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**OXFORD CAMBRIDGE AND RSA EXAMINATIONS
ADVANCED SUBSIDIARY GCE**

G642

SCIENCE

Science and Human Activity

WEDNESDAY 9 JUNE 2010: Morning

DURATION: 1 hour 45 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

Candidates answer on the Question Paper

OCR SUPPLIED MATERIALS:

None

OTHER MATERIALS REQUIRED:

Electronic Calculator


Ruler (cm/mm)

READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes on the first page.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **ALL** the questions.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your Candidate Number, Centre Number and question number(s).

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 **100**.
- You are advised to show all the steps in any calculations.
-  Where you see this icon you will be awarded marks for the quality of written communication in your answer.

This means, for example, you should:

- ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear;
- organise information clearly and coherently, using specialist vocabulary when appropriate.
- You may use an electronic calculator.

AS SCIENCE RELATIONSHIPS SHEET

pressure = force ÷ area

**energy transferred =
mass × specific heat capacity × temperature rise**

density = mass ÷ volume

wavenumber = 1 / wavelength

speed = frequency × wavelength

energy = Planck constant × frequency

current = charge ÷ time

power = voltage × current

power loss = (current)² × resistance

Answer ALL the questions.

1 This question is about protein structure and function.

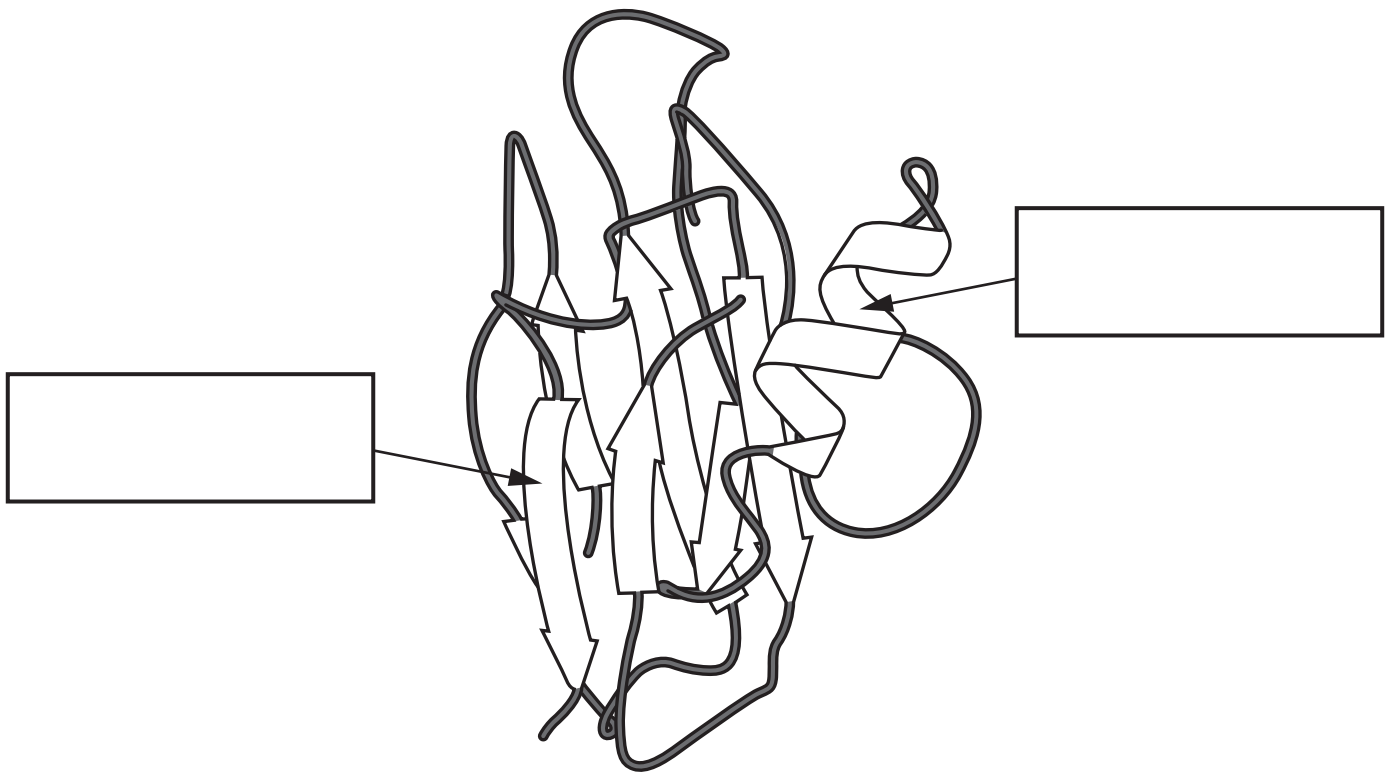
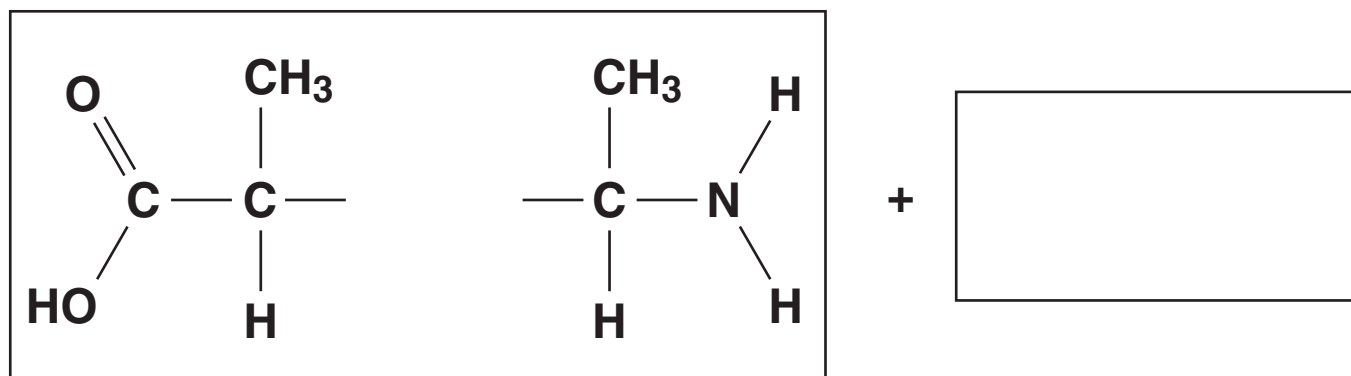
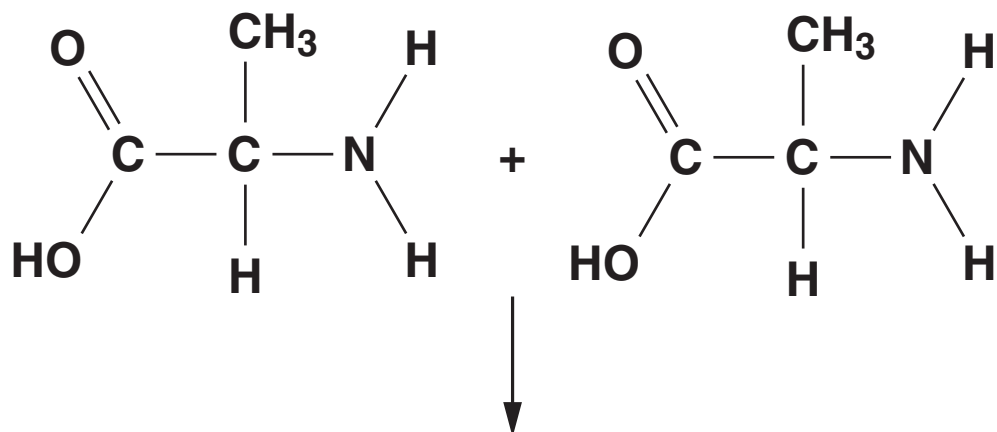


Fig. 1.1

- (a) (i) Fig. 1.1 shows a ribbon diagram of a protein. Label the TWO types of secondary structure in Fig. 1.1. [2]

(ii) Two amino acids are shown below. Show the TWO products when the dipeptide is formed.

[3]



