

Monday 17 June 2013 – Afternoon

A2 GCE HUMAN BIOLOGY

F224/01 Energy, Reproduction and Populations

Candidates answer on the Question Paper.

OCR supplied materials:
None

Other materials required:

- Electronic calculator
- Ruler (cm/mm)

Duration: 1 hour 15 minutes



Candidate forename		Candidate surname	
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Centre number							Candidate number				
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INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **60**.



Where you see this icon you will be awarded marks for the quality of written communication in your answer.

- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- This document consists of **20** pages. Any blank pages are indicated.

Answer **all** the questions.

- 1 (a) Couples who have tried unsuccessfully to conceive may seek the advice of a qualified health professional. Health professionals may suggest that a fertility treatment such as IVF would be appropriate.

The stages of IVF treatment are listed in Table 1.1 but are not in the correct order.

Stage	Description of stage
A	ultrasound used to locate ripe follicles
B	oocytes placed in special medium and maintained at body temperature
C	embryos allowed to develop for 3 days
D	sperm added to each oocyte separately
E	sperm obtained from male
F	FSH given to woman to cause several follicles to mature at the same time
G	oocytes removed from follicles just before ovulation
H	after 16–20 hours oocytes checked for fertilisation
J	healthy embryos transferred to uterus

Table 1.1

Complete Table 1.2 to show the **correct** order of the stages in IVF treatment.

Two of the stages have been done for you.

Correct order	Letter of stage
1	F
2
3
4
5	E
6
7
8
9

[3]

Table 1.2

(b) Some of the embryos produced as a result of IVF treatment may be frozen and then stored.

Suggest reasons **why** embryos may be stored.

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..... [2]

- (c) Some people are concerned about the widespread availability and use of fertility treatments such as IVF.

Outline the **objections** some people may have about providing fertility treatment for couples who are unable to conceive naturally.

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..... [3]

[Total: 8]

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Question 2 begins on page 6

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- 2 Many different molecules are involved in the process of aerobic respiration in cells. Some of these molecules are found either in the cytoplasm or in the mitochondria. Other molecules can move between the cytoplasm and the mitochondria.

Fig. 2.1 shows a photomicrograph of a mitochondrion in a cell.



Fig. 2.1

- (a) Table 2.1 summarises the role and the precise location or locations in the cell of some molecules involved in aerobic respiration.

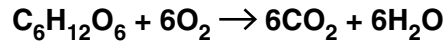
Molecule	Role in cell	Precise location(s) in cell
	synthesis of ATP using chemiosmosis	inner membrane of mitochondria
	acts as a hydrogen acceptor	matrix of mitochondria only
triose phosphate	converted to pyruvate	
	converted to ATP by substrate level phosphorylation	
pyruvate decarboxylase	breakdown of pyruvate to release carbon dioxide	

Table 2.1

Complete Table 2.1 by inserting **either** the name of the molecule **or** the precise locations of the molecule in the cell or **both**. [7]

(b) Many different molecules can be broken down in cells by aerobic respiration.

- When a carbohydrate such as glucose is broken down aerobically, the number of oxygen molecules used is equal to the number of carbon dioxide molecules produced.
- The aerobic breakdown of glucose can be summarised by the equation



- The *respiratory quotient* (**RQ**) for carbohydrate is 1.

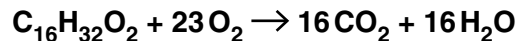
(i) State the precise role of oxygen in the breakdown of glucose by aerobic respiration.

.....

 [1]

(ii) The RQ for the breakdown of a fatty acid by aerobic respiration is always less than 1.

Palmitic acid is a fatty acid found in coconut oil. The aerobic breakdown of palmitic acid can be summarised by the following equation:



Show, by calculation, that the RQ obtained for the breakdown of palmitic acid by aerobic respiration is less than 1.

Your answer **must** show relevant working.

Give your answer to one decimal place.

RQ = [2]

[Total: 10]

- 3 (a) Most of the oxygen transported in the blood is carried in erythrocytes (red blood cells) in the form of oxyhaemoglobin.

During an endurance race such as a marathon, the body's demand for oxygen is very high. The properties of haemoglobin ensure that the quantity of oxygen delivered to the tissues is matched to their oxygen requirements.

Fig. 3.1 shows the oxygen dissociation curve for adult haemoglobin.

