Name:_____

Pre-Applied Science (Biomedical Sciences) BTEC professional pathway summer home learning

In September 2022, you will begin your studies of the Applied Science (Biomedical Sciences) professional pathway course. In order to help you prepare, you must spend a total of 6 hours on this home learning project over the summer.

This will be due to your Y12 form tutor on your first day.

Part 1: 1.5 hours

done? ☐

Read the extract from **"Life on the Edge: The Coming of Age of Quantum Biology"**

Answer the **essay** question "**What is the next big revolution in Biology?**" Your essay question should take at least one side of A4. You may type and print your response.

Part 2: 4.5 hours

done? ☐

Answer all the exam questions. These are from the GCSE course and all supporting knowledge should be secure before arriving in September. You should thoroughly complete any revision necessary to answer the questions. You will be given the answers during your first week.

Part 1

Read the extract from the book **"Life on the Edge: The Coming of Age of Quantum Biology"**. This should take about 20 minutes. You should annotate the extract and highlight words/phrases you want to look up.

THE WINTER FROST has arrived early this year in Europe and there is a penetrating chill in the evening air. Buried deep within a young robin's mind, a once vague sense of purpose and resolve grows stronger.

The bird has spent the past few weeks devouring far more than her normal intake of insects, spiders, worms and berries and is now almost double the weight that she was when her brood flew the nest back in August. This extra bulk is mostly fat reserves, which she will require as fuel for the arduous journey upon which she is about to embark.

This will be her first migration away from the spruce forest in central Sweden where she has lived for the duration of her short life and where she reared her young chicks just a few months ago. Luckily for her, the previous winter was not too harsh, for a year ago she was not yet fully grown and therefore not strong enough to undertake such a long journey. But now, with her parental responsibilities discharged until next spring, she has only herself to think about, and she is ready to escape the coming winter by heading south to seek a warmer climate.

It is a couple of hours after sunset. Rather than settle for the night, she hops in the gathering gloom to the tip of a branch near the base of the huge tree that she has made her home since the spring. She gives herself a quick shake, much like a marathon runner loosening up her muscles before a race. Her orange breast glistens in the moonlight. The painstaking effort and care she invested in building her nest – just a few feet away, partially hidden against the moss-covered bark of the tree trunk – is now a dim memory.

She is not the only bird preparing to depart, for other robins – both male and female – have also decided that this is the right night to begin their long migration south. In the trees all around her she hears loud, shrill singing that drowns out the usual sounds of other nocturnal woodland creatures. It is as though the birds feel compelled to announce their departure, sending out a message to the other forest inhabitants that they should think twice before contemplating invading the birds' territory and empty nests while they are gone. For these robins most certainly plan to be back in the spring.

With a quick tilt of her head this way and that to make sure the coast is clear, she takes off into the evening sky. The nights have been lengthening with winter's advance and she will have a good ten hours or so of flying ahead of her before she can rest again.

She sets off on a course bearing of 195° (15° to the west of due south). Over the coming days she will carry on flying in, more or less, this same direction, covering two hundred miles on a good day. She has no idea what to expect along the journey, nor any sense of how long it will take. The terrain around her spruce wood is a familiar one, but after a few miles she is flying over an alien moonlit landscape of lakes, valleys and towns.

Somewhere near the Mediterranean she will arrive at her destination; although she is not heading for any specific location, when she does arrive at a favourable spot she will stop, memorizing the local landmarks so that she can return there in the coming years. If she has the strength, she may even fly all the way across to the North African coast. But this is her first migration, and her only priority now is to escape the biting cold of the approaching Nordic winter.

She seems oblivious to the surrounding robins that are all flying in roughly the same direction, some of which will have made the journey many times before. Her night vision is superb, but she is not looking for any landmarks – as we might were we making such a journey – nor is she

tracking the pattern of the stars in the clear night sky by consulting her internal celestial map, as many other nocturnal migrating birds do. Instead, she has a rather remarkable skill and several million years of evolution to thank for her capacity to make what will become an annual autumn migration, a trip of some two thousand miles.

Migration is, of course, commonplace in the animal kingdom. Every winter, for instance, salmon spawn in the rivers and lakes of northern Europe, leaving young fry that, after hatching, follow the course of their river out to sea and into the North Atlantic, where they grow and mature; three years later, these young salmon return to breed in the same rivers and lakes where they spawned. New World monarch butterflies migrate thousands of miles southward across the entire United States in the autumn. They, or their descendants (as they will breed en route), then return north to the same trees in which they pupated in the spring. Green turtles that hatch on the shores of Ascension Island in the South Atlantic swim across thousands of miles of ocean before returning, every three years, to breed on the exact same eggshell-littered beach from which they emerged. The list goes on: many species of birds, whales, caribou, spiny lobsters, frogs, salamanders and even bees are all capable of undertaking journeys that would challenge the greatest human explorers.

How animals manage to find their way around the globe has been a mystery for centuries. We now know that they employ a variety of methods: some use solar navigation during the day and celestial navigation at night; some memorize landmarks; others can even *smell* their way around the planet. But the most mysterious navigational sense of all is the one possessed by the European robin: the ability to detect the direction and strength of the earth's magnetic field, known as magnetoreception. And while we now know of a number of other creatures that possess this ability, it is the way the European robin (*Erithacus rubecula*) finds her way across the globe that is of greatest interest to our story.

The mechanism that enables our robin to know how far to fly, and in which direction, is encoded in the DNA she inherited from her parents. This ability is a sophisticated and unusual one – a *sixth sense* that she uses to plot her course. For, like many other birds, and indeed insects and marine creatures, she has the ability to sense the earth's weak magnetic field and to draw directional information from it by way of an inbuilt navigational sense, which in her case requires a novel type of chemical compass.

Magnetoreception is an enigma. The problem is that the earth's magnetic field is very weak – between 30 and 70 microtesla at the surface: sufficient to deflect a finely balanced and almost frictionless compass needle, but only about a hundredth the force of a typical fridge magnet. This presents a puzzle: for the earth's magnetic field to be detected by an animal it must somehow influence a chemical reaction somewhere in the animal's body – this is, after all, how all living creatures, ourselves included, sense any external signal. But the amount of energy supplied by the interaction of the earth's magnetic field with the molecules within living cells is less than a billionth of the energy needed to break or make a chemical bond. How, then, can that magnetic field be perceptible to the robin?

