container. Then she sealed and labelled the tubes and cleaned up, disposing of the latex gloves.

Less than a year later she died from mercury poisoning.

After the experiment, she remembered spilling a small amount on her gloved hand. Later tests showed that the methyl mercury would have passed through the gloves and started entering her skin within 15 seconds. She had received an acute dose of mercury. It is now recommended that highly resistant multi-layered gloves should be worn under long neoprene rubber gloves when working with mercury.

Five months after the experiment she developed worrying symptoms: tingling fingers and slurred speech. She started to have problems with her balance and eyesight. Tests showed that she was suffering from mercury poisoning. Her blood mercury level was 4000 $\mu g\ kg^{-1}$ (microgrammes of mercury per kilogram), 80 times the toxic threshold. Methyl mercury in the blood passes easily into the brain. It is one of the most dangerous neurotoxins known. It causes abnormal foetal development, liver damage and kidney failure and it reduces coordination and sensitivity by inhibiting the action of enzymes which contain sulfur.

There have been many other cases of mercury poisoning.

Mercury nitrate was used to soften the fur that was used to make hats. Many hat workers suffered chronic poisoning due to bioaccumulation following frequent regular small doses. They suffered muscular shaking and slurred speech. Inorganic mercury fungicides were used to protect grain seeds that were supposed to be planted. In Iraq in 1971 some treated grain was used to make bread, resulting in over 400 deaths.

A plastics factory in Minamata, Japan discharged inorganic mercury waste into the sea. Bacteria changed this into methyl mercury which is more liposoluble. People that ate the local fish were eventually poisoned, with over 1400 dying. Mercury levels in the water were as low as 0.000008 $\mu g\ kg^{-1}$, but they were up to 1.2 $\mu g\ kg^{-1}$ in plankton, 24.1 $\mu g\ kg^{-1}$ in fish and 145 $\mu g\ kg^{-1}$ in humans.

14 (a) Outline the principles of **two** methods that the research chemist used to reduce the risk of exposure to mercury (lines 3-8).

1.....

.....

2.....

.....

(2 marks)

14 (b) Explain the difference between acute and chronic effects (lines 13 and 27).

.....

.....

.....

.....

(2 marks)

14 (c) Give **two** pieces of evidence to show that mercury damages the nervous system.

1.....

.....

2.....

.....

(2 marks)

14 (d) Calculate the toxic threshold of mercury (lines 19-20).

Show your working.

.....$\mu g\ kg^{-1}$

(1 mark)

14 (e) Use the pollution problems caused by mercury that are described in the text to explain the importance of the following in mercury pollution.

14 (e) (i) Bioaccumulation

.....

.....

.....

.....

(2 marks)

14 (e) (ii) Biomagnification

.....

.....

.....

.....

(2 marks)

14 (e) (iii) Liposolubility

.....

.....

.....

.....

(2 marks)

14 (f) Suggest why the mercury on the grain seeds in Iraq may not have caused poisoning if they had been planted (lines 29-31).

.....

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.....

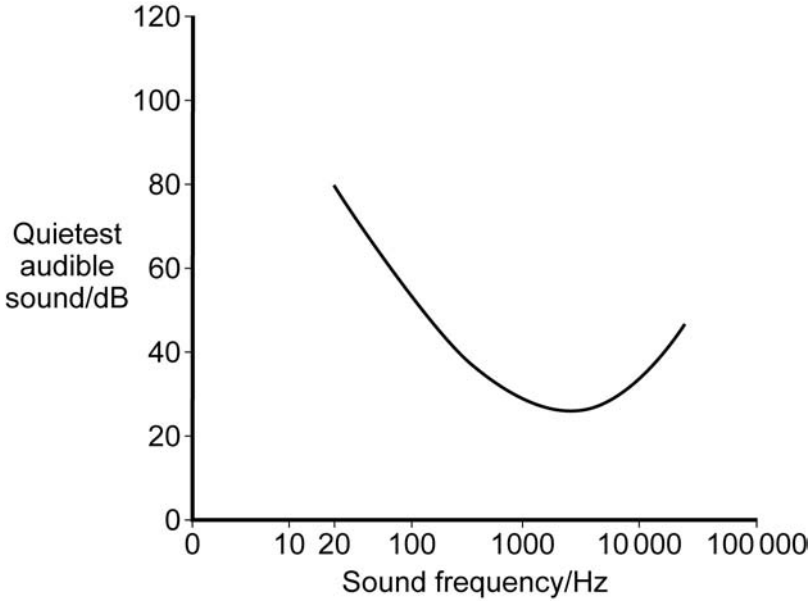
.....

(2 marks)

15

Noise Pollution

15 The graph shows the hearing sensitivity, to a range of sound frequencies, of a person with good hearing.



15 (a) (i) Draw a line on the graph to show the hearing sensitivity of someone with hearing damage caused by noise pollution.

(1 mark)

15 (a) (ii) Suggest why the graph does not give results for hearing below a frequency of 20 Hz.

.....

.....

(1 mark)

15 (b) Explain how the noise pollution experienced by residents near an airport could be reduced.

.....

.....

.....