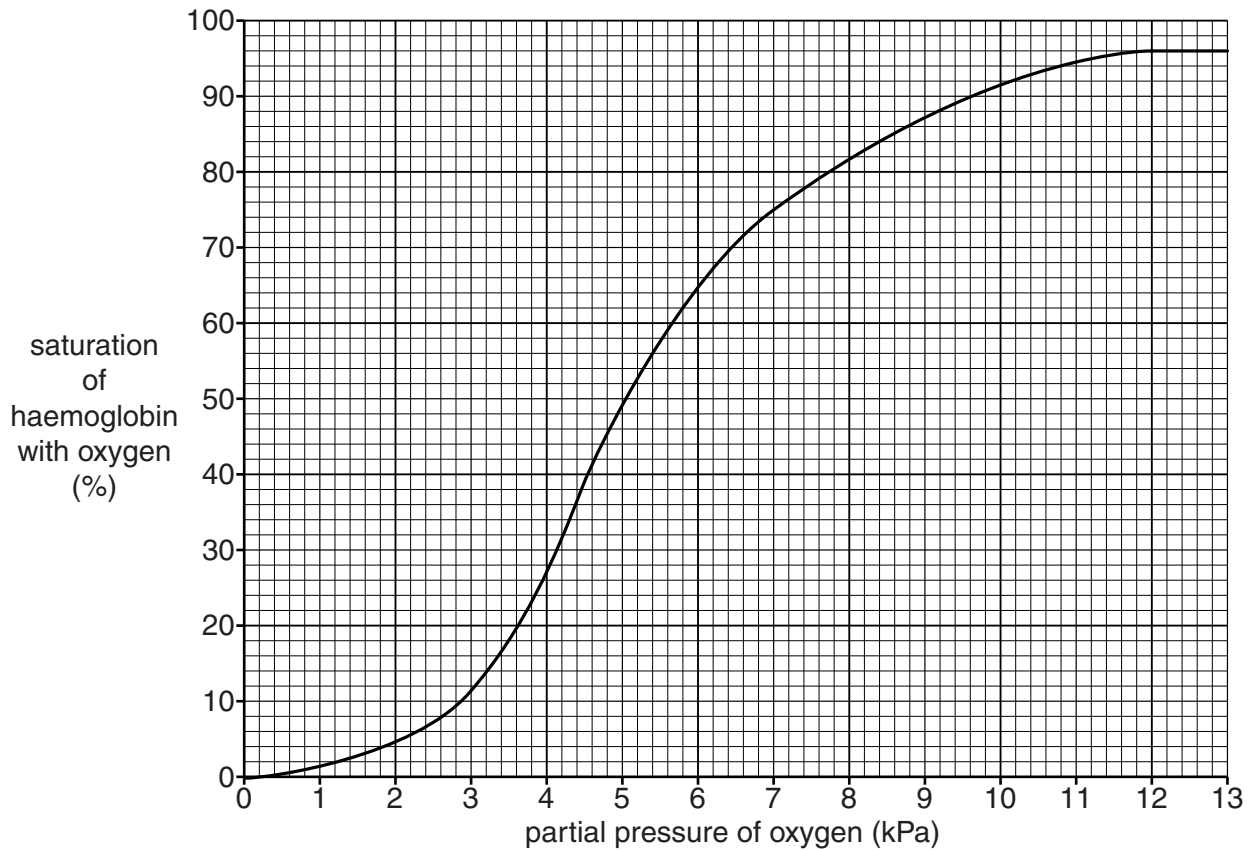


Fig. 3.1

Name a **tissue** in the body of a runner where the partial pressure of oxygen (pO_2) is likely to fall to 4 kPa during a race.

..... [1]

(b) Fig. 3.2 is a simplified diagram of an alveolus and a capillary.

