



AQA B3.4 Humans and their environment



208 minutes

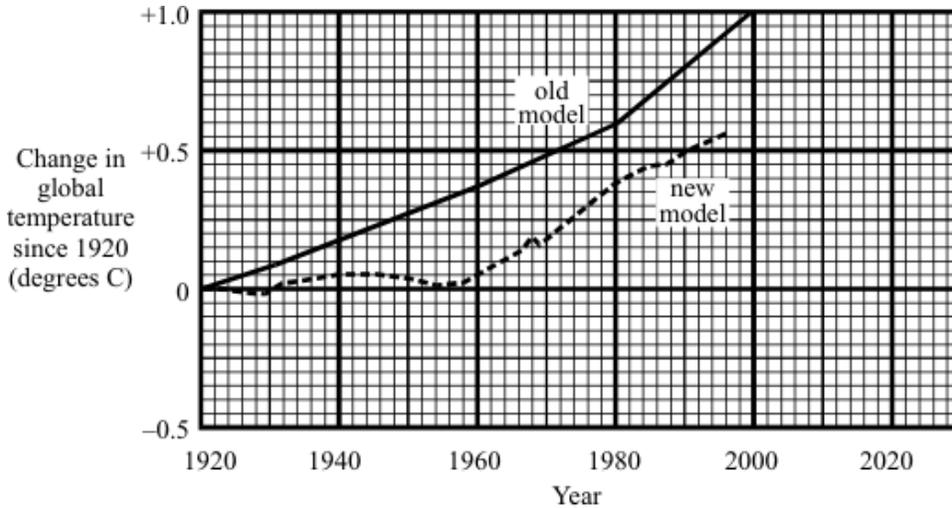


208 marks

##

Predictions on global warming are based on models taking into account all known factors including “greenhouse gases.” However recent research has shown that rises in temperature are smaller than previously predicted because of another type of pollution from power stations burning fossil fuels. This pollution contains soot and tiny droplets of an acid sulphate solution which cut down the amount of solar energy entering the atmosphere.

The graph shows predicted global warming based on models before and after recent research.



(a) What would be the predicted rise in global temperature for 2000AD using the new model?

.....

(1)

(b) How does burning fossil fuels contribute to global warming?

.....
.....
.....

(3)

(c) Explain carefully why the predictions from the new model are different from the old one.

.....
.....
.....

(2)

(d) Why are countries with industrial areas trying to reduce air pollution by sulphate droplets?

.....
.....
.....
.....

(2)
(Total 8 marks)

Q2. The figures below show the levels of carbon dioxide in air from 150 000 years ago.

TIME	CARBON DIOXIDE CONCENTRATION
1500 years ago	270 parts per million
1800 AD	290 parts per million
1957	315 parts per million
1983	340 parts per million

(a) Explain why carbon dioxide levels in the atmosphere are changing.

.....
.....
.....
.....
.....

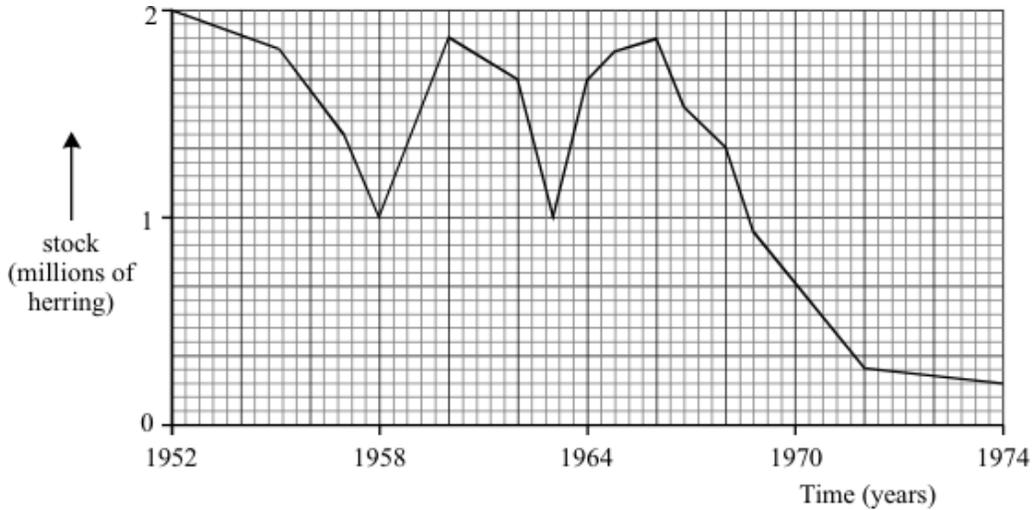
(3)

- (c) A paragraph which describes a new process for fermenting straw with genetically engineered bacteria and evaluates its potential from an economic and environmental point of view.

1 When fermenting straw with yeast, the process has to be stopped periodically to separate out the ethanol. This takes time and costs money.	2 In Britain, cereal farmers produce 10 million tonnes of waste straw each year.	3 Digesting straw with the genetically engineered bacteria releases enough energy to keep the fermenting mixture at 70°C.
4 The traditional way of getting rid of waste straw is by burning it. Burning straw is now forbidden by European law.	5 A new genetically engineered bacterium called <i>Bacillus stearothermophilus</i> can digest straw, including hemicelluloses, to produce ethanol.	6 Ethanol can be used as a fuel for cars, either by itself or mixed with petrol. Carbon dioxide and water are the main waste products.
7 Straw can be digested by fermenting it with yeast. Ethanol and carbon dioxide are produced.	8 Only 4 million tonnes of straw are needed each year in Britain for animal bedding or—after special treatment—for animal feed.	9 When using yeast to ferment straw, energy has to be supplied to keep the fermenting mixture warm.
10 Straw contains a lot of substance called hemicellulose which cannot be digested by yeast. This waste then has to be disposed of.	11 Burning straw produces lots of smoke and carbon dioxide (a “greenhouse” gas).	12 At 70°C, ethanol can be continuously evaporated off from a fermenter simply by keeping the pressure slightly reduced.

(Total 10 marks)

Q4.



The graph shows the variations in the North Sea herring population between 1952 and 1974. These fish were formerly caught in large numbers by fleets of trawlers but fishing has been restricted since 1974 as a conservation measure. Herrings lay about 20 000 eggs per year but do not reproduce until they are about 3–5 years old, when they are about 25cm long. It takes 11 years for a herring to reach its mature adult length.

The following measures have been suggested to prevent overfishing:

- limiting mesh size of nets,
- specifying maximum catch by each boat per year.
- prohibiting fishing in herring breeding grounds.
- prohibiting fishing at certain times of the year.

Evaluate their probable effects on both fish stocks and the fishermen, using the information given above.

(Total 9 marks)

Q5. Compare the efficiency of these two food chains.

Food chain **A** grain → humans

Food chain **B** grain → bullocks → humans

In your answer, make **full use** of the following data.

Food	Consumer	Percentage of available energy transferred as useful energy
Grain	Human	9%
Grain	Bullock	12%
Bullock	Human	10%

One kilogram of grain has 80 000 kJ of available energy.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total 4 marks)

##

The information in the table compares two farms. Both are the same size, on similar land, close to one another and both are equally well managed.