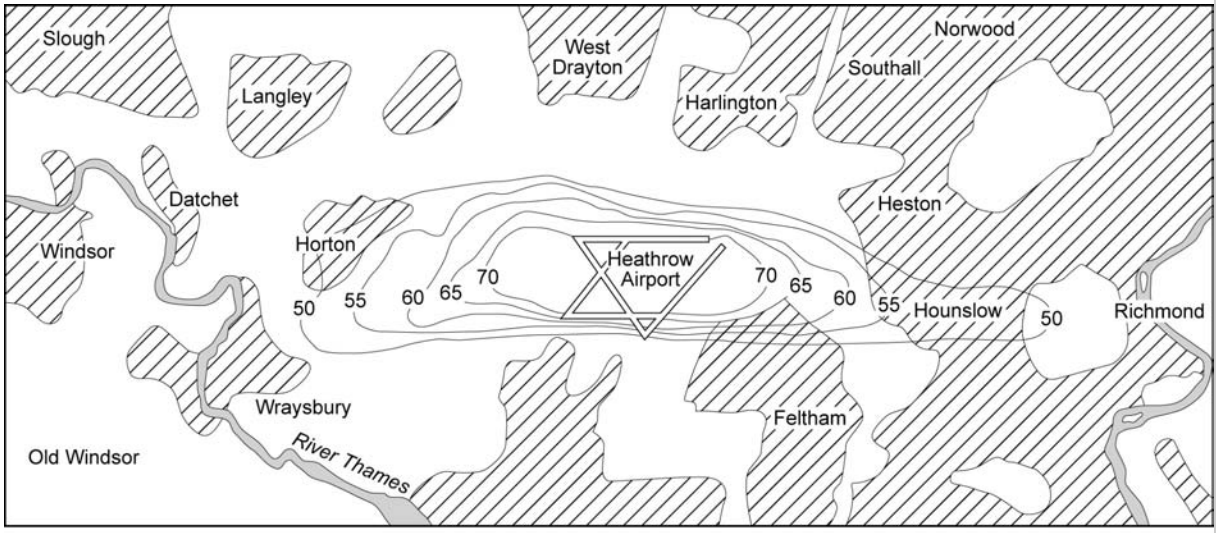
.....

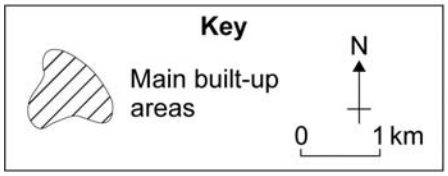
(2 marks)

4

16 The Noise and Number Index (NNI) is used to measure aircraft noise pollution. Calculation of the NNI includes the number of aircraft in a particular time period and the noise each one produces.

16 (a) The map shows isolines of NNI around Heathrow Airport for a typical day.





NNI (for the period 0600–1800 h GMT)	Average reaction
0	not noticable
20	noticable
35	intrusive
45	annoying
60	very annoying
70	unbearable

Suggest how such maps may be used in land use planning.

.....

.....

(1 mark)

16 (b) Suggest a reason why sounds below 80 deciBels (dB) are not included when the NNI is calculated.

.....

(1 mark)

16 (c) What value on the deciBel scale is the threshold of human hearing?

.....

(1 mark)

16 (d) Outline **two** ways in which excessive exposure to loud noises may cause human health problems.

1 .....

.....

2 .....

.....

(2 marks)

16 (e) Describe how aircraft operations can be managed to reduce noise nuisance.

.....

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.....

(3 marks)

16 (f) Outline **one** other method to reduce noise nuisance caused by an airport.

.....

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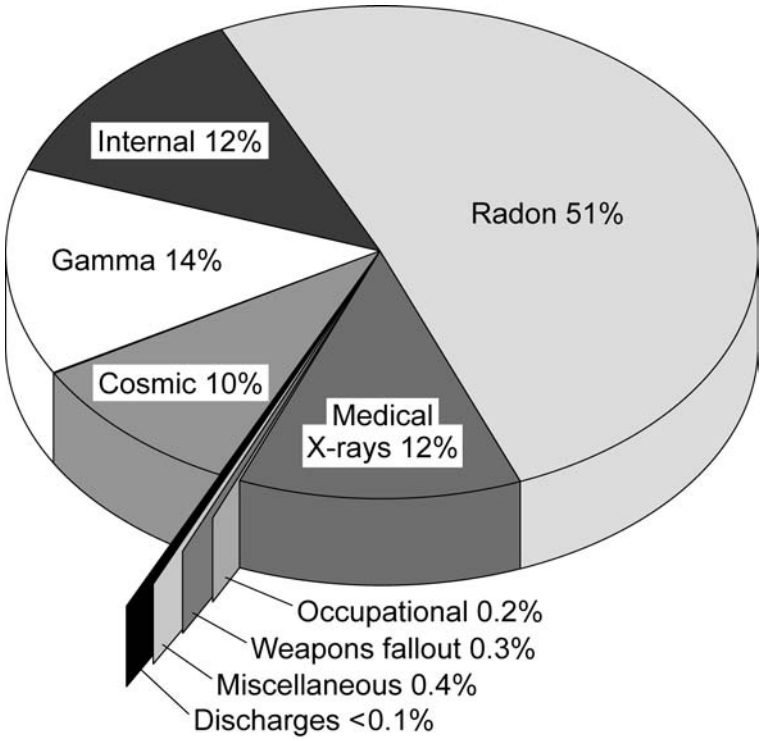
(2 marks)

10

Ionising Radiation

17 The pie chart shows the average exposure of UK citizens to ionizing radiation from different sources.



17 (a) Outline **three** ways in which an individual's exposure to ionizing radiation may be very different from the averages shown in the diagram.

1 .....

.....

(1 mark)

2 .....

.....

(1 mark)

3 .....

.....

(1 mark)

17 (b) Explain why some buildings may have higher than average levels of radon.

.....

.....

.....

.....

(2 marks)

17 (c) Explain why radioactive materials which emit alpha radiation are relatively safe when outside the body but are very dangerous if ingested.

