Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
|---|---|
| | |

**Pearson Edexcel Level 3 GCE**

Centre Number | Candidate Number

**Time** 2 hours 30 minutes

**Paper reference** **9BI0/03**

# Biology B

## Advanced

## PAPER 3: General and Practical Principles in Biology

**You must have:**
Scientific calculator, HB pencil, ruler

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You may use a scientific calculator.
- In question(s) marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically showing how the points that you make are related or follow on from each other where appropriate.

## Information

- The total mark for this paper is 120.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

## Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- Good luck with your examination.

*Turn over*


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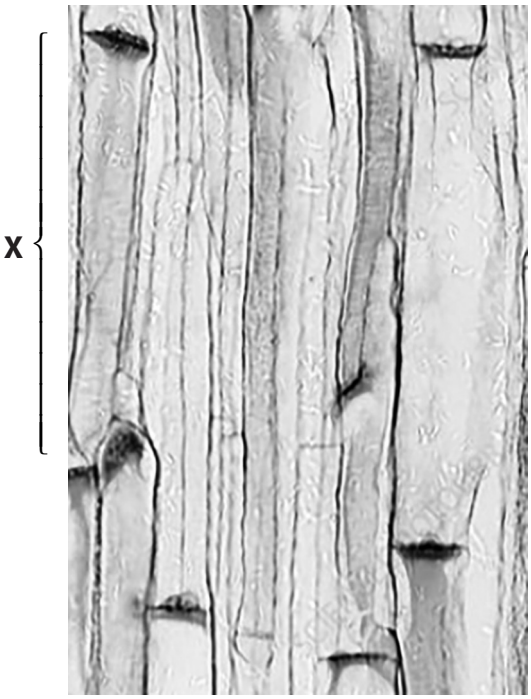
**Answer ALL questions.**

**Write your answers in the spaces provided.**

**1** Plant stems contain xylem and phloem, tissues specialised for transport.

The photomicrograph shows a longitudinal section of phloem tissue.




(a) (i) Draw the cell labelled **X**.

**(2)**

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(ii) Explain how phloem tissue is adapted for its function.

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(b) State why stains, such as methylene blue, are sometimes used when preparing a microscope slide.

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**(Total for Question 1 = 6 marks)**

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**2** (a) Compare and contrast the central nervous system and the peripheral nervous system.

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(b) During the First World War, some soldiers received head wounds that damaged one side of the cerebellum.

One soldier said

*'The movements of my left hand are done subconsciously but I have to think out each movement of my right arm.'*

(i) State one function of the cerebellum.

**(1)**

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(ii) State the part of the brain the soldier used to think about moving his right arm.

**(1)**

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(iii) Explain why this soldier had problems moving his right arm.

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**(Total for Question 2 = 7 marks)**

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**3** Anthocyanin is a purple pigment found in a range of vegetable plants.

The photograph shows some carrots from a variety called Purple Haze.

(a) Describe how you would investigate the effect of temperature on the permeability of the membranes in the root cells of these purple carrots.

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(b) The anthocyanins in purple carrots are used as antioxidants in the food industry.

Purple Haze carrots with a mass of 750g contain 1265.25 mg of anthocyanin.

Calculate the percentage of anthocyanin in these carrots.

Give your answer to two decimal places.

**(2)**

Answer .....

(c) Purple cauliflower plants also contain anthocyanins.

Cauliflowers can be light purple, dark purple or white.

The photograph shows a dark purple cauliflower.

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The colour in cauliflowers is controlled by a single gene with two alleles.

Purple colour is controlled by the allele Pr.

White colour is controlled by the allele pr.

In an investigation, dark purple cauliflowers were crossed with pure bred white cauliflowers.

The F1 generation cauliflowers were all light purple in colour.

(i) State the genotype of the F1 generation.

**(1)**

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(ii) The F1 generation was then self-fertilised to produce the F2 generation.

The numbers observed (*O*) in the F2 generation were:

31 white cauliflowers, 52 light purple and 20 dark purple cauliflowers.

It was concluded that the purple colour in cauliflowers is controlled by a single gene with two codominant alleles.

State the expected (*E*) number of each of the three phenotypes in the F2 generation.

**(2)**

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(iii) Calculate the value for Chi squared using these results.