Name of farm	Activity	Energy value of food for humans produced in one year	Number of people whose energy requirements can be met by this food
Greenbank Farm	Grows food for humans	3285 million kJ	720
Oaktree Farm	Grows food for animals on the farm which become food for humans	365 million kJ	80

- (a) Use this information to work out the average daily human energy requirement in kilojoules (kJ) per day.

.....

.....

Energy requirement = kJ/day

(2)

(b) The figures show that farms like Greenbank Farm can be nine times more efficient at meeting human food energy requirements than farms such as Oaktree Farm.

(i) The food chain for Greenbank Farm is:

vegetation → humans

What is the food chain for Oaktree Farm?

.....

(1)

(ii) Explain why Greenbank Farm is much more efficient at meeting human food energy requirements.

.....

.....

.....

.....

.....

(3)

(c) The human population has been increasing rapidly throughout this century. It is now about 6 billion and is still growing. What does the information in this question suggest about likely changes in the human diet which may need to occur during the coming century? Explain your answer.

.....

.....

.....

.....

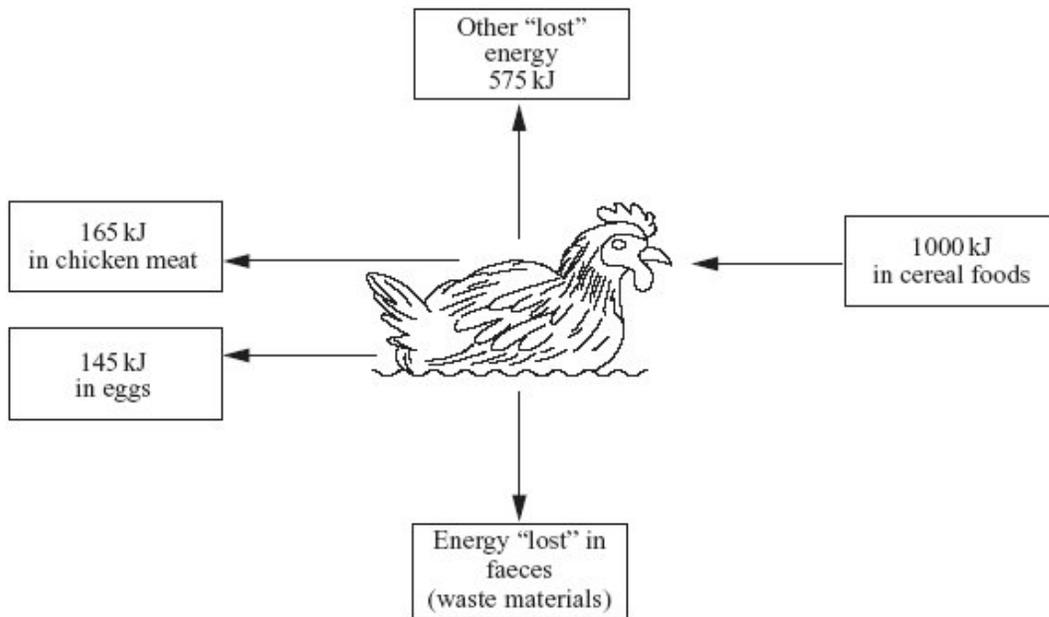
.....

.....

(4)

(Total 10 marks)

Q7. Chickens are kept as farm animals to produce food. Free-range chickens are allowed to feed in a large space outside. The diagram shows how energy supplied in food to a free-range chicken is transferred.



(a) Calculate the amount of energy "lost" in faeces.

.....

Energy "lost" = kJ

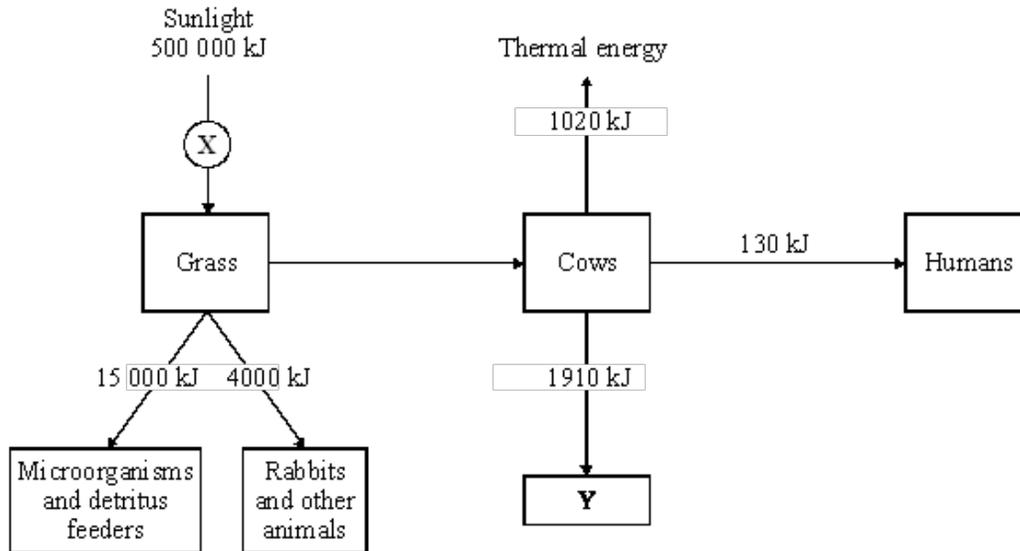
(1)

(b) Some farmers use the battery method. They keep large numbers of chickens in a small indoor space. The food yield from these chickens is higher than that from free-range chickens. Explain why, as fully as you can.

.....

(4)
 (Total 5 marks)

Q8. The diagram shows the amounts of energy that are transferred, over a period of time, through some living things in a grassland habitat.



(a) Calculate the amount of energy transferred from the grass to the cows.

.....

Amount of energy = kJ

(1)

(b) **X** is a process in plants.

(i) Calculate the amount of energy usefully transferred by process **X**.

.....

Amount of energy = kJ

(1)

(ii) Name process **X**.

.....

(1)

(c) Give **two** ways in which energy is 'lost' from the cows at **Y**.

1

2

(2)

(d) Describe how hormones can be used to improve the efficiency of producing food from plants.

.....
.....
.....
.....

(2)
(Total 7 marks)

Q9. Battery Pigs!

Some countries have battery pigs! Large numbers of pigs are kept indoors and have limited living space which restricts their movement. The temperature of their environment is carefully controlled.