.....

.....

.....

.....

(2 marks)

17 (d) Outline **two** beneficial uses of radioactive isotopes.

1.....

.....

.....

.....

2.....

.....

.....

.....

(4 marks)

11

18 Describe the methods used to monitor and reduce exposure to ionising radiation.

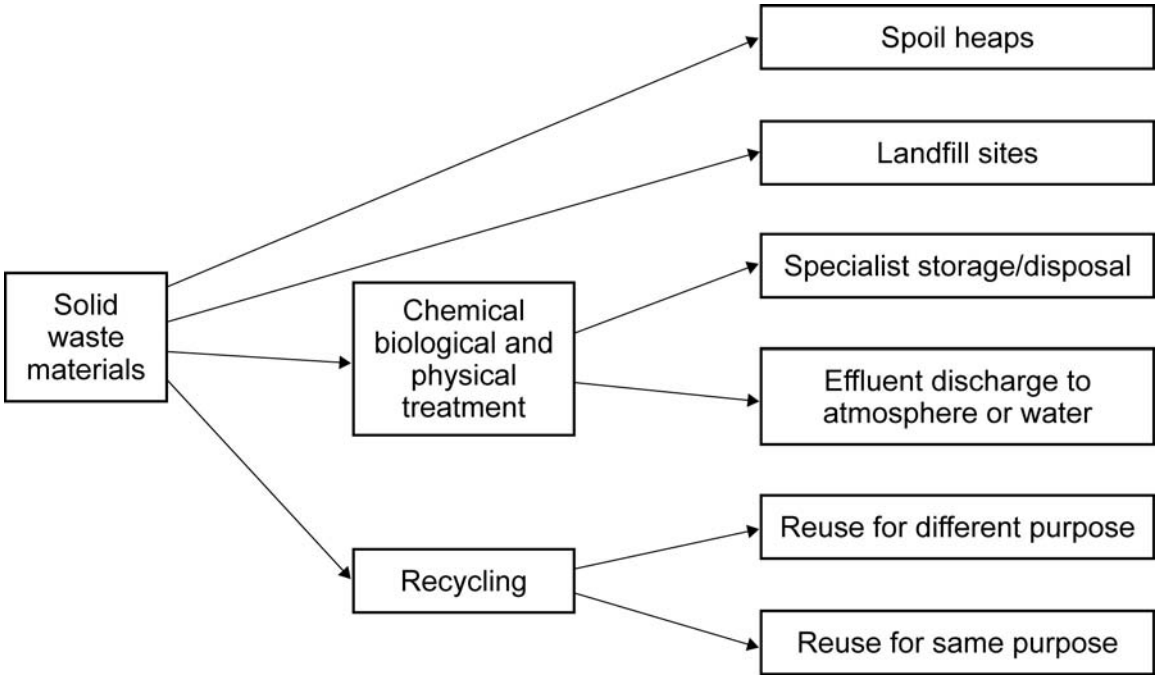
Credit will be given for your understanding of the relationship between different areas of the subject, also for the organisation and presentation of the essay and for grammar, punctuation and spelling.

(20 marks)

20

Solid Wastes

19 The diagram shows some of the methods used to deal with solid wastes.



19 (a) Give **one** strategy used by the UK Government to reduce the amount of waste disposed of in landfill sites.

.....

(1 mark)

19 (b) Outline **two** ways in which solid wastes may be used as energy resources.

1.....

.....

.....

.....

2.....

.....

.....

.....

(4 marks)

19 (c) Outline **one** way in which recycling used materials may increase pollution problems.

.....

.....

.....

.....

(2 marks)

19 (d) Describe **one** method for the long-term disposal of highly radioactive waste.

.....

.....

.....

.....

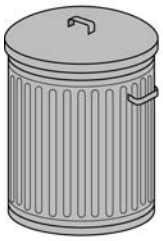
.....

.....

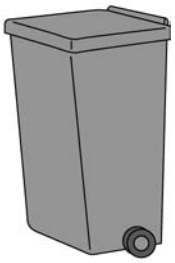
(3 marks)

10

20 The table shows the composition of domestic waste in the UK in 1950 and 2000.



1950 %	Category of waste	2000 %
2	Cloth and clothing	3
74	Dust, ashes and cinders	4
3	Food and garden waste	38
6	Glass items	10
4	Metal items	7
8	Paper and cardboard	25
0	Plastic items	5
4	'Unclassified' items	8



20 (a) Suggest **one** reason for the change in the proportion of:

20 (a) (i) ash

.....

.....

(1 mark)

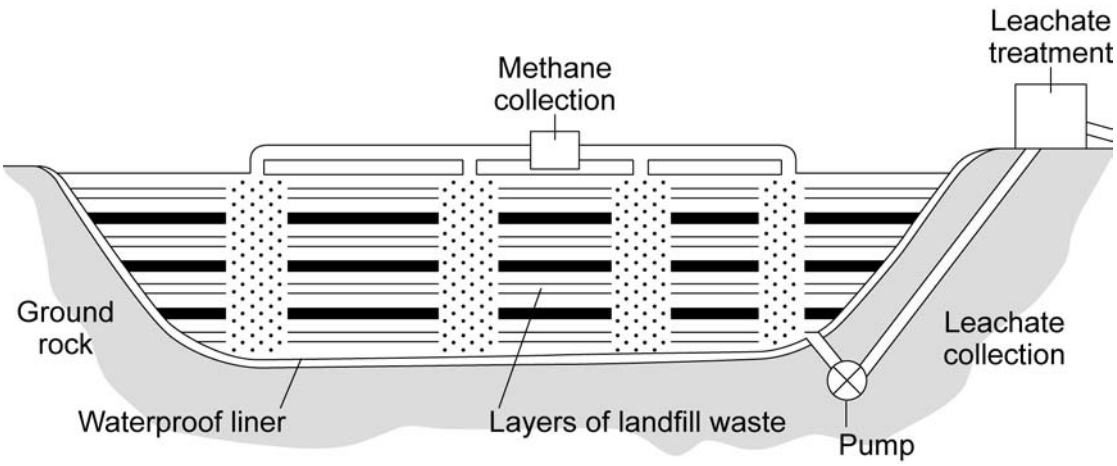
20 (a) (ii) food and garden waste.

