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# COMBINED SCIENCE

PAPER 3 3102/3

Thursday **16 JUNE 2022** 9:00 A.M.–10:30 A.M.

Additional materials:  
Graph paper

|                                                              |
|--------------------------------------------------------------|
| <b>MINISTRY OF EDUCATION</b><br><b>NATIONAL EXAMINATIONS</b> |
|--------------------------------------------------------------|

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## INSTRUCTIONS AND INFORMATION FOR CANDIDATES

**Do not open this booklet until you are told to do so.**

Write your school number, candidate number, surname and initials in the spaces provided on this question booklet

Answer **ALL** the questions in **Section A** (1 – 4) in the spaces provided.

Answer **ANY TWO** (2) out of the three [3] questions from **Section B** on the lined pages provided in this booklet.

Candidates are advised to spend no more than 35 minutes on **Section A**.

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 2.

Calculators are permitted, however **NO** graphing calculators are allowed.

| For Examiner's Use |  |
|--------------------|--|
| SECTION A          |  |
| 1                  |  |
| 2                  |  |
| 3                  |  |
| 4                  |  |
| SECTION B          |  |
| 5                  |  |
| 6                  |  |
| 7                  |  |
| TOTAL              |  |

This question paper consists of 17 printed pages and 4 lined pages and 3 blank pages.