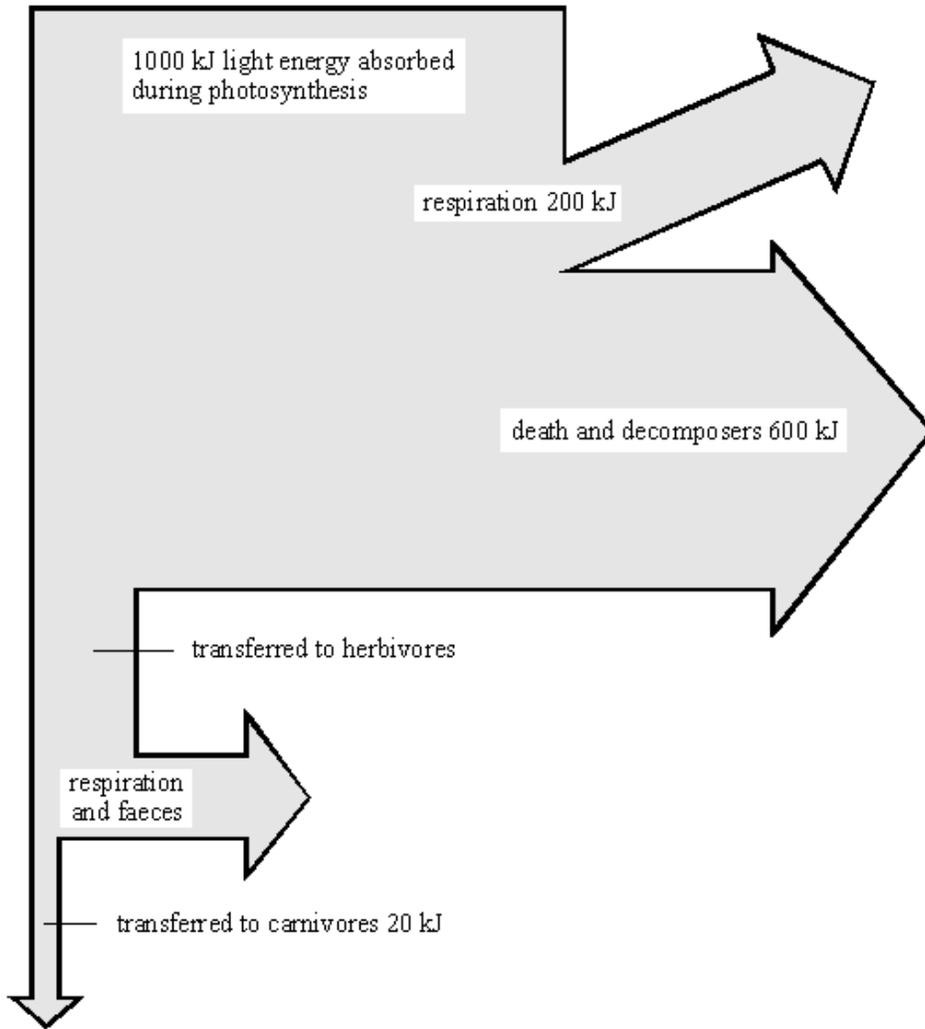
This is a way of producing food efficiently.

These pigs have their movement restricted. Explain why.

.....
.....
.....
.....

(Total 2 marks)

Q10. (a) The diagram shows what happens to each 1000 kJ of light energy absorbed by plants growing in a meadow.



Use the information from the diagram to calculate:

(i) how much energy was transferred to herbivores;

..... kJ

(1)

(ii) the percentage of the energy absorbed during photosynthesis that was eventually transferred to carnivores. Show your working.

..... %

(2)

(b) The table gives the energy output from some agricultural food chains.

FOOD CHAIN	ENERGY AVAILABLE TO HUMANS FROM FOOD CHAIN (kJ PER HECTARE OF CROP)
cereal crop \Rightarrow humans	800 000
cereal crop \Rightarrow pigs \Rightarrow humans	90 000
cereal crop \Rightarrow cattle \Rightarrow humans	30 000

Explain why the food chain *cereal crop \Rightarrow humans* gives far more energy than the other two food chains.

.....

.....

.....

.....

.....

.....

.....

.....

(3)

(c) The amounts of energy available to humans from the food chain *cereal crop \Rightarrow pigs \Rightarrow humans* can be increased by changing the conditions in which the pigs are kept.

Give **two** changes in conditions which would increase the amount of energy available. In each case explain why changing the condition would increase the available energy.

Change of condition 1

Explanation

.....

.....

Change of condition 2

Explanation

.....

.....

(4)
(Total 10 marks)

Q11. In tropical areas of the world, forests are being cut down at the rate of 150 hectares every minute of every day.

(a) Give **two** reasons why forests in tropical areas are being cut down at a high rate.

1

.....

2

.....

(2)

(b) Explain how this deforestation is affecting the composition of the atmosphere.

.....

.....

.....

.....

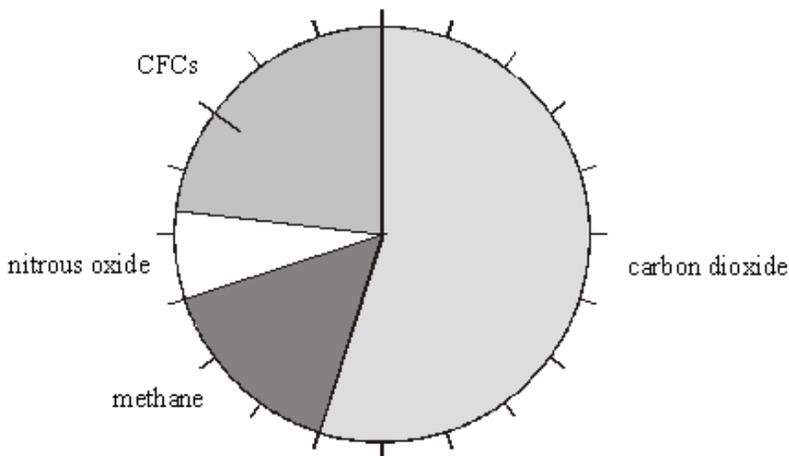
.....

.....

(5)

(Total 7 marks)

Q12. The pie chart shows the proportions of four greenhouse gases produced by human activities in the 1980s.



- (a) Calculate the percentage contribution to the greenhouse gases of methane. Show your working.

Percentage contribution %

(2)

- (b) Give **two** ways, other than respiration, by which human activities increase the proportion of carbon dioxide in the atmosphere.

1

.....

2

.....

(2)

- (c) What is the principal source of the 'human-made' methane in the atmosphere?

.....

(1)

- (d) Explain how increases in the proportion of greenhouse gases in the atmosphere lead to global warming.

.....

.....

.....

.....

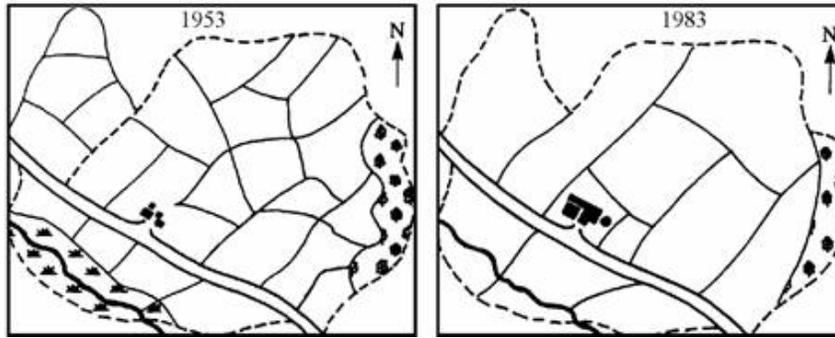
.....

