Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Biology A (Salters Nuffield)

Advanced
Paper 2: Energy, Exercise and Coordination

Tuesday 20 June 2017 – Morning
Time: 2 hours

Paper Reference
9BN0/02

You must have:
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 questions 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 100.
- 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.

Turn over ▶

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P 4 8 1 7 6 A 0 1 3 2

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Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Serotonin is found in the brain and is important in health and wellbeing.

An imbalance of serotonin can lead to problems such as depression. An individual with symptoms of depression may have low serotonin levels in the brain.

(a) Describe how low serotonin levels in an individual can affect the transmission of impulses in their brain.

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(b) The use of drugs such as MDMA (ecstasy) can cause an imbalance of chemicals in the brain.

(i) Describe how the use of MDMA could affect the transmission of impulses in the brain.

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(ii) Individuals who use MDMA may develop the symptoms of depression.

Explain how the use of MDMA could result in the development of these symptoms.

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(Total for Question 1 = 6 marks)

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2 As levels of activity increase, the heart can respond to the changing demand for oxygen.

(a) Which term describes the ability of heart muscle to contract without external stimulation?

(1)

☒ **A** autonomic

☒ **B** cardiac

☒ **C** myogenic

☒ **D** systolic

(b) Describe how the sinoatrial node (SAN) is involved in bringing about a change in heart rate as the level of activity increases.

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(c) During the cardiac cycle there are pressure changes in the chambers of the heart.

Explain how pressure differences in the heart ensure efficient pumping of the blood into the arteries.

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3 Cystic fibrosis is a condition that affects breathing.

(a) Explain why cystic fibrosis affects the rate of oxygen uptake in the lungs.

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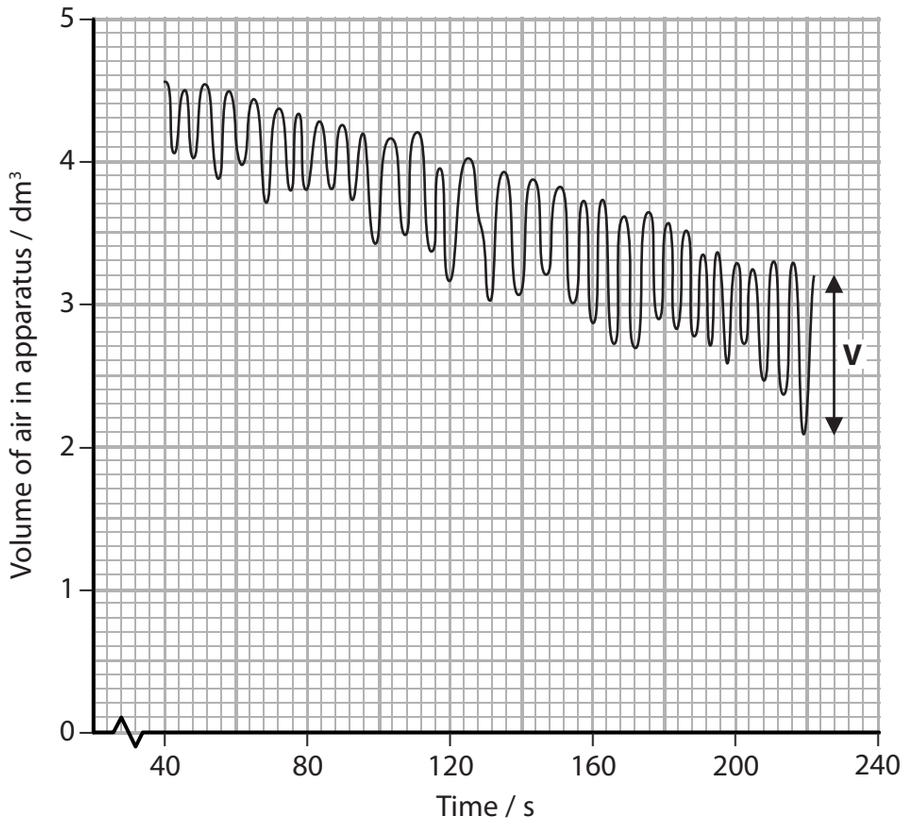
(b) A person breathed air in and out of the air chamber of a piece of apparatus.