Use the formula for Chi squared:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

**(3)**

Answer .....

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(iv) The table shows some critical values for Chi squared.

| Degrees of freedom | *p* value | | | | |
|---|---|---|---|---|---|
| | **0.900** | **0.500** | **0.100** | **0.050** | **0.010** |
| 1 | 0.016 | 0.455 | 2.706 | 3.841 | 6.635 |
| 2 | 0.211 | 1.386 | 4.605 | 5.991 | 9.210 |
| 3 | 0.584 | 2.366 | 6.251 | 7.815 | 11.345 |
| 4 | 1.064 | 3.357 | 7.779 | 9.488 | 13.277 |

Explain why the conclusion that colour in cauliflowers is controlled by a single gene with two codominant alleles is likely to be valid.

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**(Total for Question 3 = 16 marks)**

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**4** A survey was carried out to compare the biodiversity in different areas of a village.

The photograph shows a children's playing field in this village.

(a) Quadrats placed in the playing field showed predominantly grass with a few dandelion species, ribbed plantains, yarrow and clover. No animal species were observed.

The biodiversity of this playing field was low.

(i) Explain the reasons why the biodiversity of this playing field was low.

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(ii) The photograph shows a path in a woodland nature reserve near the playing field in this village.

After surveying the playing field, a survey of the woodland reserve was carried out using the following method:

- quadrats were placed at various intervals either side of the path
- plant species were counted in the quadrats
- animal species were counted at regular intervals along the path.

The table shows the results of this survey.

| | Species | Number |
|---|---|---|
| **Plant** | Dock | 10 |
| | Thistle | 10 |
| | Hawthorn | 6 |
| | Wild cherry | 2 |
| | Hazel | 5 |
| | Yarrow | 5 |
| **Animal** | Meadow brown butterfly | 2 |
| | Shield bug | 4 |
| | Beetle | 20 |
| | Honeybee | 20 |
| | Dragonfly | 4 |
| | Spider | 5 |

Calculate the biodiversity index for this woodland nature reserve.

Use the formula

$$D = \frac{N(N-1)}{\Sigma n(n-1)}$$

**(3)**

Answer .....

(iii) It was suggested that the biodiversity index calculated from this survey was an underestimate.

Criticise the method used in the survey of the woodland nature reserve.

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(b) Honeybees are important pollinators of flowers.

Surveys have suggested that butterflies, ladybirds, beetles, flies and dragonflies are also important pollinators of flowers.

A recent report has suggested that a large increase in honeybees kept in towns and cities could affect biodiversity.

Explain how the increase in honeybees in towns and cities could affect biodiversity.

**(2)**

**(Total for Question 4 = 14 marks)**

**5** The photographs show leaves from six species of plant.

Daffodil

Frogbit floating on water

Sunflower

Maize

Oak tree

Pea

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In an investigation into transpiration, a survey was carried out to measure the distribution of stomata on leaves.

The table shows the results of this investigation.

| Plant species | Density of stomata in leaf surface / number per $mm^2$ | |
|---|---|---|
| | Upper epidermis | Lower epidermis |
| Beech tree | 0 | 340 |
| Daffodil | 65 | 68 |
| Frogbit (floating leaf) | 89 | 0 |
| Maize | 52 | 58 |
| Oak tree | 0 | 450 |
| Pea | 100 | 220 |
| Sunflower | 85 | 156 |
| Sycamore tree | 0 | 860 |

(a) Analyse the data and the photographs to explain the distribution of the stomata.

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(b) As part of this investigation, the effect of light on the transpiration rate of seven-day-old maize seedlings was measured.

The transpiration rate of maize seedlings placed in dim light was measured every 30 minutes for 3.5 hours. Extra illumination was then added and the transpiration rate again measured every 30 minutes for another 3.5 hours.

The graph shows the results of this investigation.