The Periodic Table of the Elements

| Group                                                                                                                                              |                                 |                              |                              |                              |                               |                               |                                |                                |                              |                                 |                              |                                |                                |                             |                              |                             |                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|------------------------------|------------------------------|------------------------------|-------------------------------|-------------------------------|--------------------------------|--------------------------------|------------------------------|---------------------------------|------------------------------|--------------------------------|--------------------------------|-----------------------------|------------------------------|-----------------------------|---------------------------|
| I                                                                                                                                                  | II                              | 1<br>H<br>Hydrogen<br>1      |                              |                              |                               |                               |                                | III                            | IV                           | V                               | VI                           | VII                            | 0                              |                             |                              |                             |                           |
| 7<br>Li<br>Lithium<br>3                                                                                                                            | 9<br>Be<br>Beryllium<br>4       |                              |                              |                              |                               |                               |                                | 11<br>B<br>Boron<br>5          | 12<br>C<br>Carbon<br>6       | 14<br>N<br>Nitrogen<br>7        | 16<br>O<br>Oxygen<br>8       | 19<br>F<br>Fluorine<br>9       | 20<br>Ne<br>Neon<br>10         |                             |                              |                             |                           |
| 23<br>Na<br>Sodium<br>11                                                                                                                           | 24<br>Mg<br>Magnesium<br>12     |                              |                              |                              |                               |                               |                                | 27<br>Al<br>Aluminium<br>13    | 28<br>Si<br>Silicon<br>14    | 31<br>P<br>Phosphorus<br>15     | 32<br>S<br>Sulphur<br>16     | 35.5<br>Cl<br>Chlorine<br>17   | 40<br>Ar<br>Argon<br>18        |                             |                              |                             |                           |
| 39<br>K<br>Potassium<br>19                                                                                                                         | 40<br>Ca<br>Calcium<br>20       | 48<br>Ti<br>Titanium<br>22   | 45<br>Sc<br>Scandium<br>21   | 51<br>V<br>Vanadium<br>23    | 52<br>Cr<br>Chromium<br>24    | 55<br>Mn<br>Manganese<br>25   | 56<br>Fe<br>Iron<br>26         | 59<br>Co<br>Cobalt<br>27       | 59<br>Ni<br>Nickel<br>28     | 64<br>Cu<br>Copper<br>29        | 65<br>Zn<br>Zinc<br>30       | 70<br>Ga<br>Gallium<br>31      | 73<br>Ge<br>Germanium<br>32    | 75<br>As<br>Arsenic<br>33   | 79<br>Se<br>Selenium<br>34   | 80<br>Br<br>Bromine<br>35   | 84<br>Kr<br>Krypton<br>36 |
| 85<br>Rb<br>Rubidium<br>37                                                                                                                         | 88<br>Sr<br>Strontium<br>38     | 91<br>Zr<br>Zirconium<br>40  | 89<br>Y<br>Yttrium<br>39     | 93<br>Nb<br>Niobium<br>41    | 96<br>Mo<br>Molybdenum<br>42  | 101<br>Tc<br>Technetium<br>43 | 101<br>Ru<br>Ruthenium<br>44   | 103<br>Rh<br>Rhodium<br>45     | 106<br>Pd<br>Palladium<br>46 | 108<br>Ag<br>Silver<br>47       | 112<br>Cd<br>Cadmium<br>48   | 115<br>In<br>Indium<br>49      | 119<br>Sn<br>Tin<br>50         | 122<br>Sb<br>Antimony<br>51 | 128<br>Te<br>Tellurium<br>52 | 127<br>I<br>Iodine<br>53    | 131<br>Xe<br>Xenon<br>54  |
| 133<br>Cs<br>Caesium<br>55                                                                                                                         | 137<br>Ba<br>Barium<br>56       | 178<br>Hf<br>Hafnium<br>72   | 139<br>La<br>Lanthanum<br>57 | 181<br>Ta<br>Tantalum<br>73  | 184<br>W<br>Tungsten<br>74    | 186<br>Re<br>Rhenium<br>75    | 190<br>Os<br>Osmium<br>76      | 192<br>Ir<br>Iridium<br>77     | 195<br>Pt<br>Platinum<br>78  | 197<br>Au<br>Gold<br>79         | 201<br>Hg<br>Mercury<br>80   | 204<br>Tl<br>Thallium<br>81    | 207<br>Pb<br>Lead<br>82        | 209<br>Bi<br>Bismuth<br>83  | 210<br>Po<br>Polonium<br>84  | 210<br>At<br>Astatine<br>85 | 222<br>Rn<br>Radon<br>86  |
| 87<br>Fr<br>Francium                                                                                                                               | 88<br>Ra<br>Radium              | 89<br>Ac<br>Actinium         |                              |                              |                               |                               |                                |                                |                              |                                 |                              |                                |                                |                             |                              |                             |                           |
| * 58-71 Lanthanoid series<br>† 90-103 Actinoid series                                                                                              |                                 |                              |                              |                              |                               |                               |                                |                                |                              |                                 |                              |                                |                                |                             |                              |                             |                           |
| <div><div><div>a</div><div>X</div><div>b</div></div><div>a = relative atomic mass<br/>X = atomic symbol<br/>b = proton (atomic) number</div></div> |                                 |                              |                              |                              |                               |                               |                                |                                |                              |                                 |                              |                                |                                |                             |                              |                             |                           |
| 140<br>Ce<br>Cerium<br>58                                                                                                                          | 141<br>Pr<br>Praseodymium<br>59 | 144<br>Nd<br>Neodymium<br>60 | 150<br>Sm<br>Samarium<br>62  | 152<br>Eu<br>Europium<br>63  | 157<br>Gd<br>Gadolinium<br>64 | 159<br>Tb<br>Terbium<br>65    | 162<br>Dy<br>Dysprosium<br>66  | 165<br>Ho<br>Holmium<br>67     | 167<br>Er<br>Erbium<br>68    | 169<br>Tm<br>Thulium<br>69      | 173<br>Yb<br>Ytterbium<br>70 | 175<br>Lu<br>Lutetium<br>71    | 103<br>Lr<br>Lawrencium<br>103 |                             |                              |                             |                           |
| 232<br>Th<br>Thorium<br>90                                                                                                                         | 238<br>Pa<br>Protactinium<br>91 | 238<br>U<br>Uranium<br>92    | 238<br>Pu<br>Plutonium<br>94 | 238<br>Am<br>Americium<br>95 | 238<br>Cm<br>Curium<br>96     | 238<br>Bk<br>Berkelium<br>97  | 238<br>Cf<br>Californium<br>98 | 238<br>Es<br>Einsteinium<br>99 | 238<br>Fm<br>Fermium<br>100  | 238<br>Md<br>Mendelevium<br>101 | 238<br>No<br>Nobelium<br>102 | 238<br>Lr<br>Lawrencium<br>103 | 103                            |                             |                              |                             |                           |

a

X

b

a = relative atomic mass  
X = atomic symbol  
b = proton (atomic) number

## SECTION A

Answer **ALL** questions in this Section.