Mysteries, however small, are fascinating because there's always the possibility that their solution may lead to a fundamental shift in our understanding of the world. Copernicus's ponderings in the sixteenth century on a relatively minor problem concerning the geometry of the Ptolemaic geocentric model of the solar system, for instance, led him to shift the centre of gravity of the entire universe away from humankind. Darwin's obsession with the geographical distribution of animal species and the mystery of why isolated island species of finches and mockingbirds tend to be so specialized led him to propose his theory of evolution. And German physicist Max Planck's solution to the mystery of blackbody radiation, concerning the way warm objects emit heat, led him to suggest that energy came in discrete lumps called 'quanta',

leading to the birth of quantum theory in the year 1900. So, could the solution to the mystery of how birds find their way around the globe lead to a revolution in biology? The answer, bizarre as it may seem, is: yes.

A digital copy of the text can be seen at https://www.amazon.co.uk/Life-Edge-Coming-Quantum-Biology/dp/0593069323

It is not necessary, nor expected, that you purchase this book. It will not be needed for your course.

Essay question: What is the next big revolution in Biology?

Your extended response essay should take about 30 minutes to research and 30 minutes to write. You should spend about 10 minutes checking your work.

Your answer ***could*** follow this structure:

Paragraph 1: What are the big unanswered questions in Biology?

Paragraph 2: What discovery or revolution would be most impactful? Why?

Paragraph 3: Who, if anyone, is currently funding or working on research in this area? If it is not being studied, why not? What are the current priorities in biological research?

Your response does not necessarily need to refer to the extract you have just read. Your essay could focus on, but is not limited to:

- Personalisation of human medicine. Can we find a way to cure anyone of any disease, instantly?
- Creating organisms that are immune to mutation. Is this the key to eliminating cancer? If this is possible, what are the implications for evolution?
- Stopping the antibacterial resistance crisis. What could the solution to the biggest healthcare crisis of our generation be?
- Understanding and slowing human ageing. If humans could live forever, how could this discovery be used responsibly?
- Communication with other species. Will humans ever be able to talk to animals?

You could start your research with the following links to additional resources.

- https://www.cell.com/molecular-cell/pdf/S1097-2765(11)00331-5.pdf
- https://en.wikipedia.org/wiki/List_of_unsolved_problems_in_biology
- https://www.theguardian.com/science/2013/sep/01/20-big-questions-in-science
- https://www.newscientist.com/round-up/revolutionary-ideas/
- https://www.forbes.com/sites/quora/2017/02/14/what-are-the-most-important-unanswered-questions-in-science-that-are-likely-to-be-answered-by-2025/#365057d751e2

Your essay question should take at least one side of A4 or you may type and print your response (around 500 words). You should write using accurate English.

Part 2

Answer all the exam questions. These are from the GCSE course and all supporting knowledge should be secure before arriving in September. You should thoroughly complete any revision necessary to answer the questions. You will be given the answers during your first week.

BIOLOGY - Q1.

This question is about cell structures.

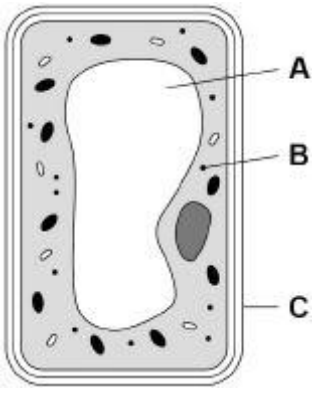
(a) Draw **one** line from each cell structure to the type of cell where the structure is found.

Cell Structure	Type of cell where the structure is found
Nucleus	Prokaryotic cells
Permanent vacuole	Plant cells only
Plasmid	Eukaryotic cells

(2)

(b) **Figure 1** shows a plant cell.

Figure 1



What are the names of structures **A**, **B** and **C**?

Tick **one** box.

Structure A	Structure B	Structure C	
Chloroplast	Vacuole	Cell wall	☐
Nucleus	Chloroplast	Cell membrane	☐
Vacuole	Mitochondrion	Cell membrane	☐

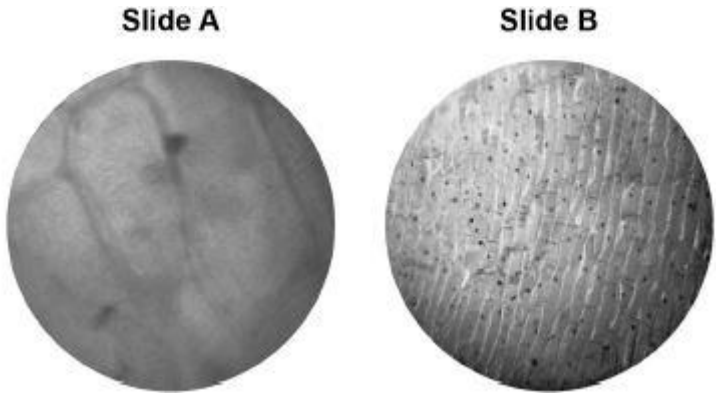
Vacuole	Ribosome	Cell wall	

(1)

A student observed slides of onion cells using a microscope.

Figure 2 shows two of the slides the student observed.

Figure 2



The cells on the slides are **not** clear to see.

(c) Describe how the student should adjust the microscope to see the cells on Slide A more clearly.

_____

_____

(1)

(d) Describe how the student should adjust the microscope to see the cells on Slide B more clearly.

_____

_____

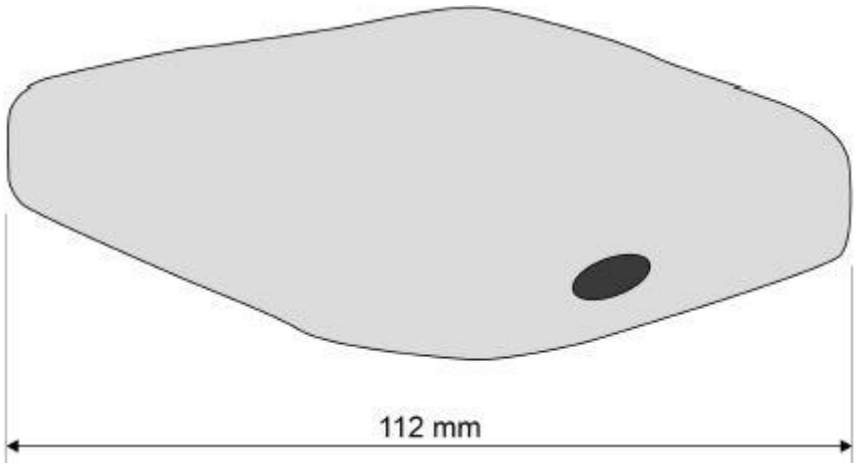
_____

(2)

(e) The student made the necessary adjustments to get a clear image.