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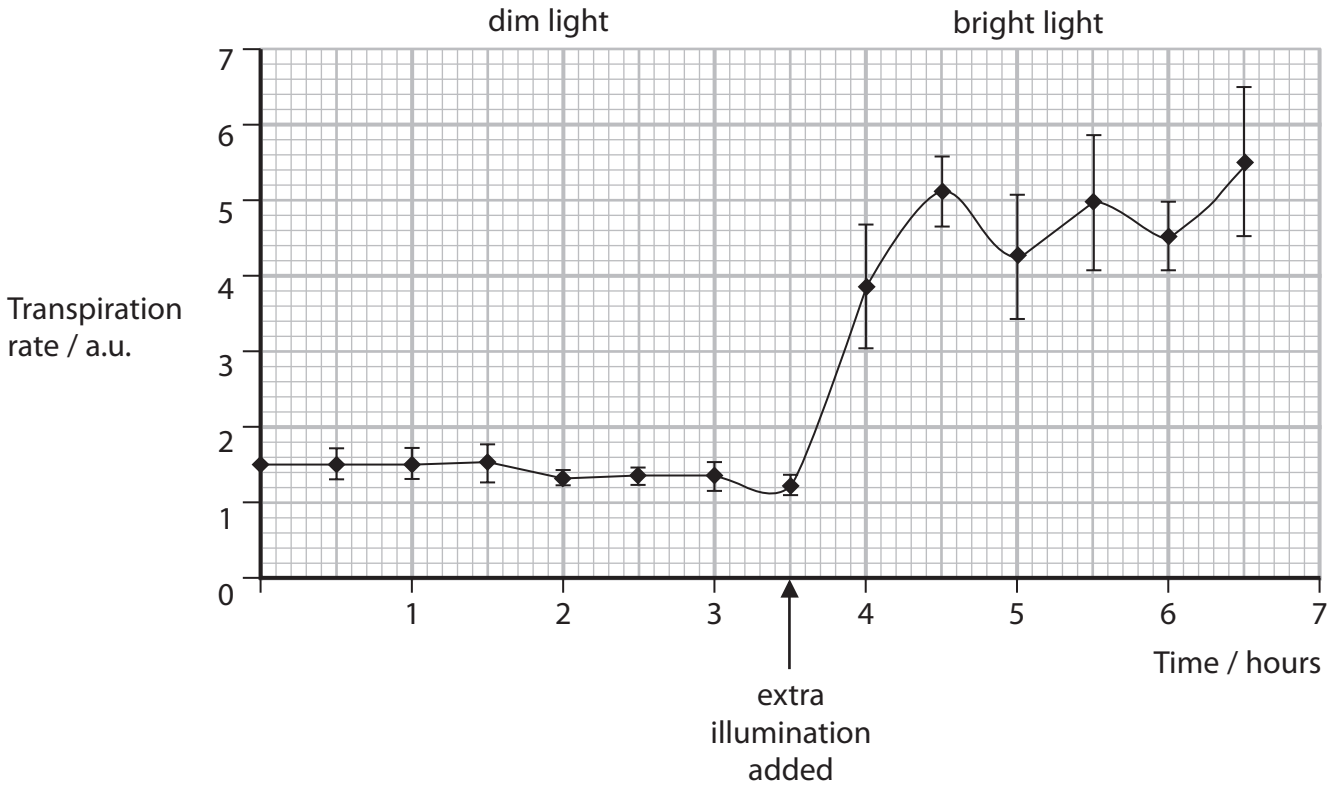


(i) Calculate the approximate percentage increase in the transpiration rate due to the extra illumination.

**(2)**

Answer .....

(ii) Explain two factors that should have been controlled in this investigation.

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**(Total for Question 5 = 9 marks)**

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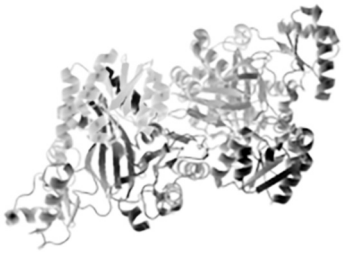
**6** Acetyl CoA is produced in the link reaction when pyruvate is broken down.

The photograph shows a molecule of the enzyme acetyl CoA carboxylase.



This enzyme is involved in the conversion of acetyl CoA into fatty acids.

The enzyme is activated by citrate.

Citrate does not bind at the active site.

Citrate is produced in the Krebs cycle.

The enzyme is inhibited by long chain fatty acyl CoA molecules.

Fatty acyl CoA molecules have a longer carbon chain than acetyl CoA.