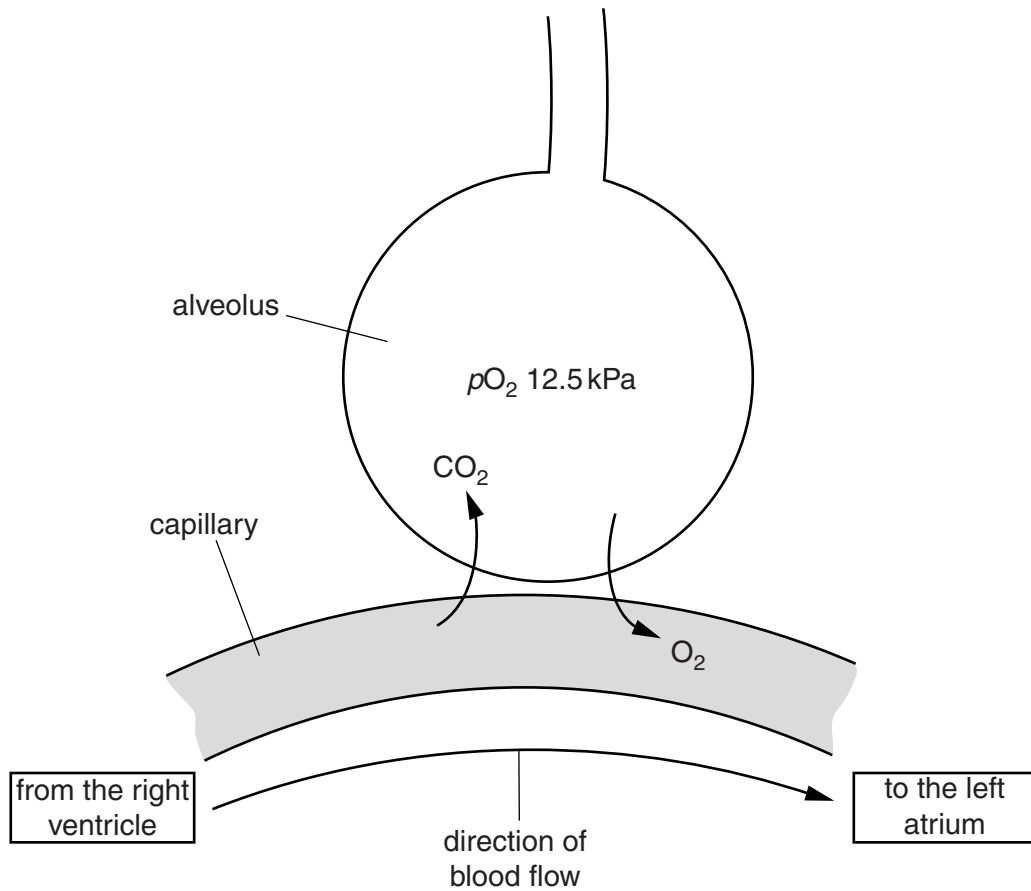


Fig. 3.2

(i) Using the information in Fig. 3.1 **and** Fig. 3.2, state the percentage saturation of haemoglobin in blood returning to the left atrium of the heart.

Answer =% [1]

(ii) Explain why the percentage saturation of haemoglobin remains high in blood flowing through the arteries and arterioles.

.....

 [1]

(c) Some marathon events take place in locations that are higher than sea level.

- At sea level, atmospheric pressure is approximately 100 kPa.
- At 2000 metres above sea level, atmospheric pressure falls to approximately 80 kPa.

Using Fig. 3.1, explain why a marathon runner is able to run at 2000 metres above sea level.

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..... [2]

(d) An increase in the partial pressure of **carbon dioxide** ($p\text{CO}_2$) in tissues lowers the affinity of haemoglobin for oxygen.

(i) **Draw**, on **Fig. 3.1 below**, the oxygen dissociation curve for haemoglobin if the $p\text{CO}_2$ is high.

The answer to this question should be drawn on Fig. 3.1 below. [2]