.....

.....

(1 mark)

20 (b) The diagram shows a landfill site.



20 (b) (i) Outline the pollution problems caused if liquid leachate containing organic matter drains into a river.

.....

.....

.....

.....

(2 marks)

20 (b) (ii) Outline **one** method used to treat landfill leachate.

.....

.....

.....

.....

(2 marks)

20 (b) (iii) Outline **one** problem caused by the escape of methane from landfill sites.

.....

.....

(1 mark)

20 (c) Although almost all wastes could be recycled, it is often practically difficult to do so.

Outline the reasons why it is difficult to recycle many types of waste.

.....

.....

.....

.....

.....

.....

(3 marks)

10

Mark scheme – Topic 2: Pollution

Instructions: ; = 1 mark / = alternative response A = accept R = reject

General Properties of Pollutants

Question 1

1	(a)	Length of time a pollutant remains in environment (before it degrades/ breaks down)**;** [**A** description based on <u>more</u> persistent] example of pollutant to illustrate – organochlorines/PCBs/CFCs/dioxins/sewage/radioisotopes or other suitable example**;** [**R** pollutants that don't degrade]	2
1	(b)	Concentrated when passed to next trophic level/up a food chain**;** example of pollutant to illustrate – organochlorines/PCBs/dioxins/ heavy metals or other suitable example**;**	2

Total marks = 4

Question 2

Toxicity;
chemical form;
specificity;
persistence;
mobility;
bio-accumulation;
bio-magnification/food-chain concentration;
synergism;
mutagenicity;
carcinogenicity;
teratogenicity;
direct/indirect effects;
degradability;
reactivity;

name of property;
definition of property;
examples of pollutant to illustrate;;
how this property causes pollutant;;;

eg chemical form;
other elements with which the substance is combined;
Mercury – metal/inorganic/organic;
organic much more toxic;
more easily absorbed;
more liposoluble;
more effective bio-accumulation;
OR
persistence;
period of time before decay/degradation/reactions to become safe;
affects time for concentration to increase;
affects distance of travel;
organochlorine insecticides;
PCBs;
dioxins;
CFCs;
example of accumulation over time;
example of long distance of travel;

Alternative method of gaining credit: use specific pollutant examples to illustrate properties. Same mps apply.

MAX 6 for each property

Total marks = 20

Essay Questions

The essay questions are marked using the following marking criteria.

Scientific content
(maximum 14 marks)

Category	Mark	Descriptor
	14	
Good	12	Most of the material of a high standard reflecting a comprehensive understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A Level study. Some material, however, may be a little superficial. Material is accurate and free from fundamental errors but there may be minor errors which detract from the overall accuracy.
	10	
	9	
Average	7	A significant amount of the content is of an appropriate depth, reflecting the depth of treatment expected from a programme of A Level study. Generally accurate with few, if any fundamental errors. Shows a sound understanding of most of the principles involved.
	5	
	4	
Poor	2	Material presented is largely superficial and fails to reflect the depth of treatment expected from a programme of A Level study. If greater depth of knowledge is demonstrated, then there are many fundamental errors.
	0	

Breadth of Knowledge
(maximum 2 marks)

Mark	Descriptor
2	A balanced account making reference to most if not all areas that might realistically be covered by an A Level course of study.
1	A number of aspects covered but a lack of balance. Some topics essential to an understanding at this level not covered.
0	Unbalanced account with all or almost all material based on a single aspect.

Relevance

(maximum 2 marks)

Mark	Descriptor
2	All material present is clearly relevant to the title. Allowance should be made for judicious use of introductory material.
1	Material generally selected in support of title but some of the main content of the essay is of only marginal relevance.
0	Some attempt made to relate material to the title but considerable amounts largely irrelevant.

Quality of Written Communication

(maximum 2 marks)

Mark	Descriptor
2	All material is logically presented in clear, scientific English and continuous prose. Technical terminology has been used effectively and accurately throughout. At least half a page of material is presented.
1	Account is logical and generally presented in clear, scientific English. Technical terminology has been used effectively and is usually accurate. Some minor errors. At least half a page of material is presented.
0	The account is generally poorly constructed and often fails to use an appropriate scientific style to express ideas.