(a) (i) Analyse the information to explain how the activity of the enzyme acetyl CoA carboxylase is controlled.

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(ii) Explain why inhibitors of this enzyme may be useful in treating obesity in humans.

**(2)**

(b) The enzyme acetyl CoA carboxylase has a different structure in bacteria.

The enzyme in bacteria is made of several polypeptide subunits whereas in humans, the enzyme is one large polypeptide.

Inhibitors of the bacterial enzyme are being developed to treat bacterial infections.

Explain why inhibitors of the bacterial enzyme may be useful when treating bacterial infections.

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**(Total for Question 6 = 9 marks)**

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**7** A student investigated the effect of the concentration of sodium chloride solution on blood.

The student set up six test tubes, each with a different concentration of sodium chloride solution.

Five drops of blood were added to each test tube.

The appearance of the solutions was then recorded.

Samples of each solution were observed using a light microscope.

The table shows the results of this investigation.

| Concentration of sodium chloride (%) | Appearance of solution after blood was added | Observation with light microscope |
|---|---|---|
| 3.0 | very cloudy | cells seen with shrunken edges |
| 1.0 | very cloudy | cells seen |
| 0.9 | very cloudy | cells seen |
| 0.7 | slightly cloudy | cells seen |
| 0.5 | cloudy at first, then went clear | no cells seen |
| 0.3 | clear | no cells seen |

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(a) Analyse the data to comment on the effect of the concentration of sodium chloride solution on blood.

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(b) The student then investigated the effect of using glucose solutions and sucrose solutions, instead of sodium chloride solutions.

The appearance of the solutions was recorded and samples were observed using a light microscope.

When the concentration of glucose solution was below 3%, the solution was clear and no blood cells could be seen. When the concentration of glucose solution was above 3%, the solution was cloudy and blood cells could be seen.

When the concentration of sucrose solution was below 6%, the solution was also clear and no blood cells could be seen. When the concentration of sucrose solution was above 6%, the solution was cloudy and blood cells could be seen.

Explain the differences in the effects of the solutions of glucose and sucrose.

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(c) (i) State the part of the brain responsible for osmoregulation.

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(ii) Explain how, on a very hot day, the brain ensures that the water potential of the blood remains constant.

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**(Total for Question 7 = 12 marks)**

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**8** Cysteine proteases are enzymes found in fruits such as pineapples.

When a protease enzyme is added to fat-free skimmed milk, the milk turns from cloudy to clear.

(a) Devise an investigation to find the optimum temperature for the activity of the enzyme cysteine protease found in pineapples.

**(6)**

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(b) Cysteine proteases are also found in the predatory bacterium *Bdellovibrio bacteriovorus* (BvB).

These bacteria are harmless to humans but prey on Gram negative bacteria.

(i) Give two differences between Gram negative and Gram positive bacteria.

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(ii) The cell of the predatory BvB is 1 μm in length and can swim 100 times its length per second.

Calculate the swimming speed of this bacterial cell in mm $s^{-1}$.

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Answer .....

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(iii) The BvB bacteria have been described as 'living antibiotics'.

Explain why the BvB bacteria might be useful in the future for treating bacterial infections.

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**(Total for Question 8 = 12 marks)**

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**9** Gilbert's potoroo is one of the most critically endangered species in the world.

Gilbert's potoroo was thought to be extinct until one was found in 1994.

It is thought that there are only 70 individuals.

The photograph shows a potoroo and its pouched baby feeding on berries.

The map shows the only part of Australia where Gilbert's potoroo is found.

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The diet of Gilbert's potoroo is about 90% fungi.

Analysis has shown that the fungal spores are spread in the faeces of the potoroos.

These spores then germinate.

(a) Explain the advantage to the ecosystem of fungal spores being spread by potoroos.

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(b) In 1994, there were only 20 Gilbert's potoroo individuals, 12 of which were in a captive colony.

A captive breeding programme was set up using:

- four adult females and one young female
- one adult male, two young males and one young male still in its mother's pouch.

(i) Explain why allele frequencies may cause problems in this population of potoroos.

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(ii) Foxes and feral cats, which are predators of potoroos, were introduced into Australia by settlers.

The photograph shows a feral cat with its prey.