.....

(3)

(Total 8 marks)

Q13. The drawings show changes to a farm between 1953 and 1983.



Key

Hedges	—
Boundary	- - -
River	—
Buildings	■ ■
Trees	⊕ ⊕
Marsh	⊕ ⊕ ⊕

The fields on the farm are separated by hedges.

(i) Give **two** major changes which were made to the land on this farm between 1953 and 1983.

- 1
-
- 2
-

(2)

(ii) How would these changes affect the number of wild animals which live on the farmland?

-
- Explain your answer.
-
-

(2)

(Total 4 marks)

Q14. Professor John Lawton researches into the problem of controlling the spread of bracken. Bracken is a fern which threatens upland farms, partly because it poses a health risk to people and animals.

Professor Lawton is waiting for government permission to release the Conservular caterpillar which feeds on the bracken.

The Secretary of State has to decide whether the Conservular caterpillar can be released.

The article printed below describes some of the problems faced by the Secretary of State.

David the caterpillar to bracken's Goliath

Yorkshire farmer Maurice Cottrill has just forked out £500 to have a helicopter hover over his land and spew out gallons of chemicals aimed at destroying one of the most pervasive and dangerous weeds known to man – bracken. In a little box in a laboratory near Ascot, Berkshire, lies a tiny caterpillar which could have done the job for nothing.

Whether or not that caterpillar and thousand of its chums will ever be let loose on the massive carpet of bracken that is sweeping over Britain at the rate of 53 square kilometres a year has to be decided by the Secretary of State for the Environment.

Weed control through the release of imported insects has never been tried in Britain before. If the Secretary of State permits the experiment, the caterpillar is in for the feast of its life, because five years of painstaking research have proved that bracken is its only food. However, is that the full story? Will the beast stop there, or will it go on, wreaking unforeseen devastation. Can scientists predict what will happen when imported insects are released into the wild?

Bracken is poisonous – more than 20 000 sheep and 1 000 cattle suffer poisoning each year. Its spores are carcinogenic, posing a threat to hill walkers. Bracken costs a depressing £4m a year to control while rendering useless grazing land valued at £5m annually. “Bracken is one factor which is leading to hill farming becoming uneconomic”, says the director of the Ramblers Association. “We are worried about that because, the more uneconomic hill farms become, the more prospect there is of the forestry industry taking over.”

The National Farmers Union are concerned about the consequences of the caterpillar getting out of control. What if it started consuming garden ferns? What if it loved potatoes? On the other hand, the caterpillar might help to preserve important uplands where wildlife flourishes when bracken is kept at bay. However, the experiment takes the scientists into unknown territory.

World-wide, 94 species of weeds have been controlled by biological releases involving 215 types of animal in 50 countries. Professor Lawson says that approximately one-third have achieved effective control and the remainder have failed.

Upland farms are artificial ecosystems, created and maintained mainly for the rearing of sheep and cattle. These farms are being threatened by the spread of bracken. Up to now the only treatment for bracken has been to use herbicides.

Use the article to explain, as fully as you can, what advice you would give the Secretary of State.

Explain the arguments for and against that lead to your decision.

You will **not** receive marks for simply copying extracts from the article.

(Total 8 marks)

Q15. (a) The world-wide use of fossil fuels has increased rapidly during this century.

(i) Give **two** reasons for the increase in the amount of fossil fuels used.

1

.....

2

.....

(2)

(ii) Give **two** effects on the environment of this increase in the amount of fossil fuels used.

1

.....

2

.....

(2)

(b) Describe and explain the long term effects of large-scale deforestation on the Earth's atmosphere.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(Total 8 marks)

Q16. Large areas of rain forest are being cleared and burnt in many parts of the world. The cleared land will often produce crops for only a few years.

(a) Explain why rain forests are being burnt to provide land for crops in many parts of the world.

.....
.....
.....
.....

(2)

(b) Explain why such cleared land will often produce crops for only a few years.

.....
.....
.....
.....

(2)

(c) Explain the effects that large-scale burning of forests may have on the Earth's atmosphere in the short and in the long term.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

(4)

(Total 8 marks)

##

The table shows the sources of some of the energy used in India between 1960 and 1970.

Year	Source of energy in millions of tonnes			
	Non-renewable fuels		Renewable fuels	
	Coal	Oil	Cow dung	Vegetable waste
1960	47	7	101	31
1965	64	10	112	34
1970	71	15	123	38

- (a) The change in the use of renewable fuels differs from that of non-renewable fuels. Calculate the percentage of renewable fuels used in 1960 and in 1970. Show clearly how you work out your final answer.

1960

.....

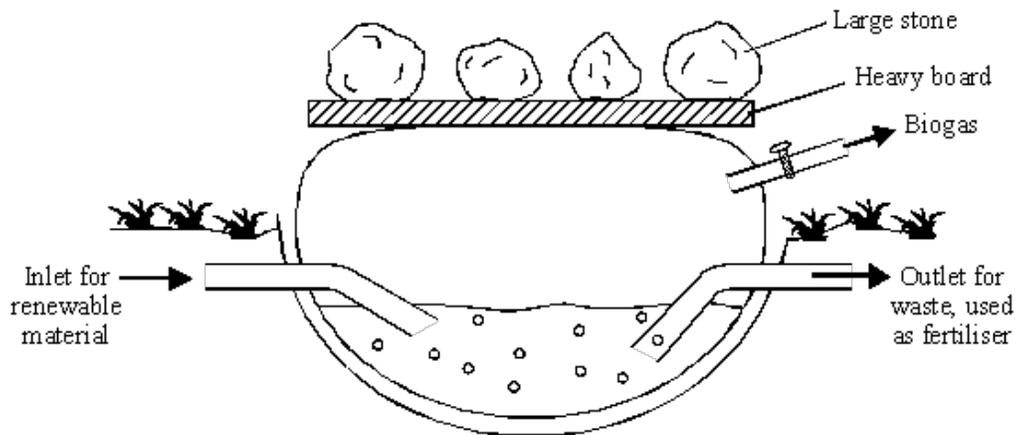
1970

.....

(3)

- (b) The Indian government suggested that villagers should make better use of renewable resources.

They introduced biogas generators. The diagram shows one type of biogas generator.



The table shows the economic costs and benefits of using this type of generator.

Feature	Cost or profit in £s
Cost of generator and fitting	250
Annual maintenance costs	40
Annual profit from gas produced	30
Annual profit from fertiliser produced	40

Evaluate the advantages and disadvantages of using this type of generator.

.....

.....

.....

.....

.....

.....

.....