Question 3

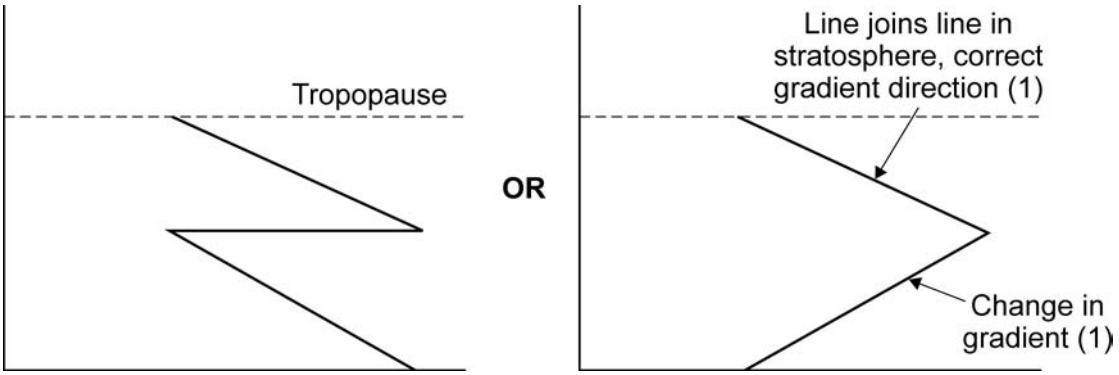
A Hot water/thermal pollution/organic matter/eg of organic pollutant/any reducing pollutant eg sulfide/iron**;**
B Smoke/suspended particles/PM10/SPM/smog/dust/soot**;**
C Acid pollutants/eg of acid/acidic gas eg SO_x/HCl**;**
[**R** acid rain]
D Lead/mercury/cadmium/other heavy metal/named neurotoxin eg organophosphate insecticide**;**
E CFCs/NO_x**;** 5

Total marks = 5

Atmospheric Pollution

Question 4

4 (a)



2

4 (b) Label – correct place**;** 1

4 (c) Air/pollutants cooler than air above (inversion layer)/cooler air trapped below warmer air**;**
so less buoyant/more dense and cannot rise**;** 2
[**R** pollutants cannot rise]

4 (d) Reduction/conversion**;**
of NO_x**;**
to Nitrogen**;**
oxidation**;**
of hydrocarbons/conversion**;**
to H_2O and CO_2**;**
prevents production of secondary pollutants/
Peroxy Acetyl Nitrates/PANs**;** MAX 2
[**R** smog]
[**R** CO → CO_2]

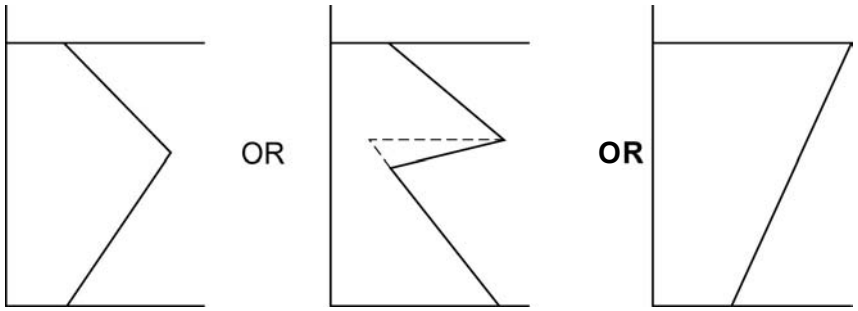
Total marks = 7

Question 5

5 (a) (i) Oxides of nitrogen/NO_x**;**
AND
Hydrocarbons/VOCs/sunburnt vehicle fuel**;**
AND
ozone**;** 1

5 (a) (ii) Solar energy/nuclear fusion/sunlight/sun**;** 1

5 (b) (i)



1

5 (b) (ii) Emissions are cooled/lower air is colder**;**
become more dense/air is more dense**;**
less buoyant**;** (MAX 2) (MAX 1 if no ref to emissions)
(cannot rise above inversion layer) into warmer layer/
less dense air**;** MAX 3

Total marks = 6

Question 6

6	(a)	15 (±1) **;**	1
6	(b)	Interaction with (unburnt) hydrocarbons/petrol/diesel/VOCs**;** in presence/absorption of sunlight/UV**;** production of ozone**;** production of PANs**;** [**R** temperature inversions/climatic/topographical conditions]	MAX 2
6	(c)	Catalytic converter**;** named catalyst eg platinum/palladium/rhodium**;** chemical reduction/separation of oxygen from nitrogen**;** production of nitrogen and oxygen**;** **OR** lean burn engine**;** air:fuel ratio**;** **OR** aquazole**;** water-diesel mix**;** [**R** public transport/alternative transport etc]	MAX 2

Total marks = 5

Question 7

7 (a) Change to low-sulfur fuels/named (low sulfur) fuel**;**
eg from coal/oil to natural gas, nuclear power, renewables

named method of reducing fossil fuel use**;**

named desulfurisation techniques/detail of process**;**
second named desulfurisation techniques/detail of process**;**
eg
coal bacterial/streaming/high temperature (fluidised bed) oxidation/gasification
crude oil hydrotreating/hydrogen sulfide removal
natural gas hydrogen sulfide removal

(wet) Flue-Gas Desulfurisation/scrubbing/Wellman-Lord process**;**
(dry) Flue-Gas Desulfurisation/gypsum**;** 2
[**R** catalytic converters]

7 (b) (i) Named tissue affected/cell membrane/protein/ enzyme/ cuticle/gill/skin/egg/ stomata/leaf/root hair/ exoskeleton damage/respiratory problems/nutrient leaching**;**

detail of damage/effect/denatured/reduced breeding/population decline/fear shoots/crown dieback/low growth/reduced nutrient/water uptake/gaseous exchange/photosynthesis**;** 2

7 (b) (ii) Corrosion/dissolving/weathering/erosion/leaching/mobilisation**;**
named material/metal/ion/limestone/sandstone/named structure/ buildings**;**
(heavy) metal solubility**;** MAX 2