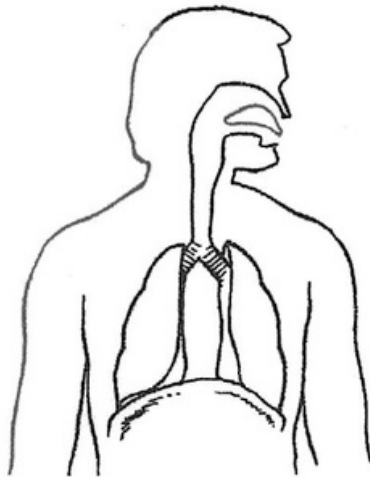
1. (a) (i) Define the term breathing.

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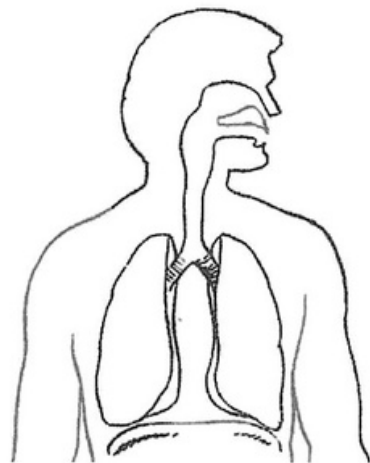
---

[2]

- (ii) There are **two** phases involved in the breathing process.



**Diagram A**



**Diagram B**

Using the diagrams, list which phase is taking place in **Diagram A**

State **two** reasons, visible in the diagram to support your answer.

**Phase in Diagram A** \_\_\_\_\_

**Reason 1** \_\_\_\_\_

\_\_\_\_\_

**Reason 2** \_\_\_\_\_

\_\_\_\_\_

[3]



- (b) The table shows the percentage composition of oxygen and carbon dioxide in inspired and expired air.

| Gas            | % inspired air | % expired air |
|----------------|----------------|---------------|
| Oxygen         | 21             | 16            |
| Carbon dioxide | 0.04           | 4             |

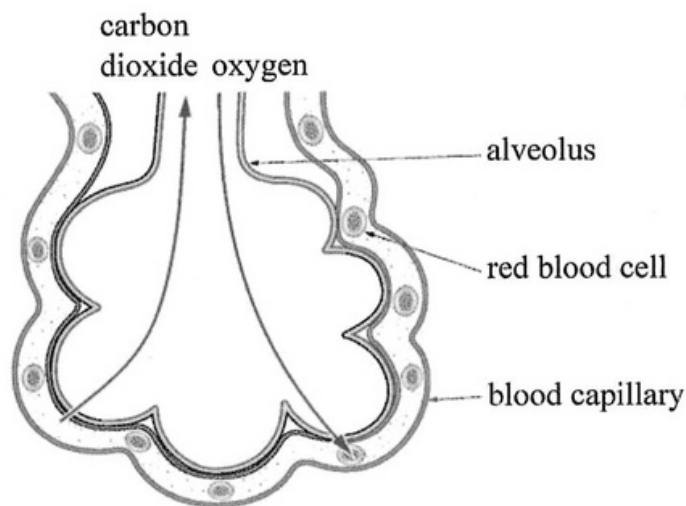
- (i) Explain the change in gas composition between inspired and expired air.

\_\_\_\_\_ [2]

- (ii) Calculate how many times greater the concentration of carbon dioxide is in expired air compared to inspired air.

[1]

- (c) The diagram shows a single alveolus.



Gas exchange between the alveolus and the blood in the capillary occurs through the wall of the alveolus.

Give **two** ways in which the alveolus is adapted for gaseous exchange.

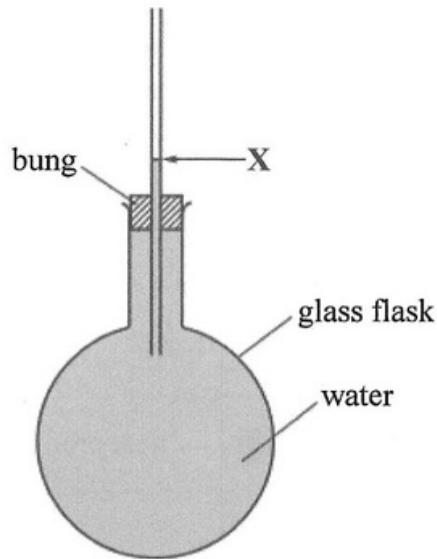
1 \_\_\_\_\_

2 \_\_\_\_\_ [2]

**TOTAL MARKS [10]**



2. (a) The diagram shows a flask full of water at  $10^{\circ}\text{C}$ , sealed with a bung. A long glass tube passes through the bung into the water. The water level in the tube is at **X**.