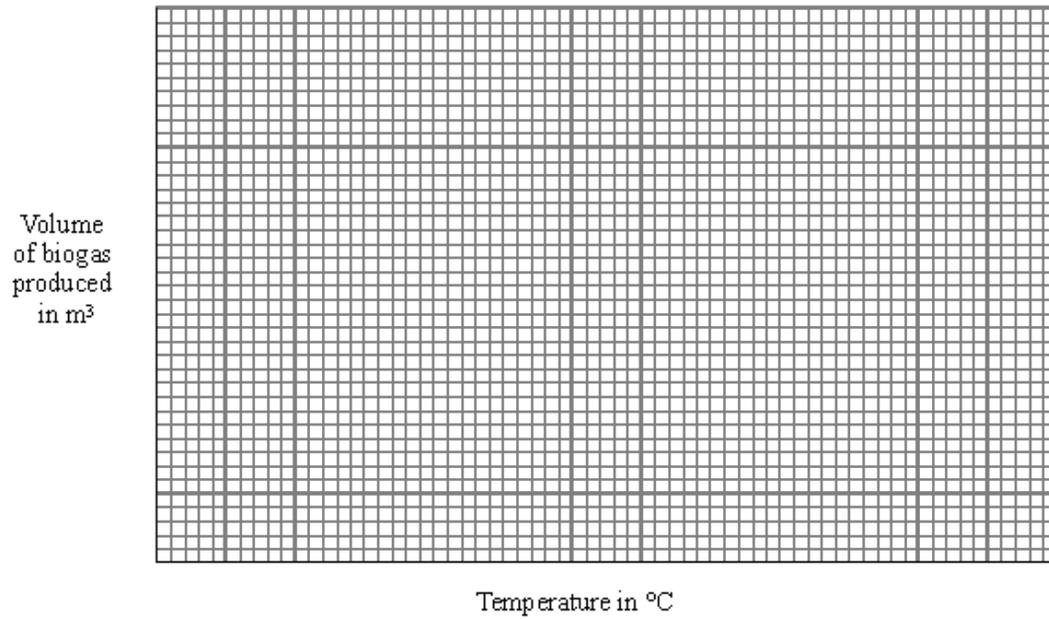
.....

(4)

(c) The table shows how temperature affects the rate of biogas production in the generator.

Temperature in °C	10	15	20	25	30	35	40
Volume of biogas produced each day in m³	0.50	0.55	1.50	1.70	3.00	3.45	3.30

- (i) Use the grid to draw a graph to show how temperature affects the rate of biogas production.



(3)

- (ii) Temperatures in India may reach over 35 °C. Explain the advantage of the generator being mainly underground.

.....

.....

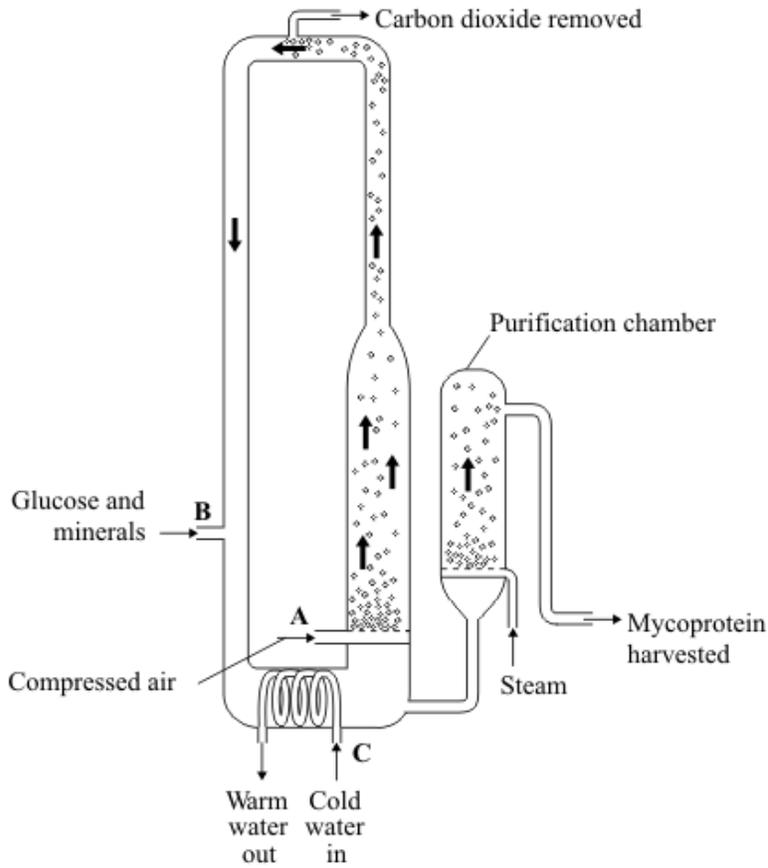
.....

.....

(2)

(Total 12 marks)

Q18. The diagram shows a fermenter. This fermenter is used for growing the fungus *Fusarium* which is used to make mycoprotein.



(a) Bubbles of air enter the fermenter at **A**.

Give **two** functions of the air bubbles.

- 1
-
- 2
-

(2)

(b) Glucose is added to the fermenter at **B**.

Explain why glucose is added.

-
-

(1)

- (c) The fermenter is prevented from overheating by the cold water flowing in through the heat exchanger coils at **C**.

Explain what causes the fermenter to heat up.

.....

(1)

- (d) It is important to prevent microorganisms other than *Fusarium* from growing in the fermenter.

- (i) Why is this important?

.....

(1)

- (ii) Suggest **two** ways in which contamination of the fermenter by microorganisms could be prevented.

1

.....

2

.....

(2)

- (e) Human cells cannot make some of the amino acids which we need. We must obtain these amino acids from our diet.

The table shows the amounts of four of these amino acids present in mycoprotein, in beef and in wheat.

Name of amino acid	Amount of amino acid per 100 g in mg			Daily amount needed by a 70 kg human in mg
	Mycoprotein	Beef	Wheat	
Lysine	910	1600	300	840
Methionine	230	500	220	910
Phenylalanine	540	760	680	980
Threonine	610	840	370	490

A diet book states that mycoprotein is the best source of amino acids for the human diet.

Evaluate this statement.

Remember to include a conclusion in your evaluation.

.....

.....

.....

.....

.....

.....