Measurements were made of changes in the volume of air in the chamber. The carbon dioxide produced was removed from the chamber. The changes in volume were recorded on the trace shown in the diagram.



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(i) Which of the following is the name of this piece of apparatus?

(1)

☒ **A** colorimeter

☒ **B** potometer

☒ **C** respirometer

☒ **D** spirometer

(ii) Which of the following is shown by the label **V** on the trace?

(1)

☒ **A** alveolar volume

☒ **B** tidal volume

☒ **C** total lung volume

☒ **D** ventilation rate

(iii) Which of the following is the breathing rate in breaths per minute between 80 and 120 seconds?

(1)

☒ **A** 6 breaths min^{-1}

☒ **B** 9 breaths min^{-1}

☒ **C** 12 breaths min^{-1}

☒ **D** 16 breaths min^{-1}

(iv) Calculate the rate of oxygen uptake between 80 and 120 seconds.

(3)

Answer .....cm^3 min^{-1}

(Total for Question 3 = 9 marks)

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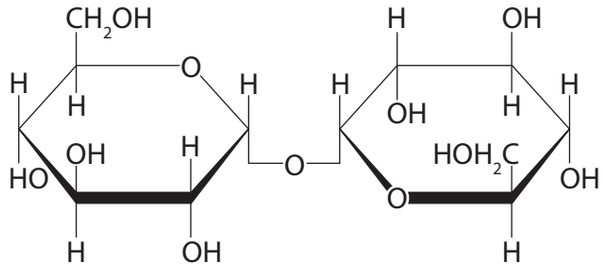
4 Maltose and trehalose are disaccharides. Trehalose is formed from two molecules of α-glucose.

The diagram shows a molecule of trehalose.



(a) (i) Describe the reaction that joins two α-glucose molecules to form a disaccharide.

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(ii) Compare and contrast the structures of trehalose and maltose.

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(b) Some flying insects store trehalose and glycogen in their wing muscles.

(i) Trehalose is broken down to glucose by the enzyme trehalase.

Which of the following describes how glucose is produced from trehalose?

(1)

☒ **A** anabolism

☒ **B** catalysis

☒ **C** glycolysis

☒ **D** hydrolysis

(ii) Insect flight uses a lot of energy. Explain the advantage of insects storing both trehalose and glycogen.

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5 The sex of a mammal is determined by a pair of sex chromosomes. There are two types of sex chromosome known as X and Y.

(a) (i) Which row in the table correctly shows the sex chromosomes found in the male and female gametes of mammals?

(1)

		Present in egg	Present in sperm
☒	**A**	Y	either X or Y
☒	**B**	either X or Y	X
☒	**C**	either X or Y	Y
☒	**D**	X	either X or Y

(ii) Explain why genes found on the sex chromosome pair have a pattern of inheritance that is different from genes found on other chromosome pairs.

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(b) Inheritance of sex in birds is also determined by a pair of sex chromosomes.

A breeding experiment was carried out to investigate the inheritance of sex in birds.

A gene found on the sex chromosomes in pigeons determines the colour of their feathers. The dominant allele, B, produces blue feathers and the recessive allele, b, produces red feathers.

Male pigeons with red feathers were crossed with females that had alleles for blue feathers only.

(i) Use a genetic diagram to explain the expected results of this cross if birds inherit sex in the same way as mammals.

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(ii) The cross between male pigeons with red feathers and female pigeons with alleles for blue feathers only was carried out.

The offspring produced suggested that sex chromosomes in birds have a different effect on sex compared with the sex chromosomes in mammals.

All the male offspring had blue feathers and all the female offspring had red feathers.

Deduce how the inheritance of sex in birds differs from that in mammals.