The flask is placed in hot water. The water level in the glass tube falls a little below **X** at first. It then rises above **X**.

Explain the following:

- (i) The water level falls a little below **X** at first.

---

---

[2]

- (ii) The water level rises above **X**.

---

---

[2]

- (iii) After 5 minutes, the water rises more than it falls.

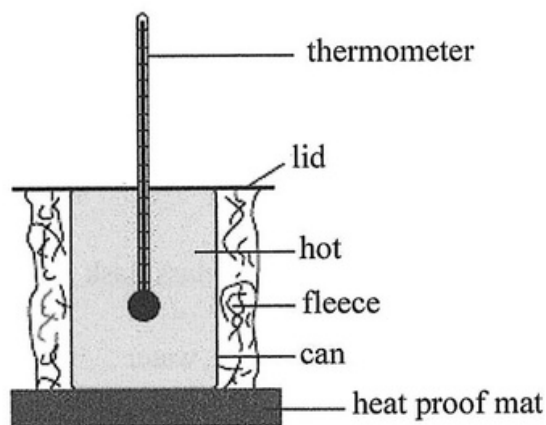
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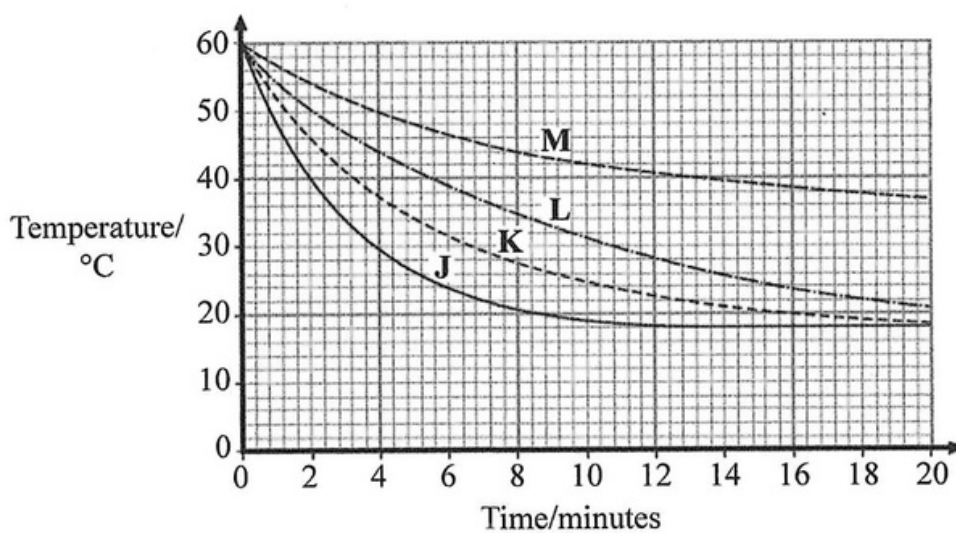
[1]



- (b) A student tested four different types of fleece, **J**, **K**, **L** and **M**, to find which would make the warmest jacket. Each type of fleece was wrapped around a can which was then filled with hot water. The temperature of the water is taken every two minutes for 20 minutes.



The graph shows the student's results.



- (i) In each test, the water cooled faster during the first five minutes than during the last five minutes. Explain why this happens.

---



---

[2]



- (ii) Estimate what the temperature of the water in the can wrapped in fleece **K** would be after 40 minutes.

\_\_\_\_\_ [1]

- (iii) Which type of fleece, **J**, **K**, **L** or **M**, should the student recommend to be used in the jacket?

Give a reason for your answer.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