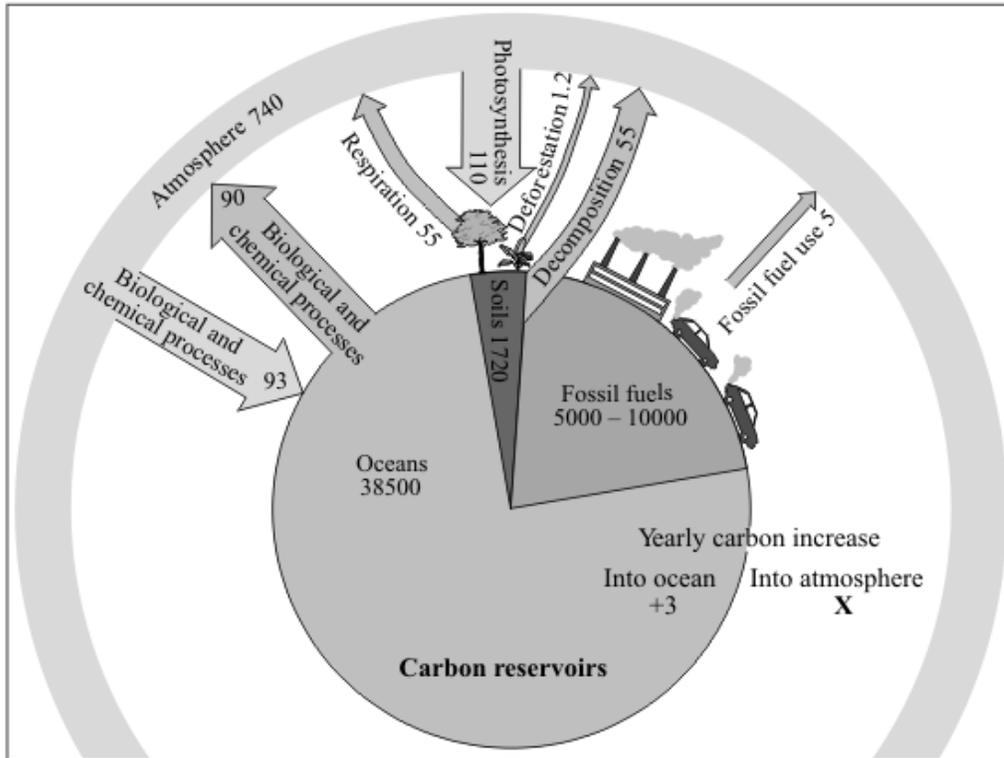
.....

.....

.....

(4)
(Total 11 marks)

Q19. The diagram shows the mass of carbon exchanged between carbon reservoirs and the atmosphere. The pie chart in the diagram shows the mass of carbon in three reservoirs: oceans, soils and fossil fuels. The figures are in billions of tonnes of carbon per year.



Reproduced by permission of Philip Allan Updates

(a) Calculate **X** (the yearly carbon increase into the atmosphere).

Show all your working.

.....

.....

.....

.....

X = billion tonnes of carbon

(2)

(b) Give **one** reason why deforestation increases the carbon dioxide concentration of the atmosphere.

.....

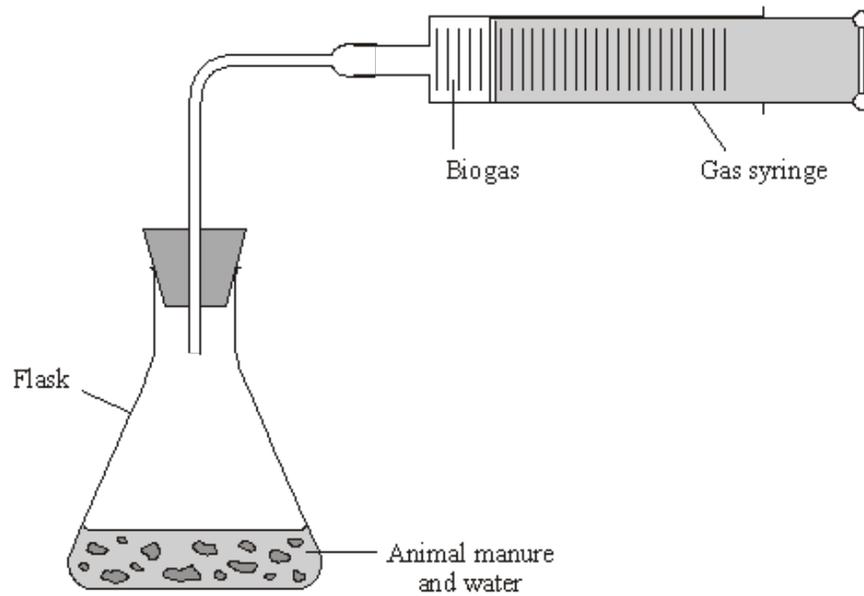
.....

(1)

(Total 3 marks)

Q21. Some students investigated the production of biogas from animal manure.

They used the apparatus shown in the diagram.



In their first investigation, the students collected the biogas in the gas syringe.

The table shows the percentage composition of the biogas.

Gas	Percentage composition
Methane	55
Carbon dioxide	40
Water vapour	5

- (a) To make the biogas a more efficient fuel, the percentages of two of the gases in the table should be reduced.

Which **two** gases should these be?

1

2

(1)

(b) The students then used the apparatus for a second investigation.

They bubbled oxygen through some fresh manure and water for one hour. They then set up the apparatus again and collected a second sample of biogas in the gas syringe.

Predict the effect of this procedure on the composition of the second sample of biogas.

Explain your answer.

.....

.....

.....

.....

.....

.....

.....

.....

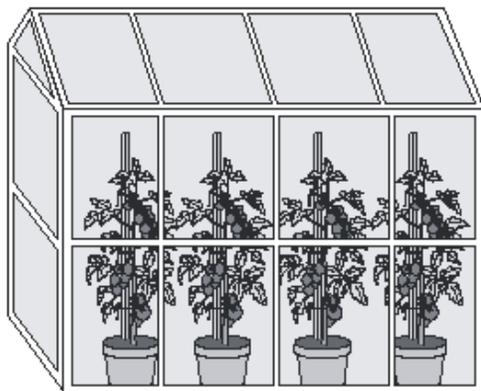
.....

.....

.....

(4)
(Total 5 marks)

Q22. In this country most tomatoes are grown in greenhouses.



(a) Suggest **one** way in which a grower could increase the yield of tomatoes from plants growing in his greenhouse.

.....

.....

(1)

(b) Large supermarkets often import tomatoes from overseas.

(i) Suggest **two** reasons why a supermarket might decide to import tomatoes rather than buy them from British growers.

1

.....

2

.....

(2)

(ii) Importing tomatoes may be more damaging to the environment than selling tomatoes grown in this country.

Explain why.

.....

.....

.....

.....

(2)

(Total 5 marks)

Q23. Producing food for humans affects the environment.

(a) Increasing the efficiency of human food production will help to feed an increasing world population.

Give **three** ways in which the efficiency of human food production can be increased.

For each of these ways explain why the efficiency of food production is increased.

1

.....

.....

2

.....

.....

3

.....

.....

(6)

- (b) Organic foods have become popular in recent years. They are grown without the use of artificial pesticides and fertilisers.

A government report in 2007 showed that the production of some organic foods is more damaging to the environment than their non-organic equivalents.

However, supporters of organic farming claim that it is better than non-organic farming in conserving biodiversity and is better for the soil.

- (i) What is meant by biodiversity?

.....

(1)

- (ii) Why is it important to conserve biodiversity?

.....

(1)

- (c) The table compares some of the effects of non-organic and organic food production on the environment.

Environmental effect and units per kilogram of production on farm	Sheep meat		Chicken		Milk	
	Non-organic	Organic	Non-organic	Organic	Non-organic	Organic
Energy used (in MJ)	23	18	12	16	2.5	1.6
Global warming potential (in grams of CO ₂ equivalent)	17 400	10 100	4750	6680	1060	1230
Freshwater pollution potential by fertiliser (in grams of phosphate equivalent)	200	584	49	86	6.3	10.3
Land use (in hectares)	0.0014	0.003	0.64	1.4	0.001	0.002

© Dr Adrian Williams Cranfield University

Use data from the table to answer these questions.