The Australian government is using poisoned sausages in an attempt to kill 2 million feral cats by 2020.

The sausages contain chunks of kangaroo meat combined with chicken fat, herbs, spices and a poison.

The content of the sausages was based on flavours irresistible to cats.

The poison used is produced by the Swan River pea plant that is found in Western Australia. Other Australian plants that contain the poison are: *Acacia*, Wedge Peas and *Nemcia*.

This poison is a natural toxin that biodegrades rapidly and the native wildlife in Australia has evolved natural resistance to it.

A group of 160 000 people in Australia have signed a petition against the plan to poison feral cats.

Discuss whether the plan to poison feral cats is justified.

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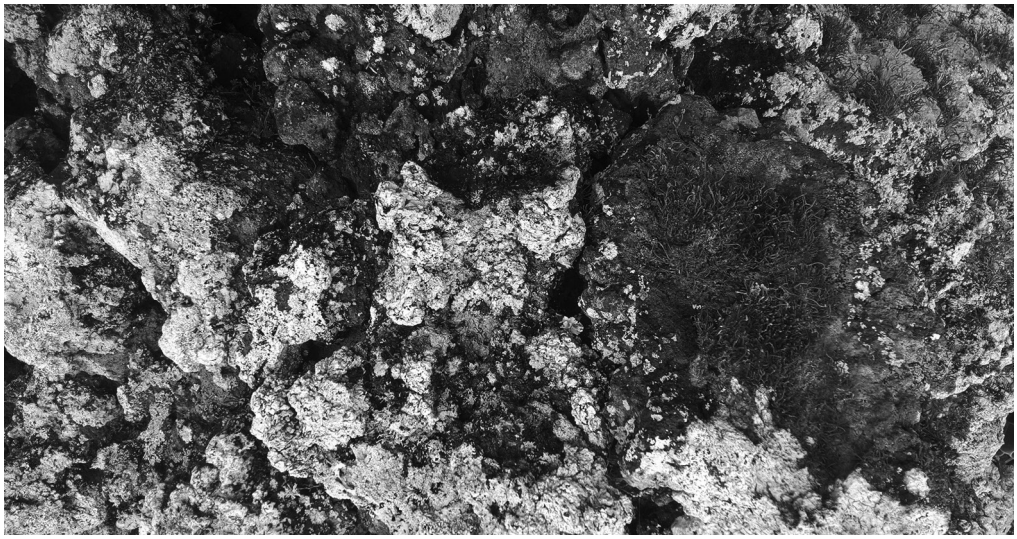
**(Total for Question 9 = 14 marks)**

**10** Lanzarote is a volcanic island in the Atlantic Ocean. It lies near the coast of West Africa.

The photograph shows lichens growing on volcanic rock in Lanzarote.



Lichens are organisms composed of a fungus and algae living together.

Lichens colonise bare rock.

(a) Explain how colonisation of bare rock by lichens can result in succession over long periods of time.

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(b) Devise an investigation to show how the lichen distribution is affected by a named abiotic factor.

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**(Total for Question 10 = 10 marks)**

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**11** White clover plants provide a rich source of nitrogen for cattle when grown with grass plants in fields.

The photograph shows a clover plant growing in a field of grass.

A student noticed that the grass plants growing near patches of clover were a darker green than other grass plants.

(a) Devise an investigation to show whether the presence of clover plants affects the concentration of the green pigment chlorophyll in grass plants.

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(b) Clover plants have bacteria living in root nodules.

These bacteria convert atmospheric nitrogen ($N_2$) to ammonia ($NH_3$) using the enzyme nitrogenase.

(i) State one organic molecule containing nitrogen atoms which is found in plant cells.

**(1)**

(ii) Nitrogen is a relatively unreactive gas that forms 80% of the atmosphere.

The enzyme nitrogenase catalyses the reaction shown:

$$N_2 + 8H^+ + 16\ ATP \rightarrow 2NH_3 + H_2 + 16\ ADP + 16\ Pi$$

The activation energy for this reaction is very high.

Analyse the information to explain how the enzyme nitrogenase is involved in the energy changes required for this reaction.

**(4)**

**(Total for Question 11 = 11 marks)**

**TOTAL FOR PAPER = 120 MARKS**



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