**TOTAL MARKS [10]**



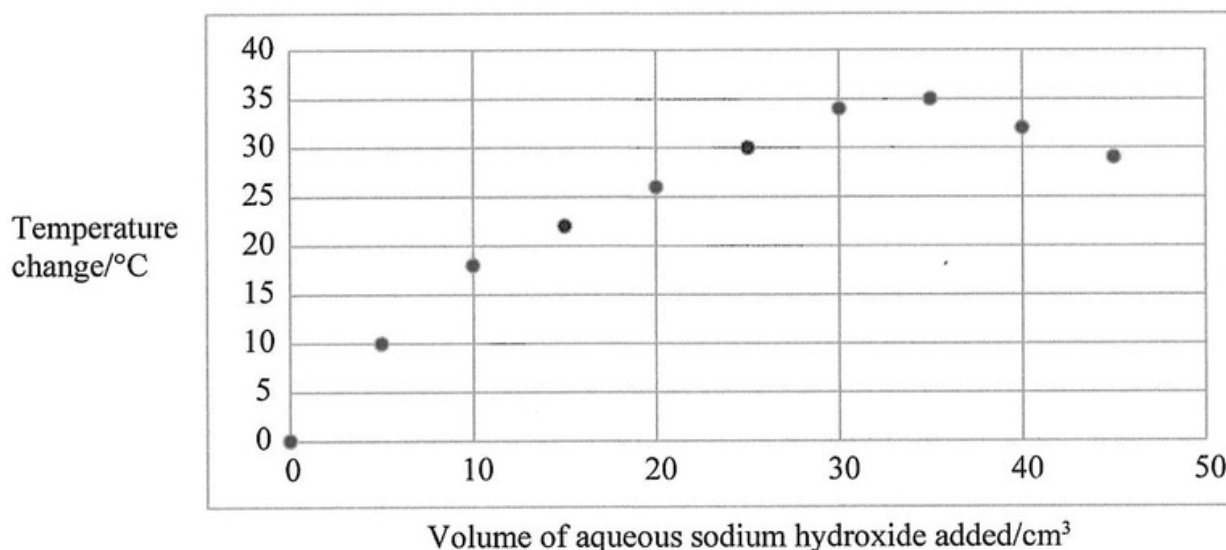
3. A student carries out a reaction using aqueous sodium hydroxide and dilute sulphuric acid, to investigate the temperature change. The word equation shown describes this reaction.

sodium hydroxide + sulphuric acid  $\rightarrow$  sodium sulphate + water

- (a) Write a balanced symbol equation for the reaction shown.

[2]

- (b) A student added 20 cm<sup>3</sup> of dilute sulphuric acid to a beaker and recorded the temperature. They then added 5 cm<sup>3</sup> of aqueous sodium hydroxide, stirred and recorded the temperature. This was repeated until 45 cm<sup>3</sup> of aqueous sodium hydroxide has been added. The results of the investigation are shown on the graph.



- (i) Suggest how the results on the graph show that the reaction is exothermic.

[1]



- (ii) Describe an exothermic reaction in terms of the energy involved in bond breaking and bond making.

---

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---

---

[3]

- (c) (i) Identify **two** factors that may affect the temperature change recorded in the investigation.

1 

---

2 

---

[2]

- (ii) Why does the temperature begin to decrease when 35 cm<sup>3</sup> of sodium hydroxide is added?

---

[1]

- (d) Suggest **one** other exothermic reaction.

---

[1]

**TOTAL MARKS [10]**

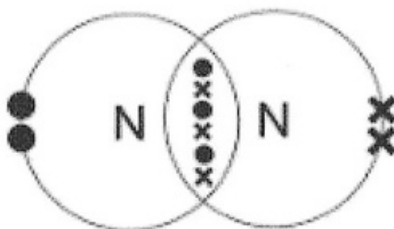


4. Nitrogen gas is found in the Earth's atmosphere.

(a) What percentage of the air is made up of nitrogen gas?

\_\_\_\_\_ [1]

(b) The diagram shows a nitrogen molecule.



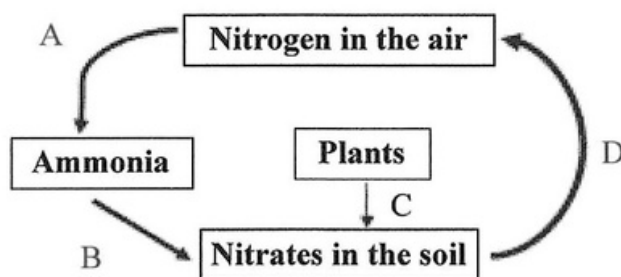
Suggest why nitrogen is unreactive.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

(c) Why is nitrogen important for plants and animals?

\_\_\_\_\_ [1]

(d) The diagram shows a simplified version of the nitrogen cycle.



(i) Write the chemical formula for the nitrate ion.

\_\_\_\_\_ [1]



- (ii) Name the type of organism found in the soil that assists in the conversion of nitrogen to ammonia in **step A** of the diagram.