Figure 3 shows the student's drawing of one of the cells.

Figure 3



The real length of the cell was 280 micrometres (µm).

Calculate the magnification of the drawing.

_____

_____

_____

_____

_____

Magnification = × _____

(3)

(Total 9 marks)

Q2.

(a) Balance the following equation for photosynthesis.

_____ CO_2 + _____ H_2O → $C_6H_{I2}O_6$ + _____ O_2

(1)

(b) Give **two** conditions necessary for photosynthesis apart from a suitable temperature range and the availability of water and carbon dioxide.

1. _____

2. _____

(2)

(a) Plants have leaves which contain guard cells and palisade cells. Explain how **each** of these kinds of cell assists photosynthesis.

Guard cells _____

_____

_____

_____

(2)

Palisade cells _____

_____

_____

_____

(2)

(d) Glucose is a product of photosynthesis. Give **three** uses which green plants make of glucose.

1. _____

2. _____

3. _____

(3)

(Total 10 marks)

Q3.

(a) In humans there are two types of cell division: **mitosis** and **meiosis.**

The table below gives statements about cell division.

Tick (✓) **one** box in each row to show if the statement is true for mitosis only, for meiosis only, or for both mitosis **and** meiosis.

The first row has been done for you.

Statement	**Mitosis only**	**Meiosis only**	**Both mitosis and meiosis**
How cells are replaced	✓		
How gametes are made			
How a fertilised egg undergoes cell division			
How copies of the genetic information are made			
How genetically identical cells are produced			

(4)

(b) Stem cells can be taken from human embryos.

In therapeutic cloning, an embryo is produced that has the same genes as the patient.

(i) Name **one** source of human stem cells, other than human embryos.

_____

(1)

(ii) Stem cells from embryos can be transplanted into patients for medical

treatment.

Give **one** advantage of using stem cells from embryos, compared with cells from the source you named in part (i).

_____

_____

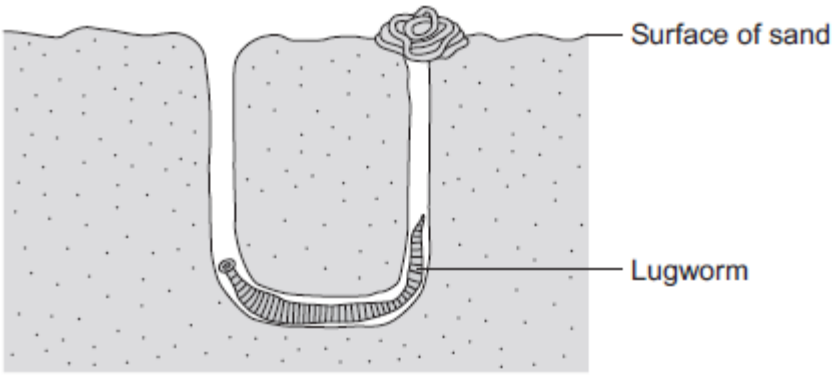
(1)

(Total 6 marks)

Q4.

The lugworm lives in a U-shaped burrow in the sand on the seashore.

The diagram below shows a lugworm in its burrow.



(a) Some scientists investigated the effect of different salt concentrations on lugworms.

The scientists:

- collected 50 lugworms from the seashore
- separated them into five groups of 10 lugworms
- weighed each group of 10 lugworms
- placed each group into a different concentration of salt solution and left them for 8 hours
- took each lugworm out of the solution and placed it on blotting paper for 30 seconds
- re-weighed each group of 10 lugworms.

(i) Why did the scientists use groups of 10 lugworms and not just 1 lugworm at each concentration?

_____

_____

(1)

(ii) Suggest why the scientists placed each lugworm on blotting paper for 30 seconds before they reweighed the groups of lugworms.

_____

_____

(1)

(iii) How might the method of blotting have caused errors in the results?

_____

_____

(1)

(iv) Suggest **one** improvement the scientists could make to their investigation.

_____

(1)

(b) The table below shows the scientists' results.

Concentration of salt in arbitrary units	Mass of 10 lugworms at start in grams	Mass of 10 lugworms after 8 hours in grams	Change in mass in grams	Percentage (%) change in mass
1.0	41.2	61.8	+20.6	+50
2.0	37.5	45.0	+7.5	
3.0	55.0	56.1	+1.1	+2
4.0	46.2	22.2	-24.0	-52
5.0	45.3	22.6	-22.7	-50

(i) The scientists calculated the **percentage** change in mass at each salt concentration.

Why is the **percentage** change in mass more useful than just the change in mass in grams?

Use information from the table in your answer.

_____

_____

_____

_____

(2)

(ii) Calculate the percentage change in mass for the 10 lugworms in the salt solution with a concentration of 2.0 arbitrary units.