7 (c) Named taxon/lichens**;**
range of sensitivity/resistance**;**
state of health/size**;**
reproduction**;**
presence/absence/abundance**;**
species diversity**;**
long-term indicator**;**

ease of identification**;**
ease of finding**;**
normally present**;**
generally distributed**;**

named biotic index eg Trent**;**
reference to scoring system/scale**;**
named sampling method eg kick/Surber**;** MAX 4

Total marks = 10

Water Pollution

Question 8

8 (a) Increased temperature reduces solubility/concentration/availability/ level of oxygen**;**
oxygen driven off if water is already saturated/if water temperature rises oxygen levels decline**;**
DO level may drop below that necessary for organisms to survive/ thrive**;**
need for special adaptations to low DO**;**
greater species diversity at lower temp/higher DO**;**
more competition at lower temp/higher DO**;** MAX 3

8 (b) Hot water spray in cooling towers/heat passes to air in cooling towers/ district heating/heat exchanger**;** 1
[**R** 'cooling towers' with no details]

Total marks = 4

Question 9

9 (a) Easy to catch/find**;**
easy to identify/recognise/difficult to confuse**;**
normally present/common/widely distributed**;**
presence or absence indicates level of pollution/other named factor**;**
differing species sensitivities to pollution/named factor/tolerance**;**
predictable order of species appearance/disappearance**;**
named species/taxon to illustrate sensitivity**;** MAX 4

9 (b) No expensive/complicated equipment required**;**
gives estimates of past pollution**;**
gives longer-term measure if pollutant fluctuates**;**
gives measure of effect not causes**;**
instant results/quicker**;**
cost effective**;**
no need to identify/monitor specific pollutants**;** MAX 2

Total marks = 6

Question 10

Nitrates/NO_3-/phosphates/PO_3^{3-}**;**
bloom/encourage/stimulate plant growth**;**
[**R** 'organisms']
[**R** nitrogen/phosphorus]
[**R** algae use O_2 with no ref to death/decomposition/respiration]
plants die with reason – shaded/nutrient depletion/seasonal change**;**
bacterial action/decomposition/respiration/increased BOD due to organic matter**;**
rate of oxygen consumption > production/anaerobic conditions**;**
[**R** BOD with no explanation] MAX 4

Total marks = 4

Question 11

11 (a) Sulfide ores/pyrites**;**
exposure to air/oxygen/oxidation of ores/metals/
displacement of sulfur**;**
sulfur dioxide**;**
sulfuric acid**;** MAX 2

11 (b) Reduced amount of life**;**
reduced biodiversity/range of species**;**
example of sensitive species/taxon**;**
protein damage**;**
denature enzymes**;**
Ca skeleton**;**
increased infections**;**
mucous on gills**;**
named sensitive tissue/organ eg eggs/gills**;**
osmotic changes**;**
food chain effects**;**
other example of specific effect**;** MAX 2

11 (c) Amount of lime/calcium (carbonate) present**;**
example of rock from acid sensitive/insensitive area eg granite/
limestone/chalk**;**
neutralise (acids)**;**
permeability/distance of travel/pathway effect**;** MAX 2

11 (d) **Advantage**
named advantage/avoid prosecution/public image/customer acceptance/increase sales/preparation for accident/incident/ profit margin**;**
explanation of advantage**;**

Disadvantage
named disadvantage/prosecution/economic competitiveness/ public image/customer acceptance/profit margin**;**
explanation of disadvantage**;** 2×2 4
[**A** same factor for both with explanation]
[**A** factor without explanation (once only if same factor is used for both)]

11 (e) Bunds**;**
drainage collection/tailings dam**;**
(impermeable) liner**;**
impermeable cap**;**
evaporation to reduce volume**;**
neutralisation/pH control**;**
tolerant plants**;**
turbidity control/sedimentation/settling/flocculation**;**
filtration**;**
reed bed/phytoremediation**;**
oxidation to reduce solubility**;**
extraction from drainage water/electrolysis/displacement/ precipitation**;** MAX 4

Total marks = 14

Question 12

Nutrient pollution**:**

Organic
Named eg – sewage, manure, milk, food processing waste, slaughterhouse waste, paper mills, leather processing

Bacterial action
energy –rich compounds
respiration
deoxygenation
death of aquatic aerobes
growth of bacteria/sewage fungus
other organisms covered and die
BOD
changed species diversity
changed species abundance
changed species present/absent
release of inorganic nutrients
causing eutrophication

Details of organic effluent treatment works
pre treatment
- screens
- grit traps

primary treatment
- sedimentation/settling

sludge treatment
- anaerobic digestion
- drying beds
- incineration
- fertiliser
- land fill

secondary treatment
- aeration/oxidation tanks
- trickling filter beds

tertiary treatment
- phosphate stripping
- micro filtration
- chlorination

other methods
- filter beds
- reed beds
- bioremediation
- bacterial decomposition
- co-metabolism
- land farming

Inorganic
named nutrients – nitrates, phosphates
algal blooms
shading
death of macrophytes
blue-green algae release toxins
death and decay of algae
decay by bacteria
deoxygenation
leaching
eutrophication
changed species diversity
changed species abundance
changed species present/absent

details of phosphate stripping – iron sulfate, iron phosphate precipitation
details of nitrate dentrification – action of dentrifying bacteria
details of low fertiliser runoff methods
- reduced tillage/ploughing
- timing of ploughing/fertiliser application in dry weather
- buffer zones
- low solubility fertilisers
- N/P control areas
- reduced use

(Refer to guidance on essay questions from Q2)