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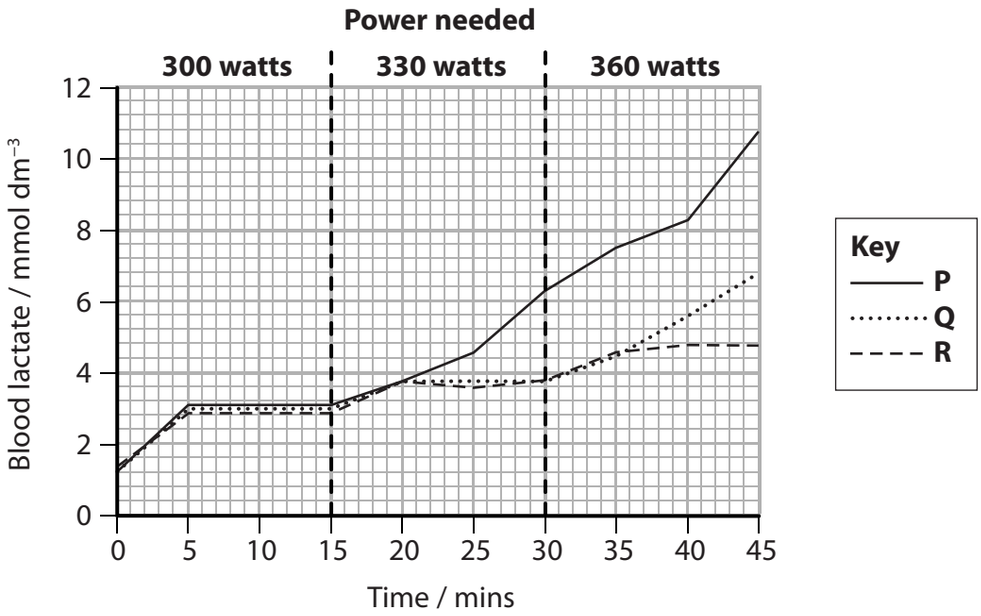
6 Athletes monitor the effect of different levels of exercise on their blood lactate concentration. This helps them to train effectively.

In a study, three athletes, **P**, **Q** and **R**, used an exercise bicycle for 45 minutes. The power needed to maintain a constant speed was increased every 15 minutes. Their blood lactate concentration was measured at 5-minute intervals.

The results are shown in the graph.



(a) Explain the increase in blood lactate concentration observed between 0 and 5 minutes.

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(b) Give reasons why blood lactate concentration remains constant between 5 and 15 minutes.

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(c) The most effective training involves the greatest power requirement over longer periods of time. Therefore, it is important to avoid high concentrations of blood lactate, which causes muscle fatigue, for as long as possible.

Analyse the data to deduce how each of these three athletes should plan their training.

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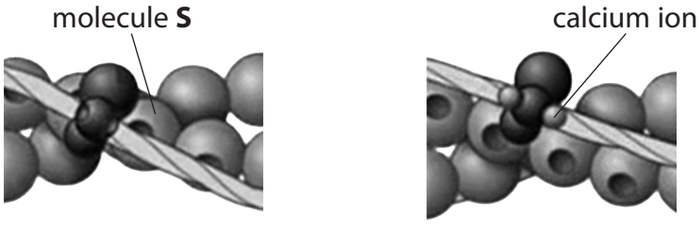
7 Muscle cells contain myofibrils. The diagrams show the arrangement of some of the molecules present in a myofibril when calcium ions are absent and when they are present.



calcium ions absent calcium ions present

(a) Which of the following is molecule **S**?

(1)

☒ **A** actin

☒ **B** myosin

☒ **C** tropomyosin

☒ **D** troponin

(b) (i) Describe the changes caused when calcium ions bind to the molecules shown in the diagram.

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(ii) Explain how these changes cause muscles to contract.

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(c) Describe how the concentration of calcium ions around the myofibrils is controlled.

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8 The muscles of the earthworm (*Lumbricus terrestris*) contract when it is touched. This is known as the withdrawal response.

(a) Which of the following terms describes a change in response as a result of repeated stimulation?

(1)

☒ **A** co-ordination

☒ **B** habituation

☒ **C** inhibition

☒ **D** reduction

(b) Contraction of the muscle in the withdrawal response is stimulated by nerve impulses. These nerve impulses can be detected using electrodes.

Explain the electrical changes in an axon that allow these nerve impulses to be detected.

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(c) Studies were carried out to investigate the withdrawal response in earthworms.

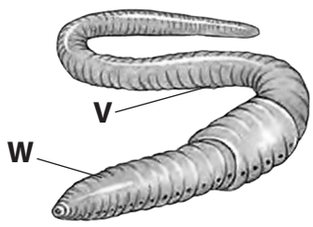
The duration of the withdrawal response is the length of time that the muscles remain contracted. If the stimulus is repeated, the withdrawal response is either reduced in duration or lost.