_____

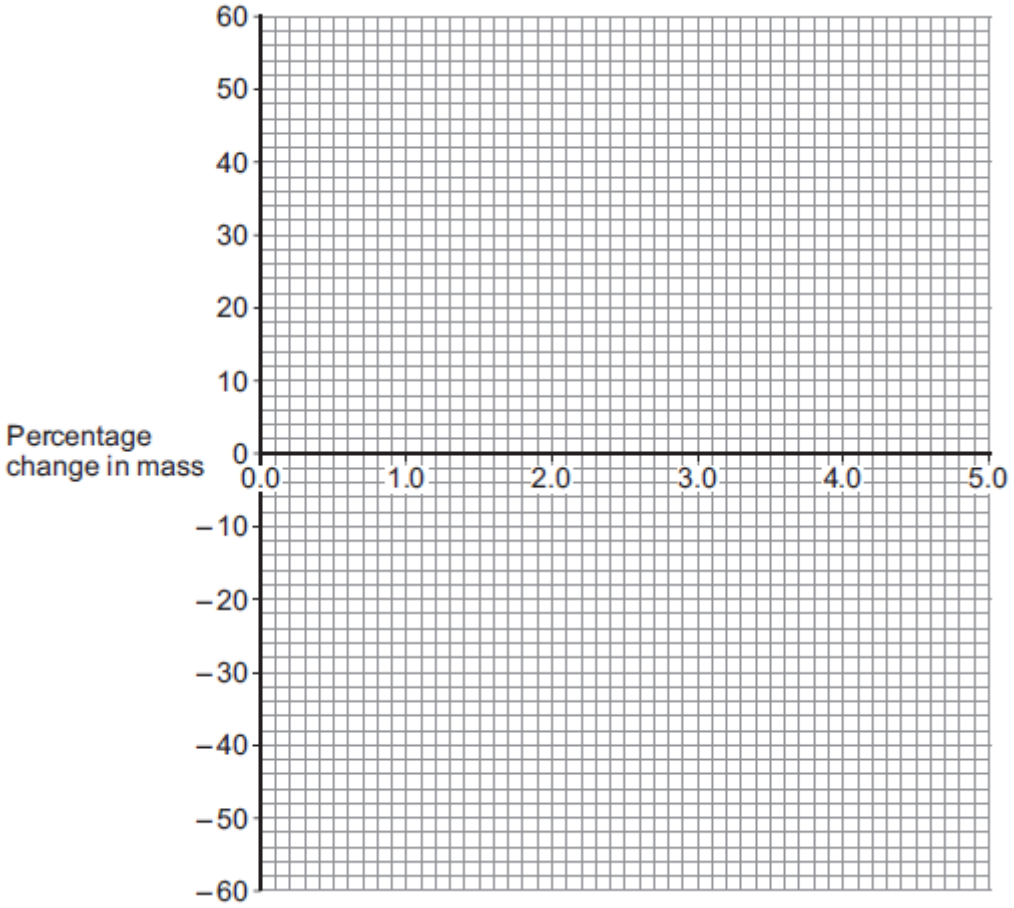
_____

Percentage change in mass = _____ %

(2)

(c) (i) On the graph paper below, draw a graph to show the scientists' results:

- plot the **percentage** change in mass
- label the horizontal axis
- draw a line of best fit.



(4)

(ii) The scientists thought one of their results was anomalous.

Draw a ring around the anomalous result on your graph.

(1)

(iii) Suggest what might have happened to cause this anomalous result.

_____

_____

(1)

(d) (i) What do you think is the concentration of salts in the lugworm's natural environment?

Use information from your graph to give the reason for your answer.

Concentration = _____ %

Reason _____

_____

_____

_____

(2)

(ii) The mass of the lugworms decreased in the salt solution with a concentration of 5.0 arbitrary units.

Explain what caused this.

_____

_____

_____

_____

_____

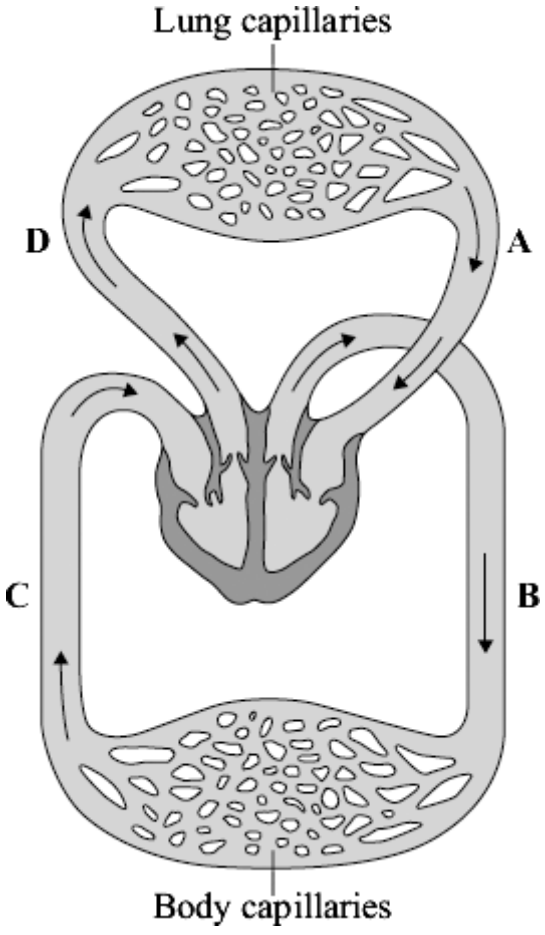
_____

(3)

(Total 19 marks)

Q5.

The diagram shows the human circulation system.



(a) (i) Give the letter of **one** blood vessel that is an artery. ☐

(1)

(ii) Give the letter of **one** blood vessel that carries oxygenated blood. ☐

(1)

(b) During exercise, the heart rate increases.

Explain, as fully as you can, why this increase is necessary.

(4)

(Total 6 marks)

Q6.

The table shows the composition of blood entering and leaving the lungs.

Gas	Concentration in arbitrary units	
	Blood entering lungs	**Blood leaving lungs**
Oxygen	40	100
Carbon dioxide	46	40

(a) Describe, in as much detail as you can, the changes that take place in the composition of blood as it passes through the lungs.

_____

_____

_____

(3)

(b) Which part of the blood:

(i) transports most carbon dioxide; _____

(ii) transports most oxygen? _____

(2)

(Total 5 marks)

CHEMISTRY - Q7.

Lithium batteries are used in laptops.

The batteries contain a lithium compound.
The formula of the compound is $LiCoO_2$

(a) Complete the table to show the number of atoms of each element in the formula, $LiCoO_2$

Lithium has been completed for you

Element	**Number of atoms in the formula $LiCoO_2$**
Lithium, Li	1
Cobalt, Co	
Oxygen, O	

(2)

(b) Some laptops have caught fire.

Scientists think sparks caused the fires.
The sparks caused small particles of lithium in the batteries to react with oxygen.

(i) Suggest where the oxygen reacting with the lithium came from.