Total marks = 20

Question 13

13	(a)	(i)	83 km (±2);	1
13	(a)	(ii)	65% (±2);	1
13	(b)		Bacterial respiration/digestion/decomposer action/aerobic bacteria; [**A** bacteria use up oxygen] [**R** eutrophication]	1
13	(c)		Reduced biodiversity/number of species; range of tolerance/differing oxygen requirements; aerobic/anaerobic conditions; food chain effects; named species/taxon;	MAX 2
13	(d)		N and P/nitrates and phosphates/stimulate/increase growth of algae/algal bloom; effect of shading on deeper plants/photosynthesis; increased BOD/decay of dead algae/macrophytes; eutrophication;	MAX 2
13	(e)	(i)	Named physiological effect/increased metabolism/death; lower DO levels/reduced solubility; O_2 exsolves/comes out of solution/more energy so escapes;	MAX 2
13	(e)	(ii)	(Steam-thermal) power stations/electricity generation;	1

Total marks = 10

Heavy Metals

Question 14

14 (a) Named method with how it works**;**
safety glasses physical barrier to eyes**;**
latex gloves physical barrier to skin**;**
cooled to reduce vapours which could be inhaled**;**
small samples to reduce possible dose**;**
use of fume cupboard reduces inhalation**;** MAX 2

14 (b) Timescale of effects**;**
chronic – long, acute – short**;** 2
[**R** reference to size of dose]

14 (c) Neorotoxin**;**
tingling fingers**;**
slurred speech**;**
reduced coordination**;**
reduced sensitivity**;**
reduced nerve action in brain**;**
enzyme inhibition**;**
muscular shaking**;**
balance**;**
eyesight**;** MAX 2

14 (d) $50\mu g\,kg^{-1}$**;** 1

14 (e) **bioaccumulation**
absorption**;**
increasing concentration within an organism**;**
due to storage of many small doses eg hatworkers**;**
Minamata – people ate local fish**;**
MAX 1 if context is food-chain concentration MAX 2

biomagnification
increased concentration**;**
along a foodchain**;**
ingestion in food and storage eg in Minamata**;** MAX 2

liposolubility
dissolves in fats/oils/lipids**;**
allows storage eg in fish, humans**;**
methyl mercury Minamata Bay**;** MAX 2

Max 1 for all three sections if the case study described is not from the text

14 (f) Mercury low solubility**;**
mercury not absorbed by plants**;**
mercury not absorbed by grain**;**
mercury not stored in grain**;**
ref to liposolubility**;** MAX 2

Total marks = 15

Noise Pollution

Question 15

15 (a) (i) Line above and parallel to existing line and narrower range of frequencies**;** (within same range) 1

15 (a) (ii) Inaudible/can't be heard/frequency below sensitivity of ear**;** 1

15 (b) Any suitable example**:**
name of method**;**
how method works**;**

absorption/insulation/deflection/reflection of noise**;**
example of technique: baffle mounds/embankments/double glazing/ bund/fencing**;**
[**R** soundproofing]

control flight paths/flight paths to reduce annoyance**;**
away from residential areas**;**
[**R** cavity wall insulation]
[**R** airport location]

restrict timing of flights/times to reduce annoyance**;**
not at night**;**

control of rate of climb to reduce annoyance**;**
not too steep (to reduce noise level)/very steep (to reduce area affected)**;**

restrictions on type of aircraft**;**
ban noisy ones/larger but fewer aircraft/develop/use quieter engines**;** 2

Total marks = 4

Question 16

16 (a) Appropriate land use positioning (related to noise level)
eg residential/school/hospital in quieter areas**;**
OR
industry/agriculture in noisier areas**;** MAX 1

16 (b) Too quiet to cause annoyance/similar to other noises eg roads**;** 1
[**R** can't be heard/noticed]

16 (c) 0/zero**;** 1

16 (d) Any two examples**:**
stress/heart disease/high blood pressure (hypertension)/hearing loss/
tinnitus/behavioural changes (insomnia)**;;** 2

16 (e) Up to two for stated operational changes**:**
flight path (changes)**;**
taxi areas**;**
angle of ascent/descent**;**
times of flights/day/night**;**
location of lowering landing gear**;**
fewer larger aircraft**;**
ear protection for workers**;**
up to two marks for explanatory details**;;** MAX 3
[**R** fewer aircraft]
[**R** low noise runway surfaces]

16 (f) Name of method**;**
detail of how it works**;**
eg baffle mounds/sound absorbing barriers/trees/walls/embankments**;**
around runway/taxi areas**;**
absorb/deflect sound**;**
OR
quieter aircraft**;**
large diameter jets/reduced jet turbulence/ban noisy aircraft**;**
OR
double/triple glazing**;**
absorb noise**;** MAX 2
[**A** additional answer from (e)]
[**R** ref to new airport construction/location]

Total marks = 10

Ionising radiation

Question 17

17 (a) Occupational variation – radiologist/nuclear energy/researcher/ nuclear manufacturing/mining**;**
more air travel absorbing cosmic rays/radiation**;**
public exposure to radioactive pollution/weapons fall-out**;**
diet rich in radioactive isotopes**;**
women – more Potassium 40**;**
recreational exposure eg potholing**;**
medical treatments eg radiotherapy/X rays**;**
garden peat**;**
location/local geology – differing radioisotope levels**;** MAX 3

17 (b) Some buildings are built of/on granite**;**
granite contains Uranium**;**
(Granite/Uranium) decays to give Radon**;**
(closed structure) traps Radon**;** MAX 2

17 (c) Short range in/easily absorbed by clothing/dead cells on outside of body**;**
chemical change/ions/genetic change/produce free radicals in/ cause fatal mutations in/cause cancerous growth of living cells inside body**;** 2