In one study, an earthworm was touched 20 times in one minute at point **V** as shown in the diagram. The shortening of the earthworm's body was measured after 20 stimuli.

The effect of touching point **W** in the same way was recorded and also the effect of alternating touches between points **V** and **W**.

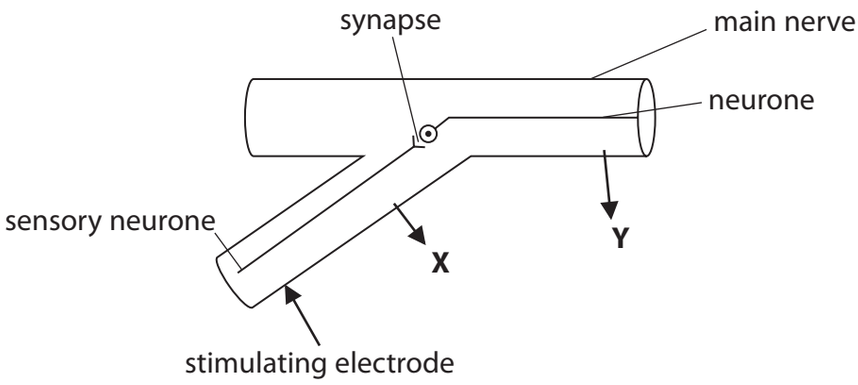
The results of this study are shown in the table.

Nature of stimulus	Change in body length after 20 stimuli / mm
All stimuli at point **V**	0
Stimuli alternating between points **V** and **W**	17
All stimuli at point **W**	0

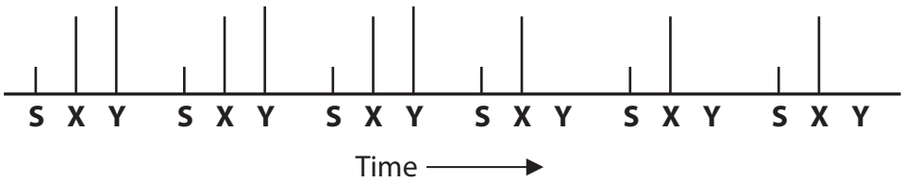


In another study, sensory neurones of an earthworm were stimulated by an electrode six times.

Nerve impulses were recorded at positions **X** and **Y** as shown in the diagram.



Nerve impulses recorded at **X** and **Y** are shown in the diagram below. The presence of a line indicates that an impulse was detected. **S** shows the stimulus.



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*(i) Analyse the data from these two studies to evaluate the most likely cause of the loss of the withdrawal response.

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(ii) Devise an experiment to show that the frequency of the stimulation used in the first study should be 20 stimuli per minute.

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9 Emphysema is a condition that causes changes to the tissues in the lungs.

In an investigation, the surface area for gas exchange and the volume of the lungs of three groups of individuals were determined. The results are shown in the table.

Measurement	Individuals without emphysema	Individuals with mild emphysema	Individuals with severe emphysema
Mean surface area for gas exchange / m^2	118 ± 11	97 ± 8	30 ± 5
Mean total lung volume / cm^3	4772 ± 223	6232 ± 410	6725 ± 384
Mean surface area for gas exchange : volume ratio	247.3 : 1		44.6 : 1

(a) (i) Calculate the mean surface area for gas exchange : volume ratio for individuals with mild emphysema.

(2)

Answer .....

(ii) There appears to be a difference in the lung volume of individuals with mild emphysema and those with severe emphysema.

Which of the following would be a relevant statistical test to determine whether this difference is significant?

(1)

☒ **A** chi-squared

☒ **B** correlation coefficient

☒ **C** standard deviation

☒ **D** Student's t-test

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(iii) Give reasons for the variation in the lung volumes of healthy individuals.

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(iv) Give a reason for calculating the surface area for gas exchange to volume ratio in this investigation.

(1)

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(b) Fick's law of diffusion can be used to calculate a value for the effectiveness of the uptake of oxygen by the lungs.

This value can be calculated using the equation

$$\text{value} = \frac{\text{surface area} \times \text{concentration difference}}{\text{diffusion distance}}$$

The diffusion distance in alveoli is 0.5 μm.