- (i) What additional data is needed to calculate which method of food production is most damaging to the environment?

.....

(1)

(ii) How would a complete change from non-organic to organic farming affect the area of land used for food production.

.....
.....

(1)

(iii) Raising sheep has a greater global warming potential than raising chickens, per kilogram of meat produced.

Suggest an explanation for this.

.....
.....
.....
.....

(2)

(iv) Give **two** ways in which global warming might affect species on a worldwide scale.

.....
.....
.....
.....

(2)

(Total 14 marks)

Q24. The design of biogas generators depends upon the climate.

Photograph 1 shows a biogas generator on a farm in India.



Indian biogas generator, © englNdia, <http://home2.btconnect.com/engindia>, 2005

(a) Describe the processes that occur in the biogas generator.

.....

.....

.....

.....

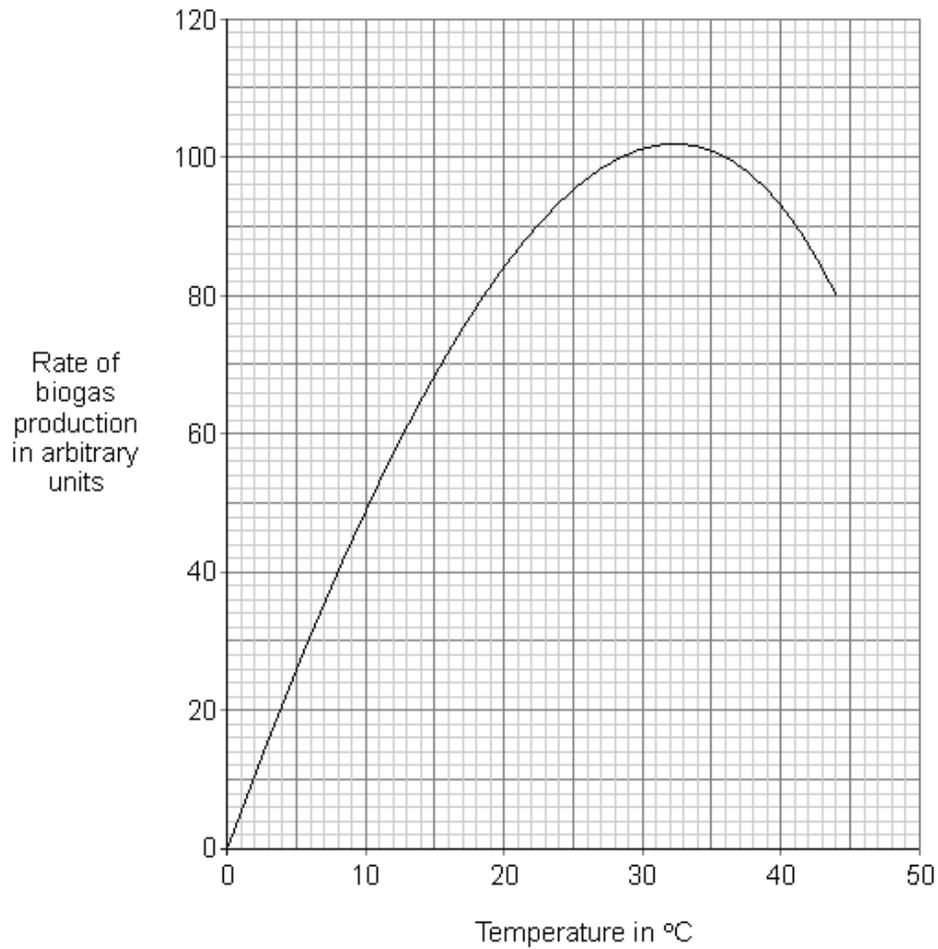
.....

.....

.....

(3)

(b) The graph shows the effect of temperature on the rate of biogas production.



Temperatures in India frequently rise to 40°C and above.

The biogas generator shown in **Photograph 1** is built mainly underground.

Use information from the graph to suggest why.

.....

.....

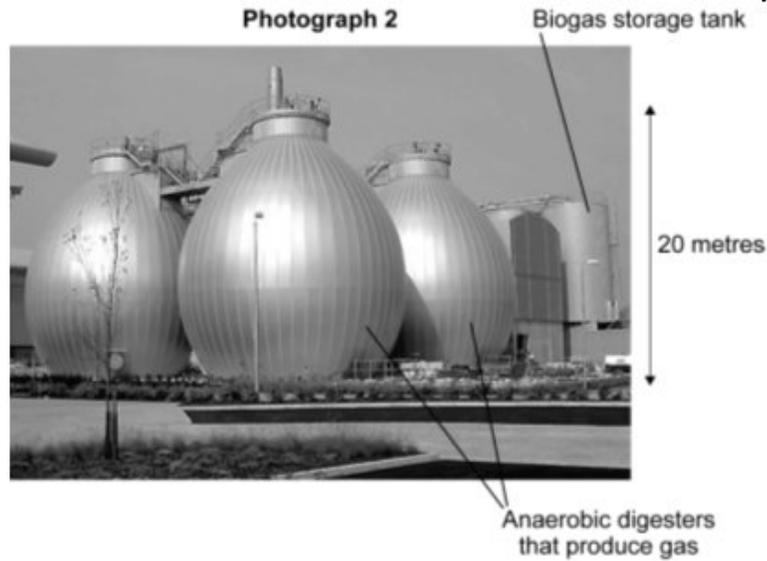
.....

.....

.....

(2)

- (c) **Photograph 2** shows a set of three biogas generators built at a sewage works in the UK in 2004.



Reading biogas generators, image courtesy of Black and Veatch Ltd

The UK biogas generator has been built with concrete walls, 60 cm thick.

Use information from the graph above to suggest why.

.....

.....

.....