\_\_\_\_\_ [1]

- (iii) Name the group of plants that have the organism named in (ii) in their root nodules.

\_\_\_\_\_ [1]

- (e) Ammonium sulphate  $(\text{NH}_4)_2\text{SO}_4$  is a fertiliser that can be made by reacting ammonia with an acid.

- (i) Name the acid that reacts with ammonia to make ammonium sulphate.

\_\_\_\_\_ [1]

- (ii) Calculate the relative molecular mass of ammonium sulphate,  $(\text{NH}_4)_2\text{SO}_4$ .

Show your working.

[2]

**TOTAL MARKS [10]**



### SECTION B

Answer any **two** questions.

5. (a) The table shows the melting point of elements in **Group I**.

| Element   | Melting point °C |
|-----------|------------------|
| lithium   | 181              |
| sodium    | 98               |
| potassium | 63               |
| rubidium  | X                |
| caesium   | 29               |

- (i) Plot a bar chart to show atomic number against melting point. [4]
  - (ii) Determine the melting point of rubidium. [1]
  - (iii) Describe the trend in melting point of the **Group I** elements as you go down the group. [1]
- (b) Hydrogen has some characteristics similar to the elements in **Group I**
- (i) State **one** way in which hydrogen is like the other **Group I** elements. [1]
  - (ii) State **one** way in which hydrogen is different from the other **Group I** elements. [1]



- (c) The table shows information about some **Group VII** elements.

| Name     | Formula        | State at room temperature (20 °C) | Colour of gas | Melting point |
|----------|----------------|-----------------------------------|---------------|---------------|
| chlorine |                |                                   |               | –107          |
| bromine  |                |                                   | orange-brown  | 7             |
| iodine   | I <sub>2</sub> |                                   | purple        | 114           |

- (i) Complete the table. [3]
- (ii) Fluorine is another **Group VII** element. State the atomic number and the electronic configuration of fluorine. [2]
- (iii) The reactivity of the **Group VII** elements decreases as you go down the group. Explain why fluorine is the most reactive element in this group. [3]
- (d) Calcium is a **Group II** element. It reacts with a chlorine molecule to form calcium chloride.
- (i) State the symbol equation for this reaction. [2]
- (ii) Draw a dot-and-cross diagram to show the bonding in calcium chloride. [2]

**TOTAL MARKS [20]**



6. (a) In January 2020, in an effort to protect the global environment, The Bahamas Government transitioned toward a ban of single-use plastic products: bags, straws, food utensils and polystyrene cups.
- (i) Discuss why this was considered necessary. [3]
  - (ii) Suggest **two** other ways in which governmental policy seek to protect our environment. [2]
- (b) Biotechnology has resulted in the development of bacteria to assist with reversing the damage to our environment.
- (i) Identify the kingdom to which bacteria belong. [1]
  - (ii) List **three** characteristics of organisms in the kingdom identified in (i). [3]
  - (iii) Define biotechnology. [2]
  - (iv) List **two** other beneficial uses of technology.  
Briefly discuss **each** example given. [6]
  - (v) Sometimes biotechnology can have a negative impact on our environment.  
Identify and discuss **one** way in which biotechnology can negatively impact the environment. [3]

**TOTAL MARKS [20]**



7. Ann clamped a ruler to a desk. She pressed down on the ruler and then let it go.



- (a) Sound exists as a type of wave.

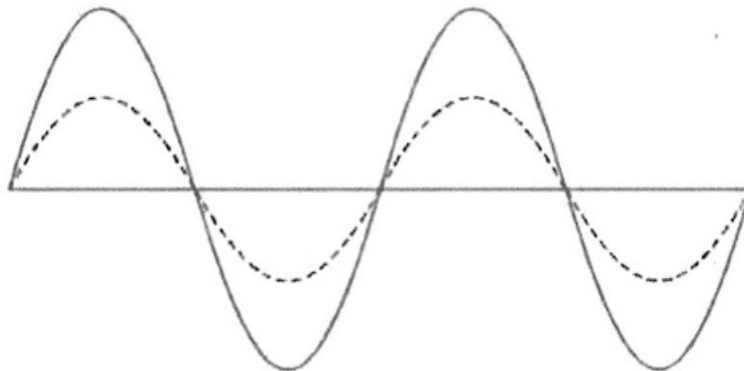
(i) What type of wave is a sound wave?