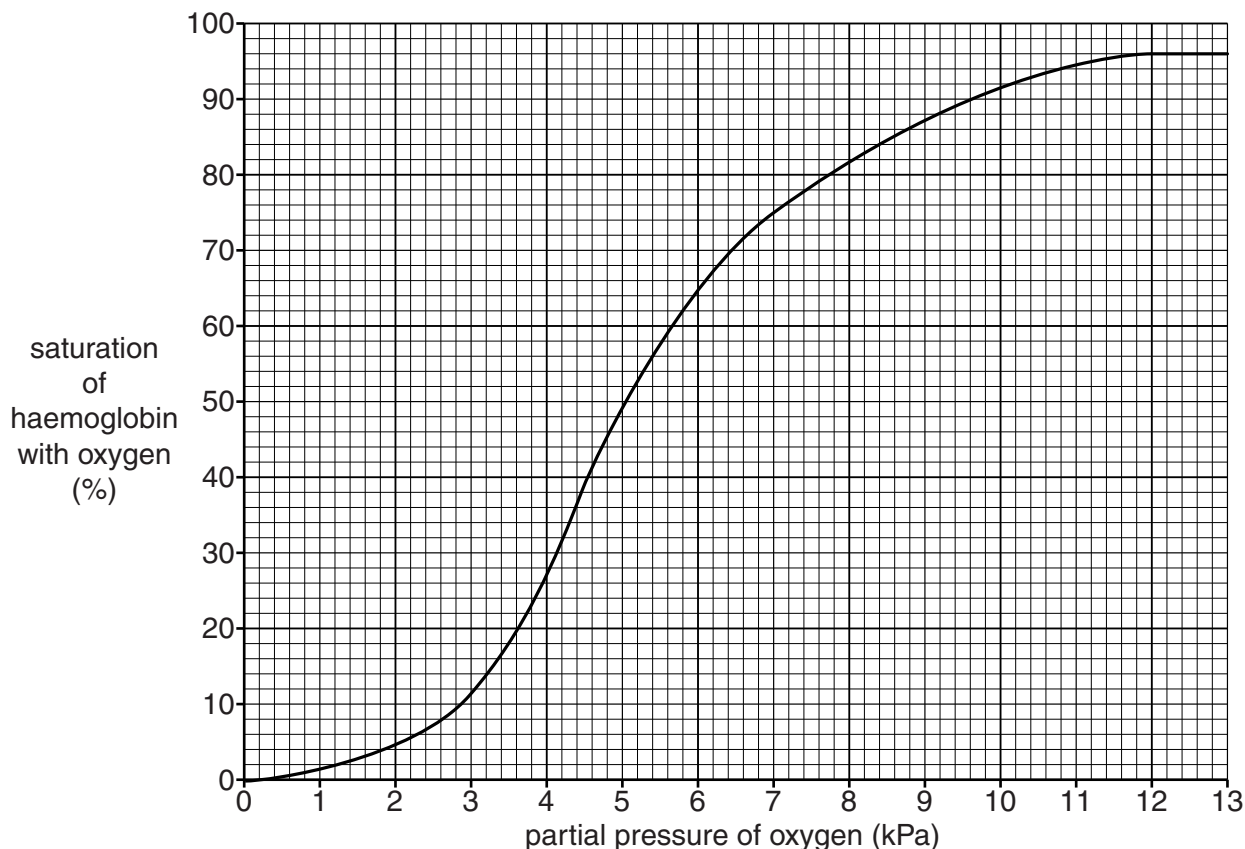


Fig. 3.1

(ii) What name is given to the effect of an increase in $p\text{CO}_2$ on the oxygen dissociation curve for haemoglobin?

..... [1]

(iii) Explain the advantage to a marathon runner of the change in the oxygen dissociation curve when the $p\text{O}_2$ in his tissues drops to 4 kPa.

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..... [1]

(e) The training which marathon runners undertake leads to changes in some of their cells. These changes result in the cells having an increased capacity to carry out aerobic respiration.

One such change in cells is an increase in the concentration of myoglobin.

Suggest the role of myoglobin in cells.

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..... [1]

[Total: 10]

- 4 Thanet Earth is the United Kingdom's largest and most technologically advanced greenhouse complex. Artificial light is used to grow crop plants such as tomatoes, peppers and cucumbers. These are all grown using a system known as **hydroponics**.

The hydroponics system does not use plants rooted in soil. Instead, plant roots are irrigated using a solution containing the mineral salts that plants require for growth. These mineral salts include nitrates which act as the plants' source of nitrogen.

- (a) Crop plants carry out photosynthesis in order to synthesise useful organic compounds such as carbohydrates. During photosynthesis, oxygen is also produced.

Photosynthesis consists of a light-dependent stage and a light-independent stage.

Fig. 4.1 outlines how the two stages of photosynthesis are linked.