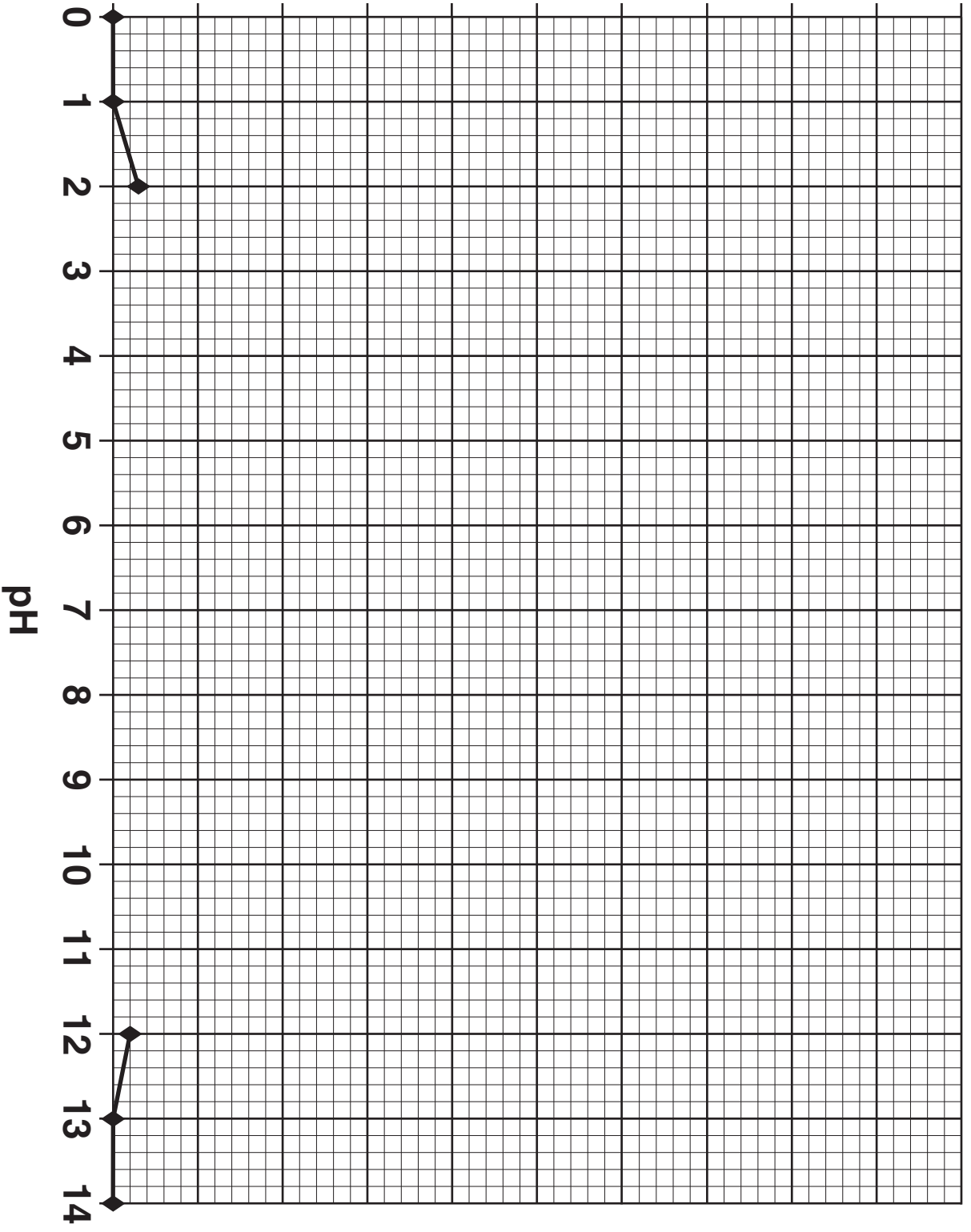
- (b) The activity of the enzyme chymotrypsin was measured over a range of pH values. The results are shown in Table 1.1.**

Table 1.1

| pH of solution | percentage activity of chymotrypsin |
|-----------------------|--|
| 0 | 0 |
| 1 | 0 |
| 2 | 3 |
| 3 | 9 |
| 4 | 27 |
| 5 | 57 |
| 6 | 89 |
| 7 | 98 |
| 8 | 78 |
| 9 | |
| 10 | 21 |
| 11 | 8 |
| 12 | 2 |
| 13 | 0 |
| 14 | 0 |

- (i) Complete the graph opposite using Table 1.1. Some of the points have been plotted for you. Draw an appropriate line of best fit. [3]**
- (ii) Use your graph to estimate the percentage activity of the enzyme at pH 9. [1]**

activity in
arbitrary
units



(c) (i) Explain what is meant by the *tertiary structure* of an enzyme.

[2]

- (ii) The data shown suggests that the optimum activity for chymotrypsin is somewhere between pH 6.5 and 7. Explain in detail why the enzyme has zero activity at very high and very low pH.



In your answer, you should make clear how your explanation links with the evidence.

[6]

[Total: 17]

2 This question is about pressure.

(a) (i) Use the molecular kinetic theory of gases to explain how a gas exerts a pressure on the walls of a container.