_____

_____

(1)

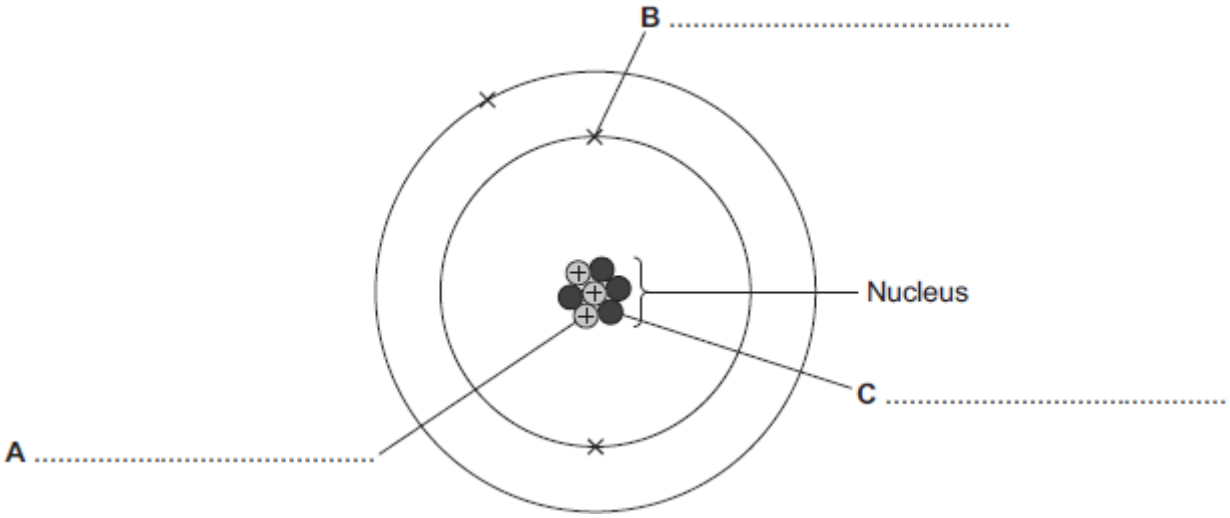
(ii) Name the product of the reaction between lithium and oxygen.

_____

(1)

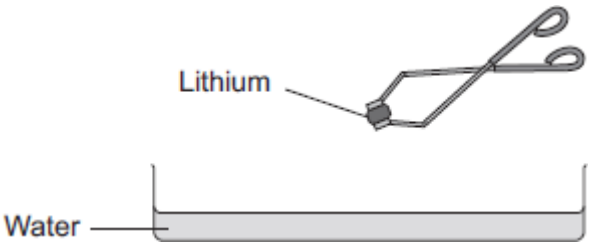
(c) The diagram below shows the structure of a lithium atom.

Name the particles labelled **A**, **B** and **C** on the diagram.



(3)

(d) Lithium hydroxide and hydrogen are produced when lithium reacts with water.



(i) Describe what you would **see** when lithium is added to water.

_____

_____

_____

_____

(2)

(ii) Complete the word equation for the reaction between lithium and water.

lithium + water ⟶ _____ + _____

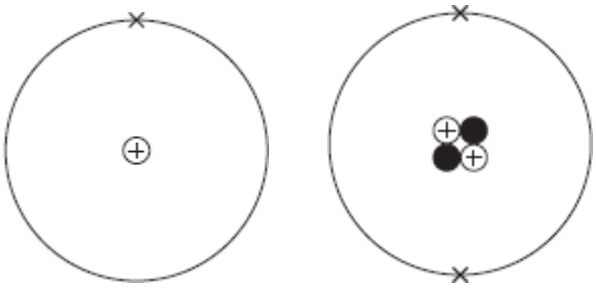
(1)

(Total 10 marks)

Q8.

The Sun produces helium atoms from hydrogen atoms by nuclear fusion reactions.

Hydrogen **Helium**



(a) Describe the differences in the atomic structures of a hydrogen atom and a helium atom.

_____

_____

_____

_____

_____

_____

_____

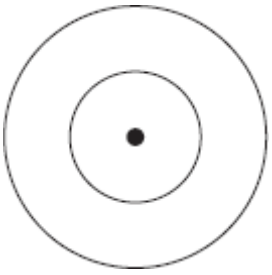
_____

(3)

(b) The Sun consists of 73% hydrogen and 25% helium.
The rest is other elements.
One of the other elements in the Sun is neon.

Use the Chemistry Data Sheet to help you to answer these questions.

(i) Complete the diagram to show the electronic structure of a neon atom.



(1)

(ii) Why is neon in the same group of the periodic table as helium?

_____

_____

_____

(1)

(Total 5 marks)

Q9.

The periodic table on the Data Sheet may help you to answer this question.

(a) Newlands and Mendeleev both designed periodic tables in which the elements were put in the order of their relative atomic masses.

When the elements are put in this order a few of them are placed incorrectly when compared with a modern periodic table.

(i) Give **one** example of a pair of elements that would be placed incorrectly if they were in the order of their relative atomic masses.

_____ and _____

(1)

(ii) Explain why placing these two elements in the order of their relative atomic masses would **not** be correct.

_____

_____

(1)

(b) In the modern periodic table the elements are put in order of their atomic (proton) numbers.

Explain how the positions of the elements in the periodic table are linked to the electronic structure of their atoms.

_____

_____

_____

_____

(2)

(Total 4 marks)

Q10.

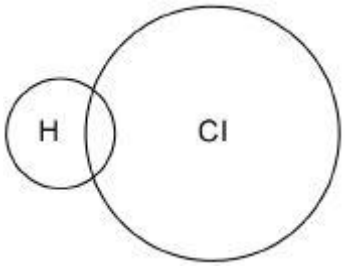
This question is about hydrogen chloride.

(a) A hydrogen atom contains 1 electron and a chlorine atom contains 17 electrons.

Complete **Figure 1** to show a dot and cross diagram for a hydrogen chloride molecule.

Show the outer electrons only.

Figure 1



(2)

Hydrogen gas (H_2) reacts with chlorine gas to produce hydrogen chloride.

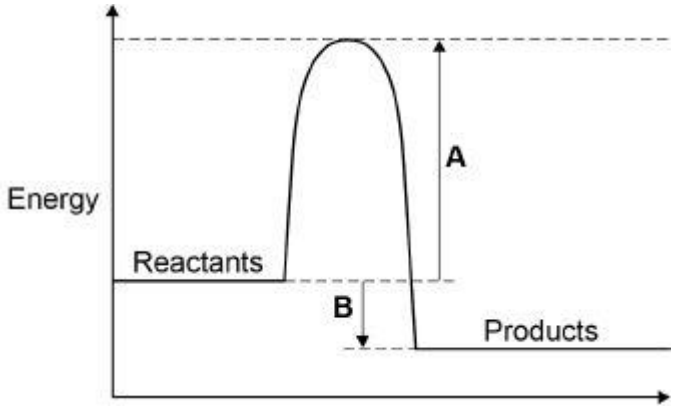
(b) Complete the balanced chemical equation for the reaction between hydrogen and chlorine.

$$H_2 + \_\_\_\_\_ \rightarrow \_\_\_\_\_$$

(2)

Figure 2 shows the reaction profile diagram for the reaction between hydrogen and chlorine.