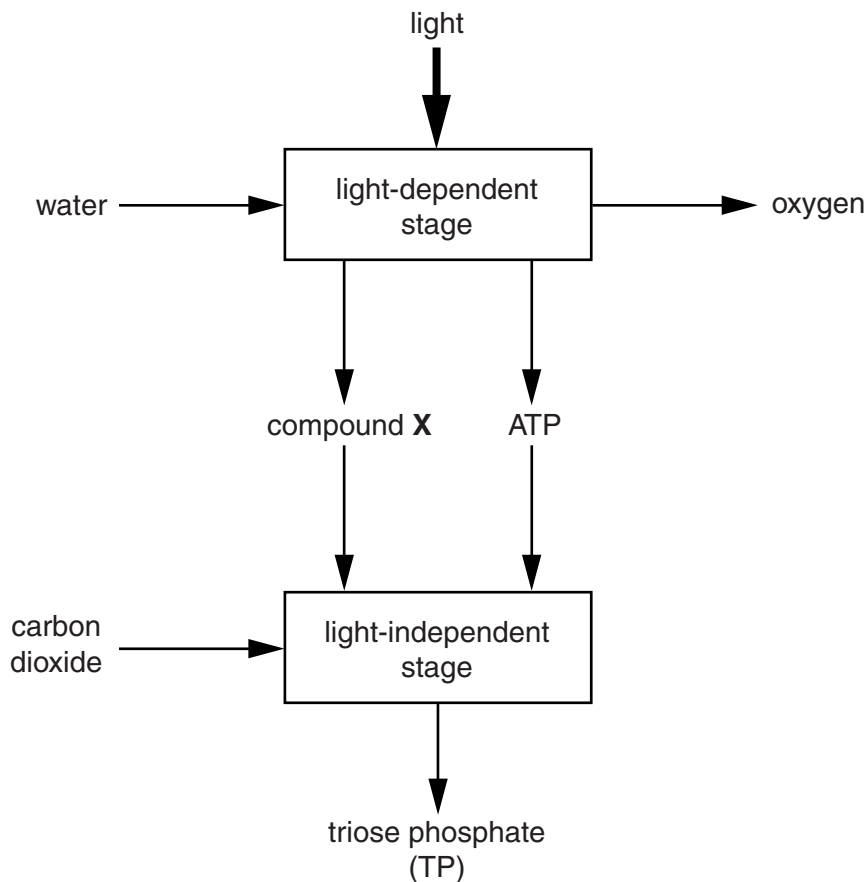


Fig. 4.1

(i) Using Fig. 4.1, identify compound **X**.

compound **X** [1]

(ii) Triose phosphate is a three-carbon sugar that can be used to make more complex molecules such as glucose. Glucose molecules are then linked to produce polysaccharides such as starch.

Name the **type** of reaction which links glucose molecules together to produce polysaccharides.

..... [1]

(iii) Not all the glucose produced by plant cells is converted into complex organic molecules.

Explain why.

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..... [1]

(b) Plant cells can use the nitrate in the hydroponic mineral solution to make amino acids. These amino acids can then be used to synthesise the proteins a plant needs for its growth.

(i) Suggest why the synthesis of some amino acids and proteins also requires the addition of **sulfate**.

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..... [1]

(ii) Suggest **one** complex organic molecule which a plant makes that requires nitrate but does **not** require sulfate.

..... [1]

- (c) Growing crops on a large scale using hydroponics is an example of intensive food production.

Discuss the damage that could be caused to the environment if there was a leakage of the mineral solution used by the grower into the surrounding environment.



In your answer you should use the appropriate technical terms, spelled correctly.

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[Total: 9]

(b) In the events leading up to fertilisation, sperm will bind to the protective layer or **zona pellucida** of the secondary oocyte.

- The zona pellucida is a membrane which surrounds and protects the secondary oocyte.
- Proteins on the cell surface membrane of the sperm attach the sperm to the zona pellucida.

(i) Suggest which component of the zona pellucida membrane acts as a binding site for the proteins on the cell surface membrane of the sperm.

..... [1]

(ii) The acrosome of the sperm contains enzymes that allow the sperm to penetrate the zona pellucida.

What type of enzyme may be contained in the acrosome?

..... [1]

(c) Research is currently being carried out into methods of manipulating testosterone concentrations in men. This could lead to the development of a male contraceptive pill.

Clinical trials have been carried out on a potential male contraceptive pill which contains a synthetic form of testosterone that lowers sperm count. Volunteers were screened for a number of criteria in order to see if they would be eligible for recruitment to the trial.

Some of the criteria required for eligibility are given below:

- male
- aged 18 to 45
- in a stable relationship and not planning a pregnancy in the next 2 years.

Those participants who were selected to take part in the trial were required to give several sperm samples before being allocated to either a control group or to one of the treatment groups.

(i) Suggest **one** additional criterion which should be met when screening volunteers for the clinical trial.