[1]

(ii) How are sound waves produced?

[2]

- (b) The diagram shows two waves

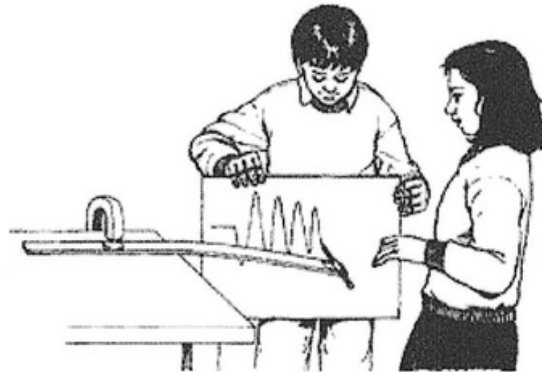


Name **one** quantity that is the same for the two waves

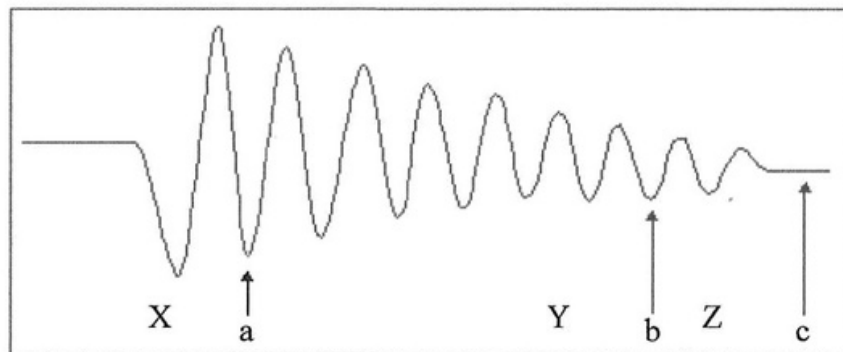
[1]



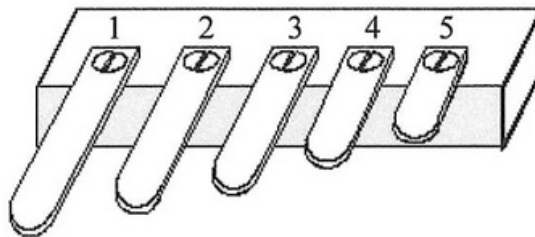
- (c) Ann fixed a pen to the end of the ruler. Jack moved towards the table with a piece of paper touching the pen. Jack moved steadily and Ann plucked the ruler once.



The diagram shows the pattern the pen made.



- (i) What happened to the volume of the sound between **X** and **Y**? [1]
- (ii) Explain what the pattern tells you about the sound at point **Z**? [2]
- (d) Ann and Jack then decide to make a musical instrument. It is shown in the diagram below.

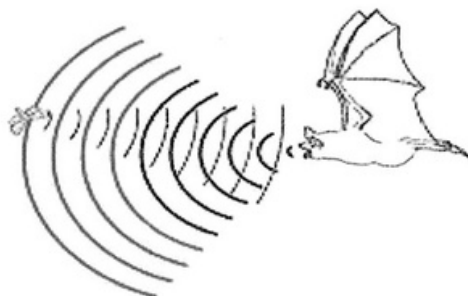


To make a sound, Jack pushes a stick down and lets it go.

- (i) Describe how Ann and Jack can make the sound louder. [1]
- (ii) Describe how the length of the stick affects the pitch of the note. [1]



- (e) The diagram shows a bat using echo location to find a moth. The pulsed wave is transmitted from the bat, which is then reflected off the prey which is then received by the bat.



The time taken to receive the echo is 0.2s after transmission. Take the speed of sound in air to be 343 m/s.

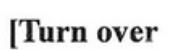
- (i) Calculate how far the bat is from the moth. [4]
- (ii) A wave has a frequency of 15Hz. The wavelength is 125m. Calculate the speed of the sound. Show the working and include the unit. [3]
- (f) A student claps his hands in an enclosed stairwell. He hears the echo 0.3s later.
- He used the speed of sound to calculate the height of the stairwell.
- (i) Give **two** reasons why the height of the stairwell might not be accurate. [2]
- (ii) Suggest how the measurement could be improved. [2]

**TOTAL MARKS [20]**



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Question .....

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Question .....

Write on both sides of the paper

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