Figure 2



(c) What do **A** and **B** represent on **Figure 2**?

A _____

B _____

(2)

(d) How does the reaction profile diagram show that the reaction is exothermic?

_____

_____

(1)

(e) Hydrogen chloride gas dissolves in water to form hydrochloric acid.

Hydrochloric acid contains hydrogen ions and chloride ions.

Explain why hydrogen chloride gas does not conduct electricity but hydrochloric acid is able to conduct electricity.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

Q11.

Many everyday items are made from iron.

(a) Haematite is an *ore* of iron. Haematite contains iron oxide, Fe_2O_3.

(i) What is the meaning of the term *ore*?

_____

_____

(1)

(ii) Iron can be produced by reacting iron oxide with carbon in a blast furnace.

What type of reaction produces the iron?

_____

_____

(1)

(iii) The word equation for this reaction is:

iron oxide + carbon → iron + carbon dioxide

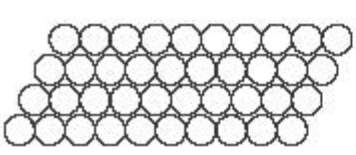
Complete and balance the symbol equation for this reaction.

___Fe_2O_3 + ___C → _____ + _____

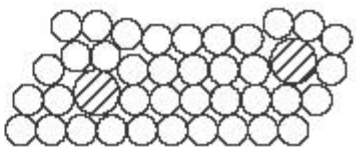
(2)

(b) Pure iron is relatively soft and not very strong.

The iron from the blast furnace is very hard and brittle. It contains about 4% carbon and is used as cast iron.



Pure iron



Cast iron

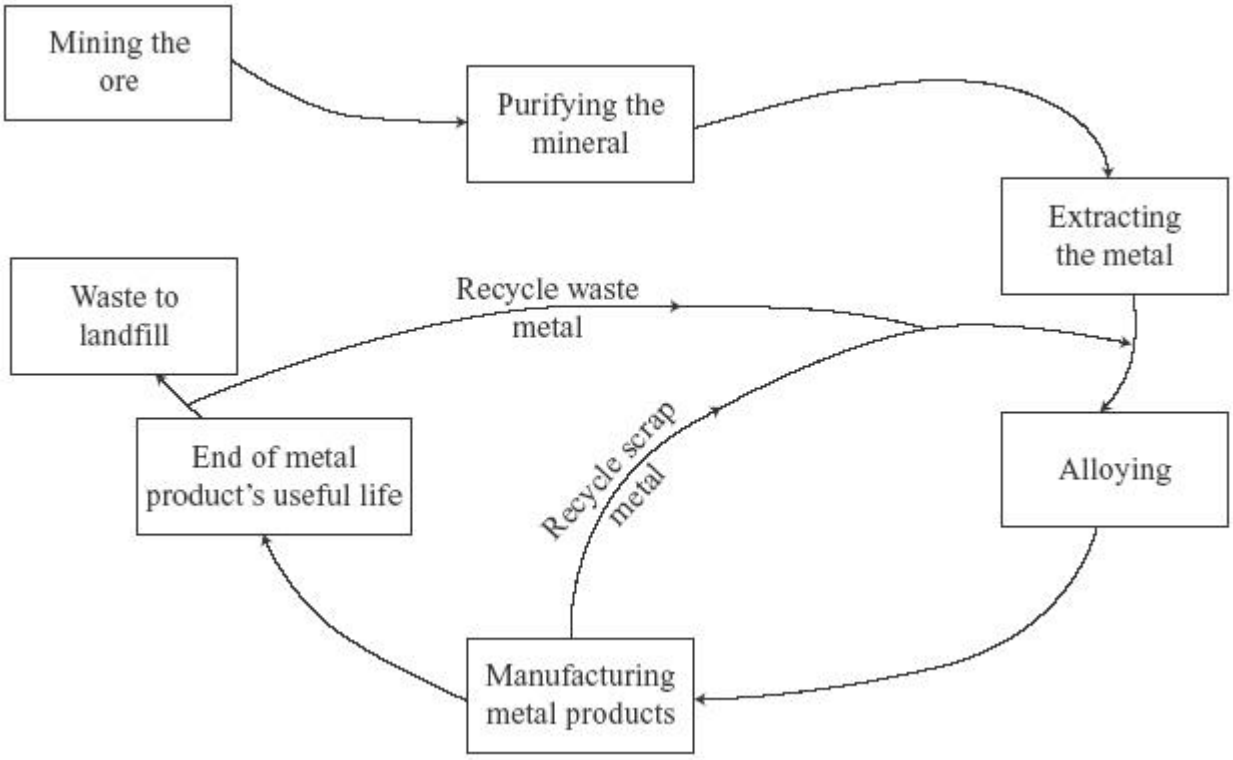
Explain the differences in the properties of pure iron and cast iron by referring to the diagrams.

_____

_____

(3)

(c) The diagram shows the way in which iron is extracted, used and recycled.



Explain why the recycling of iron is necessary for sustainable development.

(3)

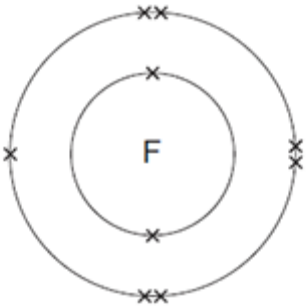
(Total 10 marks)

Q12.

This question is about fluorine.

(a) **Figure 1** shows the arrangement of electrons in a fluorine atom.

Figure 1



(i) In which group of the periodic table is fluorine?

Group _____

(1)

(ii) Complete the table below to show the particles in an atom and their relative masses.

Name of particle	Relative mass
Proton	
Neutron	1
	Very small

(2)

(iii) Use the correct answer from the box to complete the sentence.

alkalis	**alloys**	**isotopes**

Atoms of fluorine with different numbers of neutrons are

called _____ .

(1)

(b) Sodium reacts with fluorine to produce sodium fluoride.

(i) Complete the word equation for this reaction.

sodium + _____ → _____

(1)

(ii) Complete the sentence.