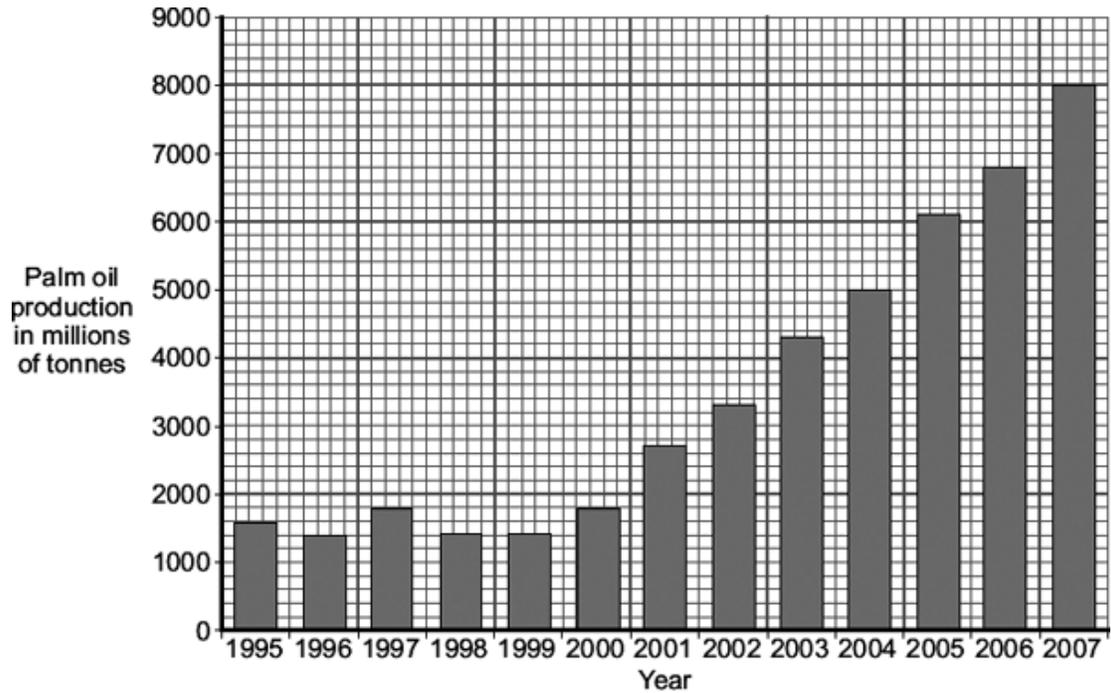
.....

.....

(2)
(Total 7 marks)

Q25. In South Asia, forests are being cleared to grow palm oil trees. The palm oil is mainly used to produce fuel for motor vehicles.

The graph shows the production of palm oil in one South Asian country.



(a) Calculate the mean increase in palm oil production per year for the five year period 2000 to 2005.

Show clearly how you work out your answer.

.....

Mean increase = millions of tonnes per year

(2)

- (b) Clearing forests and replacing the forests with palm oil trees to produce fuel for motor vehicles will affect the composition of the atmosphere.

Explain how.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(5)
(Total 7 marks)

Q26. Some scientists set up a biogas generator.

The table shows how the rate of biogas production and the composition of the biogas changed over the first 30 days.

Time in days	Rate of biogas production in cm ³ per hour	Composition of the biogas	
		Percentage of methane	Percentage of carbon dioxide
1	110	27	56
5	90	20	78
10	50	30	68
15	170	68	30
20	115	72	26
25	110	71	27
30	105	70	28

(a) (i) Name the process that produces the methane in biogas.

.....

(1)

(ii) For the first 10 days, the gas released from the generator contained a high concentration of carbon dioxide. This was because there was air in the generator when it was first set up.

Explain why the presence of air results in a high concentration of carbon dioxide in the biogas.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

(3)

- (b) The scientists concluded that it would not be profitable to collect biogas from the generator until after about 20 days.

Use the data to explain why.

.....
.....

(1)

- (c) The rate of biogas production slowed down towards the end of the investigation.

Suggest **one** reason why.

.....
.....

(1)

(Total 6 marks)

Q27. Scientists have discovered that curry spices affect sheep and cattle. Curry spices can reduce the amount of methane that grazing animals give off.

'Bad' bacteria in the animal's stomach produce methane. About 12% of the animal's food is changed into methane.

The curry spice coriander works like an antibiotic. Adding coriander to animal food reduces methane production by about 40%.

- (a) (i) Why does adding coriander to an animal's food reduce methane production?

.....
.....

(1)

- (ii) Explain **one** advantage to a farmer of adding coriander to the animal's food.

.....
.....
.....
.....

(2)

(b) Farm animals give off large amounts of methane.

Explain the effects of adding large amounts of methane to the atmosphere.

.....

.....

.....

.....

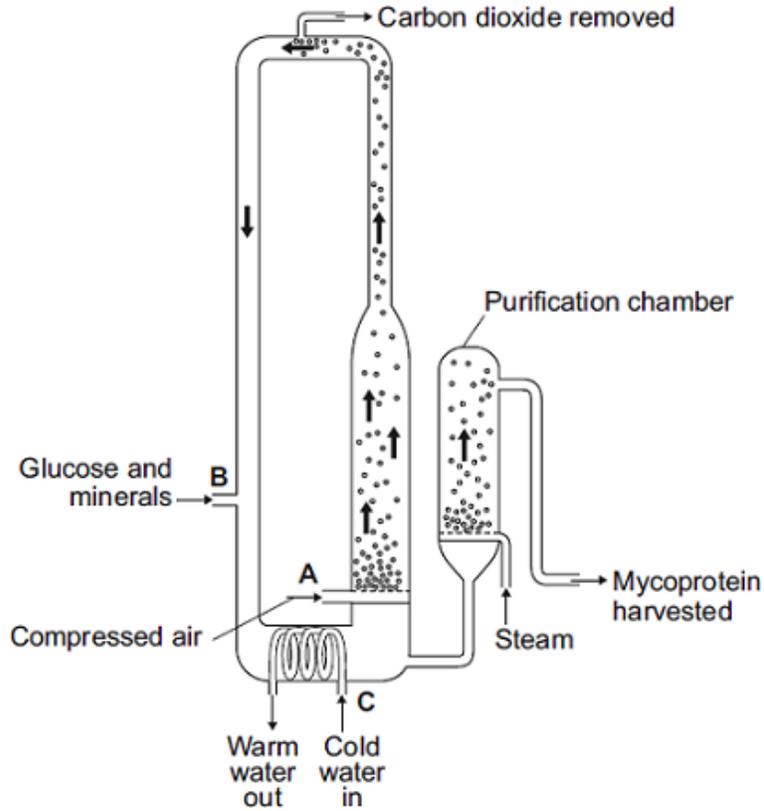
.....

.....

(3)
(Total 6 marks)

Q28. The diagram shows a fermenter. This fermenter is used for growing the fungus *Fusarium*.

Fusarium is used to make mycoprotein.



(a) Bubbles of air enter the fermenter at **A**.

Give **two** functions of the air bubbles.

- 1.....

 2.....

(2)

(b) Why is glucose added to the fermenter?

-

(1)

(c) The fermenter is prevented from overheating by the cold water flowing in through the heat exchanger coils at **C**.

Name the process that causes the fermenter to heat up.

-

(1)

(d) It is important to prevent microorganisms other than *Fusarium* growing in the fermenter.

(i) Why is this important?

.....
.....

(1)

(ii) Suggest **one** way in which contamination of the fermenter by microorganisms could be prevented.

.....
.....

(1)

(e) Human cells cannot make some of the amino acids which we need. We must obtain these amino acids from our diet.

The table shows the amounts of four of these amino acids present in mycoprotein, in beef and in wheat.

Name of amino acid	Amount of amino acid per 100 g in mg			Daily amount needed by a 70 kg human in mg
	Mycoprotein	Beef	Wheat	
Lysine	910	1600	300	840
Methionine	230	500	220	910
Phenylalanine	540	760	680	980
Threonine	610	840	370	490

A diet book states that mycoprotein is the best source of amino acids for the human diet.

Evaluate this statement.

Remember to include a conclusion in your evaluation.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)
(Total 10 marks)