[2]

(ii) The pressure of a gas in a sealed container is $100\,000\text{ N m}^{-2}$ at 20°C . Calculate the TOTAL FORCE exerted by the gas on a wall of the container. This wall has a surface area of 0.5 m^2 .

total force = _____ unit _____ [3]

- (iii) The temperature of the gas inside the container now increases. With reference to the kinetic theory of gases, describe AND explain what happens to the pressure inside the sealed container. (Assume the volume of the container remains constant.)**

[3]

(b) The pressure of air masses above the surface of the Earth influences the weather.

(i) Explain how the warming effect of the sun produces a low pressure region.

[2]

(ii) Explain why low pressure regions are often associated with wet weather.

[2]

[Total: 12]

- 3 This question concerns the causes and problems associated with acid rain. One of the causes of acid rain is the extraction of metals.

Zinc can be extracted from its ore in a TWO STEP PROCESS represented by the following reactions.



(a) The oxidation number of sulfur in ZnS is -2.

- (i) Calculate the oxidation number of sulfur in SO_2 .

oxidation number = _____ [1]

- (ii) Explain how we know that sulfur dioxide is oxidised in reaction 1.

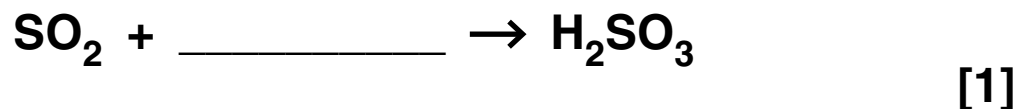
_____ [1]

- (iii) Identify which substance is being REDUCED in reaction 2 and explain your choice.

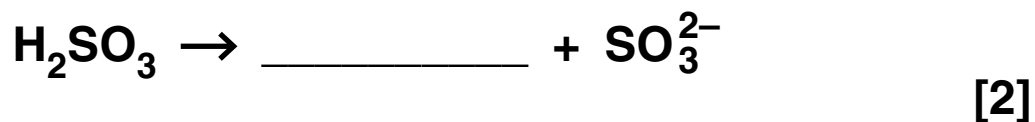
_____ [2]

(b) Sulfur dioxide reacts in the atmosphere to form an acid.

(i) Complete the equation below to show the formula of the other substance involved in the reaction.



(ii) H_2SO_3 is an acid. Complete the equation below to show the dissociation of H_2SO_3 .



(c) Give THREE problems associated with acid rain AND for each example, suggest how the problems can be minimised.

[6]

[Total: 13]

4 This question concerns the Earth's ozone layer.

(a) The formation of ozone in the upper atmosphere is a photochemical reaction that takes place in steps 1 and 2 as shown below.



followed by



(i) Explain what is meant by a *photochemical reaction*.

_____ [1]

(ii) Ultraviolet light of wavelength 200 nm ($1 \text{ nm} = 1 \times 10^{-9} \text{ m}$) can cause an oxygen molecule to split into two oxygen atoms as shown in step 1. Use a suitable equation to calculate the frequency of this ultraviolet light given that its speed is $3.0 \times 10^8 \text{ m s}^{-1}$. Show your working.

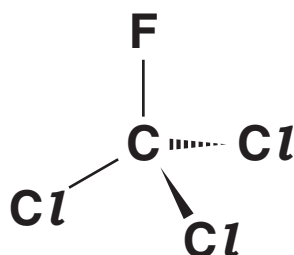
frequency = _____ unit _____ [4]

(b) Chlorofluorocarbons (CFCs) are thought to have been responsible for the depletion of the ozone layer in recent times. CFCs can react with sunlight to produce RADICALS.

(i) What is meant by the term *radical* in this context?

_____ [1]

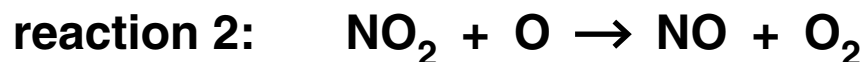
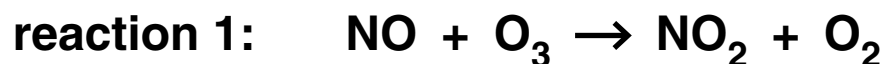
(ii) Give the formula of a radical that could be generated by the interaction of sunlight with a molecule of CFC-11.



CFC-11

formula = _____ [1]

(c) Another molecule that has been shown to contribute to ozone depletion is nitrogen monoxide (NO) which acts as a catalyst. The reactions are shown in the equations below.