Substances in which atoms of two or more different elements are chemically

combined are called _____ .

(1)

(iii) The relative formula mass (M_r) of sodium fluoride is 42.

Use the correct answer from the box to complete the sentence.

ion	**mole**	**molecule**

The relative formula mass (M_r), in grams, of sodium fluoride is one

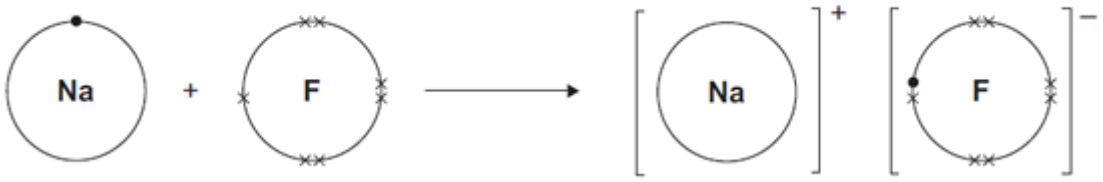
_____ of the substance.

(1)

(iv) **Figure 2** shows what happens to the electrons in the outer shells when a sodium atom reacts with a fluorine atom.

The dots (•) and crosses (×) represent electrons.

Figure 2



Use **Figure 2** to help you answer this question.

Describe, as fully as you can, what happens when sodium reacts with fluorine to produce sodium fluoride.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(v) Sodium fluoride is an ionic substance.

What are **two** properties of ionic substances?

Tick (✓) **two** boxes.

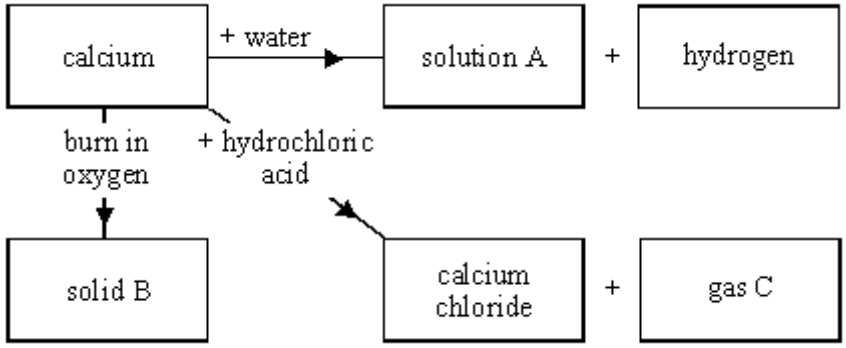
Dissolve in water	☐
Gas at room temperature	☐
High melting point	☐
Low boiling point	☐

(2)

(Total 13 marks)

Q13.

(a) The chart shows the reactions of the metal calcium with water, oxygen and dilute hydrochloric acid.



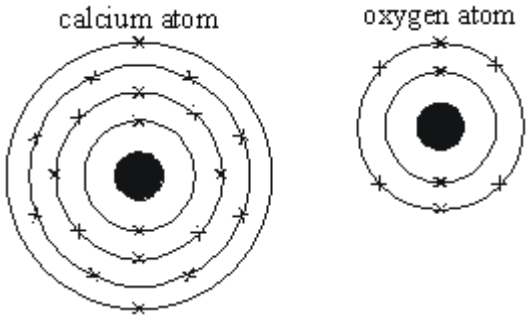
Name (i) solution A _____

(ii) solid B _____

(iii) gas C _____

(3)

(b) The diagrams below show the electronic structure of an atom of calcium and an atom of oxygen.



Describe fully what happens to its electrons when:

(i) a calcium atom forms a calcium ion. State the charge on the calcium ion formed.

_____

_____

_____

(3)

(ii) an oxygen atom forms an oxygen ion. State the charge on the oxygen ion formed.

_____

_____

_____

(3)

(c) Calcium oxide is an ionic compound. Why do ionic compounds have high melting points?

_____

_____

_____

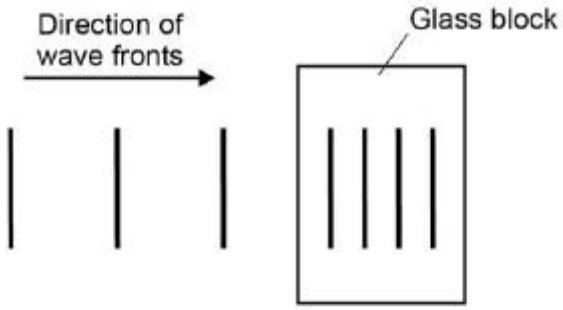
(2)

(Total 11 marks)

PHYSICS - Q14.

Figure 1 is a wave front diagram showing light travelling through the air and into a glass block.

Figure 1

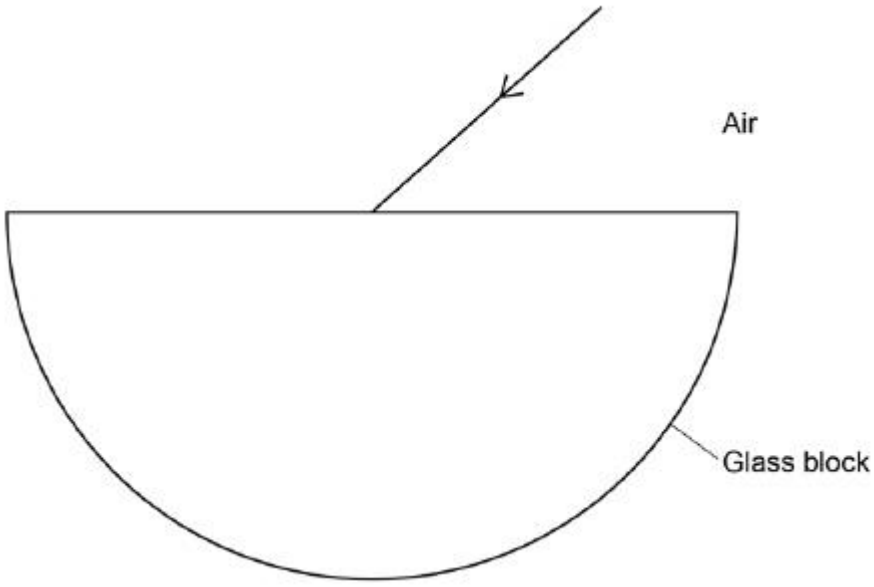


(a) Complete **Figure 1** by drawing wave fronts after they have left the glass block.