The mean oxygen concentration in alveoli is 14 kPa and in the capillaries is 5 kPa.

The calculated value for healthy individuals is 2124.

(i) Calculate the value for individuals with severe emphysema.

(2)

Answer .....

(ii) Calculate the percentage difference between the value for individuals with severe emphysema and the value for individuals without emphysema.

(2)

Answer .....

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(c) Explain why individuals with severe emphysema will tire more easily than healthy individuals.

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10 The modern bread wheat plant (*Triticum aestivum*) has been developed from other plant species that have different genomes.

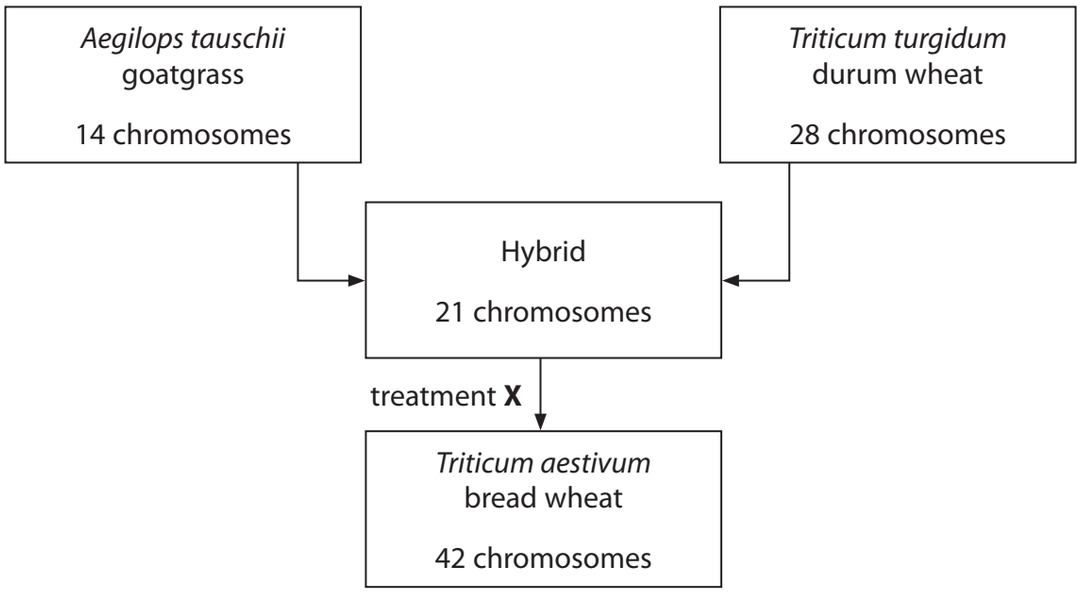
Three species of plant and their genomes are shown in the images.

Triticum aestivum
Genomes A, B and D

Triticum turgidum
Genomes A and B

Aegilops tauschii
Genome D

The diagram shows how chromosomes from different species have combined to produce the bread wheat species used to produce flour.



(a) Explain why each cell of the hybrid plant has 21 chromosomes in its nucleus.

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(b) Which row in the table shows the number of chromosomes in cells from these different plant species?

(1)

	A. tauschii gamete	*T. turgidum* leaf cell	*T. aestivum* gamete
☒ **A**	7	14	42
☒ **B**	7	28	21
☒ **C**	14	28	42
☒ **D**	14	14	21

(c) Explain why the hybrid plant cannot produce haploid gametes.

(2)

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(d) Treatment **X** in the diagram uses the chemical colchicine.

Colchicine breaks down spindle fibres in dividing cells.

Explain how treatment of cells of the hybrid plant with colchicine could result in the development of fertile *Triticum aestivum* plants.

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*(e) New varieties of plants with desirable combinations of characteristics can be produced using the methods shown in the table.

Method	Example
Formation of hybrids	In wheat, genome D includes genes for a tolerance of harsh conditions and genome A promotes large starch stores in seeds.
Genetic modification	Production of specific molecules in plant cells.
Selective breeding	Plants with desired characteristics can be used for breeding to produce plants with combinations of desired characteristics.

Evaluate the risks and benefits of producing varieties of plants using these methods.

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