(i) Explain what is meant by a *catalyst*.

[2]

(ii) Use the equations for the reactions 1 and 2 to explain why nitrogen monoxide is described as a CATALYST in the decomposition of ozone.

[2]

[Total: 11]

5 This question is about the methods, techniques and ethical issues involved in genetic engineering.

(a) Select words from the list below to complete the passage.

ADENINE

AMINO ACIDS

GUANINE

HYDROGEN

IONIC

NUCLEAR MEMBRANE

NUCLEUS

QUARTET

RIBOSOMES

THYMINE

TRANSCRIBED

TRANSLATED

TRIPLET

URACIL

Genetic information in plant and animal cells is stored in the _____ .

Chromosomes are structures in the cell in which the organism's genetic code is stored. The code is stored in the form of a _____

base code. The DNA bases are held together by _____ bonds and these

bonds ensure that cytosine always pairs up with _____ . When proteins are

synthesised, DNA is first transcribed into RNA in which the DNA base thymine is replaced by

_____ . RNA is then transported to the cell cytoplasm where the code is

_____ into protein molecules by cell organelles called _____ .

[7]

(b) On Monday April 30th 2001 the following item appeared on a news website.

GM TOMATO TO FIGHT DISEASE

Scientists have developed a genetically modified tomato that could be used to keep people healthy.

They believe the fruit could even help to ward off heart disease and cancer.

Using gene technology they were able to increase levels of beneficial chemicals called flavonols in tomato peel.

Flavonols are powerful antioxidants, chemicals that fight disease by neutralising harmful oxygen molecules that circulate in the body, damaging tissues and accelerating the ageing process.

Epidemiological studies can be used to assess the safety of genetically modified foods.

How might a team of scientists go about showing that the genetically modified tomatoes are safe for consumption?

You should include ideas about METHODOLOGY, types of EVIDENCE and possible ETHICAL ISSUES in your answer.



In your answer, you should make clear how the steps in the method are sequenced.

how you would carry out the study _____

types of evidence _____

possible ethical issues associated with the method _____

[9]

[Total: 16]

6 This question concerns atomic structure and isotopes of phosphorus (P).

(a) Explain the meaning of the term *isotopes*.

[2]

(b) (i) Complete Table 6.1 below for the isotope $^{31}_{15}\text{P}$.

Table 6.1

| SUB ATOMIC PARTICLE | NUMBER OF PARTICLES |
|---------------------|---------------------|
| proton | |
| neutron | |
| electron | |

[3]

(ii) Phosphorus-32 ($^{32}_{15}\text{P}$) decays by β emission.

Complete the equation for this process below.



[2]

(iii) Phosphorus-32 has a radioactive half life of 14.3 days.

Calculate how long it would take 1.00 g of this isotope to decay to a mass of 6.25×10^{-2} g.

Show your working.

length of time = _____ days [3]

(iv) Suggest why a sample of phosphorus-32 would be labelled as a BIOLOGICAL HAZARD and what precautions would need to be taken in handling a sample.

[4]

[Total: 14]

7 With fossil fuel resources running out, other possible sources of energy need to be considered in the future. This question is about some alternative sources of energy.

Many scientists believe that the long term global energy needs will require the exploitation of renewable energy resources such as the following:

- **solar energy**
- **wind energy**
- **wave energy**
- **tidal energy**

(a) Explain what is meant by the term *renewable energy source*.

[1]

(b) Choose THREE of the examples of renewable energy resources shown above and discuss the ADVANTAGES and DISADVANTAGES, other than cost, of using these energy sources to generate a reliable energy source.

[6]

(c) In the future, scientists hope to make use of **NUCLEAR FUSION** reactors.
Current nuclear power stations make use of the energy generated by **NUCLEAR FISSION**.

(i) Explain what happens in the processes of *nuclear fusion* and *nuclear fission*.

nuclear fusion _____

nuclear fission _____

_____ [4]

(ii) Nuclear reactions in the centre of the Sun generate energy that is transmitted to the surface of the Earth. In what form is **MOST** of the energy transmitted to the Earth's surface?

_____ [1]

- (iii) The Sun also generates cosmic rays such as high energy protons and electrons.
Why are these rays potentially harmful?

[2]

- (iv) What is responsible for minimising the impact of these rays on the Earth's surface?

[1]

- (v) Elements heavier than helium can be made at the Sun's core.
Complete the equation below for the formation of ${}^7_3\text{Li}$.



[2]

[Total: 17]

END OF QUESTION PAPER



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