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..... [1]

(ii) Why are several sperm samples required from each participant before the start of the clinical trial?

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- (iii) Suggest a method that may have been used to allocate participants to each of the groups in the clinical trial.

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..... [1]

- (iv) Suggest **one** factor in the male participants, **other than a lower sperm count**, that could be used to evaluate the success of the male contraceptive pill in the clinical trial.

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..... [1]

- (d) In a condition known as Congenital Adrenal Hyperplasia (**CAH**), the adrenal glands produce large amounts of testosterone which is released into the bloodstream.

In 2009, an 18 year old **female** athlete won the 800 m race in the athletics world championships, easily beating the former world record. It has been suggested that she had CAH.

- (i) What positive effects could a high blood concentration of testosterone have on a **female** athlete?

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..... [2]

- (ii) Testosterone is a larger molecule than glucose but, unlike glucose, it can enter cells directly without the need for transport proteins.

Suggest why testosterone molecules can enter cells directly.

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..... [1]

[Total: 15]

- 6 (a) The Office for National Statistics recently reported that death rates in the population of England and Wales had reached the lowest levels ever recorded.

Fig. 6.1 shows how death rates in England and Wales have changed between 1901 and 2009.

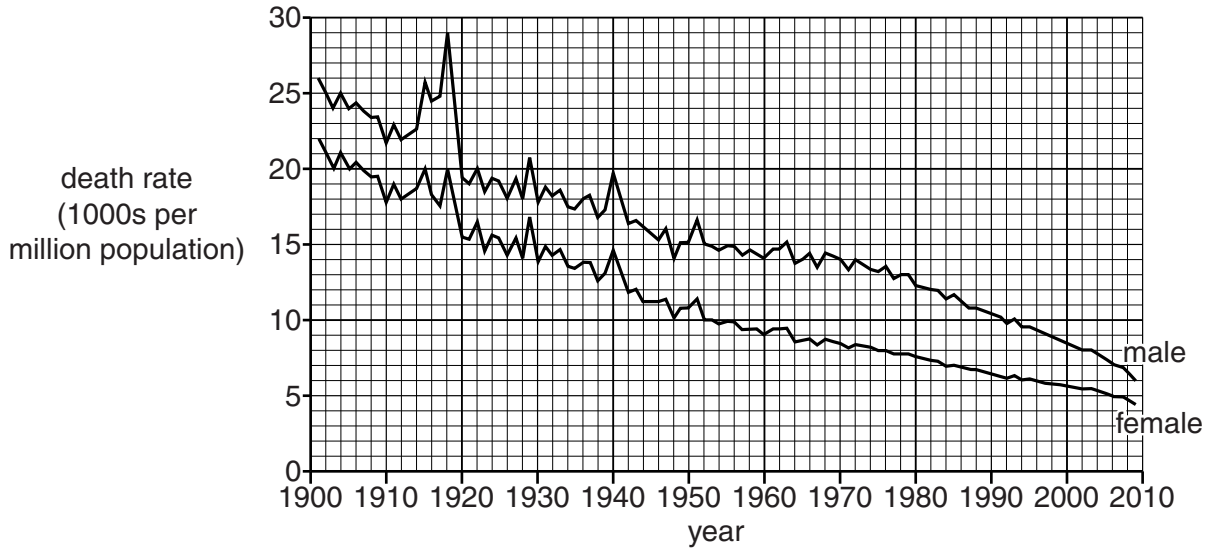


Fig. 6.1

- (i) Using Fig. 6.1, **compare** the death rates of men and women in England and Wales between 1901 and 2009.

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- (ii) Peaks on the graph indicate sudden increases and decreases in death rates. Sudden increases in death rates for both men and women can be seen around the time of World War 1 (1914–1918) and World War 2 (1939–1945).

Suggest **one** further reason for sudden increases in death rate other than casualties of war.

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(iii) Suggest reasons, other than the absence of major wars, why fewer peaks appear on the graph from approximately 1950 onwards.

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(b) Changes in death rates have contributed to an increase in the population of economically developed countries such as the United Kingdom.

A rise in population in an economically developed country will have a greater impact on the global carbon footprint compared to a rise in the population of a less economically developed country.

(i) State what is meant by the term *carbon footprint*.

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..... [1]

(ii) Discuss ways in which a **government** can reduce the carbon footprint of a country.

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..... [2]

[Total: 8]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines across the rest of the page, providing space for writing answers.



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