17 (d) Names of uses – for 1 mark
description of use – for 1 mark
example of isotope – for 1 mark
[**R** description of activity alone]

Cancer treatment**;**
turbine testing**;**
smoke detectors**;**
beta lights**;**
roll steel/paper thickness testing**;**
pathway analysis**;**
radiolabelling**;**
autoradiography**;**
nuclear power stations**;**
ship propulsion reactors**;**
pest control**;**
food sterilisation**;**
(isotope) dating/aging**;**
barium meals**;** MAX 2 x 2 = 4
[**R** second mark if barium is stated as the radioactive material]

Total marks = 11

Question 18

Absorption
examples of absorbing materials
ease of absorption/penetration of α β γ radiation
distance
inverse square law
duration of exposure
open/closed sources

waste storage methods;
high level waste, vitification, glass, stainless steel, cooled
intermediate level waste, stainless steel, cement
low level waste, steel drums, containers, concrete trench, filtered and released
locations of waste respositories

waste reprocessing methods
dissolved and separated

location of site
half lives

radon ventilation
air extraction/filters

worker monitoring
film badges
dosemeters
full body monitors
health checks

critical pathway analysis
atmosphere, water

critical group monitoring
members of public most at risk due to lifestyle

environmental monitoring
dust, soil, water, grass, fish, milk, shellfish

role of organisations
NII
ICRP
EA
(Refer to guidance on essay questions from Q2)

Total marks = 20

Solid Wastes

Question 19

19 (a) Named financial penalty/incentive/aggregate tax/landfill tax/ Agenda 21/waste minimisation targets/method to encourage recycling**;** 1

19 (b) Name of method**;**
name of waste used**;**
detail of energy production process**;**
[**R** uses of energy]

combustion/incineration/pyrolysis**;**
flammable domestic/industrial waste/refuse derived fuel/plastics/ forestry waste/tyres/other named waste**;**
hot water/steam/electricity**;**
OR
anaerobic digestion**;**
sewage/manure/named organic waste**;**
methane**;**
OR
landfill**;**
organic matter/domestic refuse**;**
anaerobic bacteria/anaerobic digestion/methane/archaebacteria**;**
OR
decomposition**;**
named organic waste/forestry waste**;**
heat of respiration/heat recovery/hot water**;** 2 × MAX 2 MAX 4

19 (c) Eg of cause**;**
detail of pollution**;**
OR
eg increased energy use/transport for collection/processing**;**
vehicle exhausts/process energy pollution/named pollutant released**;**
OR
de-inking of used paper**;**
use of chlorine bleach produces dioxins**;**
OR
release/mobilisation of pollutants/contaminants from recycled materials**;**
eg mercury from fluorescent tubes/cadmium from batteries/ CFCs from fridges/other suitable example**;**
[**A** visual pollution/noise of collection facilities]
OR
use of matrials to clean/decontaminate**;**
eg washing powder/named cleaning agent**;** 2

19 (d) Vitrification/encapsulation**;**
in (solid) glass**;**
in stainless steel containers/cylinders**;**
sealed**;**
in cooled building**;**
in concrete**;**
shielding/radiation absorption**;**
low seismic activity**;**
impermeable rock**;**
deep burial**;**
low water movement**;**
[**R** lead, disposal at sea, disposal in space]
OR
dry storage**;**
CO_2 gas**;**
corrosion control**;**
no fire risk**;**
convection/heat dissipation**;**
no reprocessing**;**
concrete**;**
shielding/radiation absorption**;** MAX 3

Total marks = 10

Question 20

20 (a) (i) Reduction in the use of open fires/coal/wood/use of new fuels/ more efficient combustion**;** 1

20 (a) (ii) Fewer compost heaps/ more wasteful preparation/more wasteful society/ fewer domestic livestock/more time now for gardening hence more waste**;** 1
[**R** food packaging]

20 (b) (i) Excess growth/eutrophication/high BOD**;**
action of bacteria/blue-green algae/decay/decomposition**;**
deoxygenation/death of aerobic aquatic organisms**;**
low pH**;**
enzyme inhibition**;**
increased turbidity**;**
reduced light/reduced photosynthesis**;**
pathogens**;**
disease/named disease**;** MAX 2

20 (b) (ii) Named method**;**
how it works**;**
eg aeration (tank)/trickling filter bed/reed bed**;**
aerobic action/respiration/bacteria**;**
breakdown/decay/decomposition**;**
OR
neutralization**;**
addition of lime/high pH material**;**
OR
sedimentation**;**
static (to allow settling)**;**
OR
flocculation**;**
joining/charge neutralization/settling**;**
OR
sterilization**;**
use of chlorine/ozone/UV**;** MAX 2

20 (b) (iii) Explosion/fire risk/flammable**;**
global climate change/enhanced greenhouse effect/global warming**;** MAX 1

20 (c) Difficulties**;;;**
description of difficulty**;**

contamination due to mixing**;**
eg of contaminating/contaminated material**;**

lower quality of product**;**
limited use of product/example of less useful product**;**

small quantities**;**
high cost:income**;**

transport costs**;**
high due to small amounts/scattered sources**;**

sorting costs**;**
labour intensive**;**

energy costs**;**
stated reason for high costs**;**
eg small quantities

contains/produces toxins/hazardous materials**;**
named example**;**
eg heavy metal, dioxin

public acceptance of recycled goods**;**
example of material perceived as less desirable**;**
eg recycled oil/paper MAX 3
[**R** NIMBY issues related to recycling centres]

Total marks = 10

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