(1)

(b) **Figure 2** shows a ray of light incident on a semi-circular glass block.

Figure 2



Complete the ray diagram in **Figure 2**.

- Draw the ray of light passing through and leaving the glass block.
- Label the angle of refraction.

(4)

(c) Explain why the light is refracted.

_____

_____

_____

_____

(2)

(d) A student investigated how different coloured light was refracted by glass.

The student aimed rays of different coloured light at a glass block.

She measured the angle of refraction for each colour.

Give **two** variables that the student should control.

1. _____

2. _____

(2)

The table shows the student's results.

Colour of light	**Angle of refraction in degrees**
Red	27.94
Orange	27.90
Yellow	27.82
Green	27.78
Blue	27.70

(e) Explain why these results could **not** have been obtained with a normal protractor.

_____

_____

_____

_____

(2)

(f) What conclusion can be made about the relationship between the wavelength of light and the angle of refraction?

_____

_____

(1)

(g) Glass does **not** transmit ultraviolet radiation.

Suggest what happens to ultraviolet radiation when it is incident on glass.

_____

_____

(1)

(Total 13 marks)

Q15.

(a) Sound and light are different types of waves.

Give **two** similarities and **two** differences between sound waves and light waves.

_____

_____

_____

_____

_____

_____

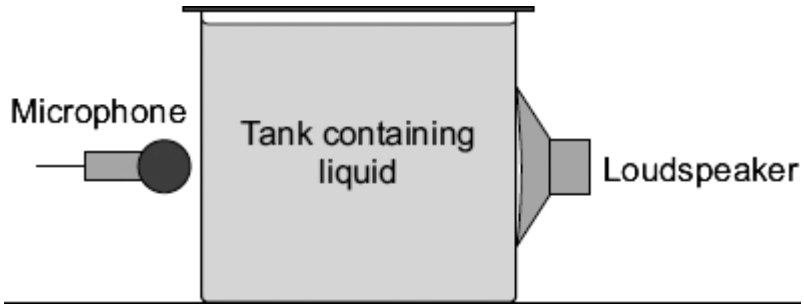
_____

_____

(4)

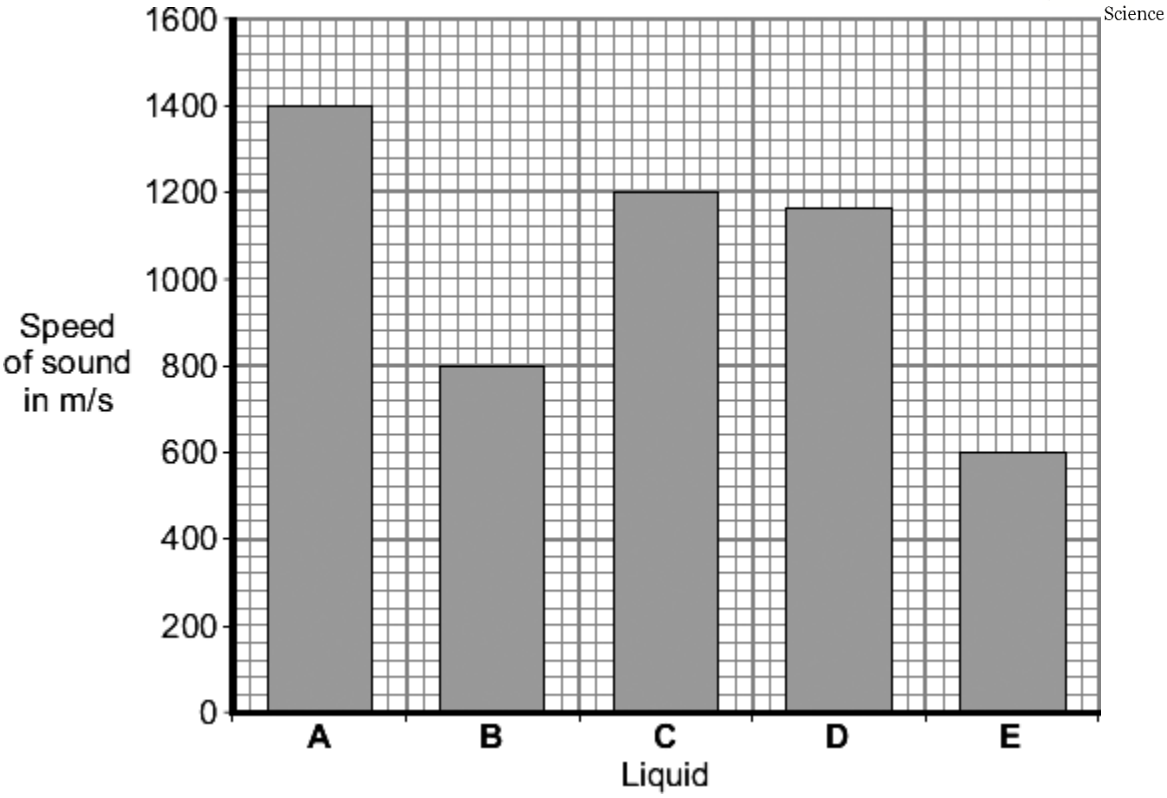
(b) A student does an experiment to investigate the speed of sound in different liquids.

The student uses the apparatus shown.



A loudspeaker makes a sound wave. The sound wave travels through the liquid in the tank. The time it takes to travel this distance is used to calculate the speed of sound.

The bar chart shows the student's results.



(i) When a sound wave with a frequency of 4800 hertz passes through one of the liquids, it has a wavelength of 0.25 m.

Calculate the speed of the wave and identify the liquid used.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

_____

_____

_____

_____

_____

Speed = _____ m/s

The liquid used was _____

(3)

(ii) The student's hypothesis was:
'There is a link between the density of a liquid and the speed of sound in the same liquid.'

Liquid	Density in g/cm^3	Speed of sound in m/s
Ethoxyethane	0.71	985
Ethanol	0.80	1150

Kerosene	0.82	1300
Water	1.00	1500
Mercury	13.50	1450

Use the information in the table to decide whether the student's hypothesis was completely correct or not.

Was the student's hypothesis completely correct?

Draw a ring around your answer. **Yes** / **No**

Give reasons for your answer.

_____

_____

_____

_____

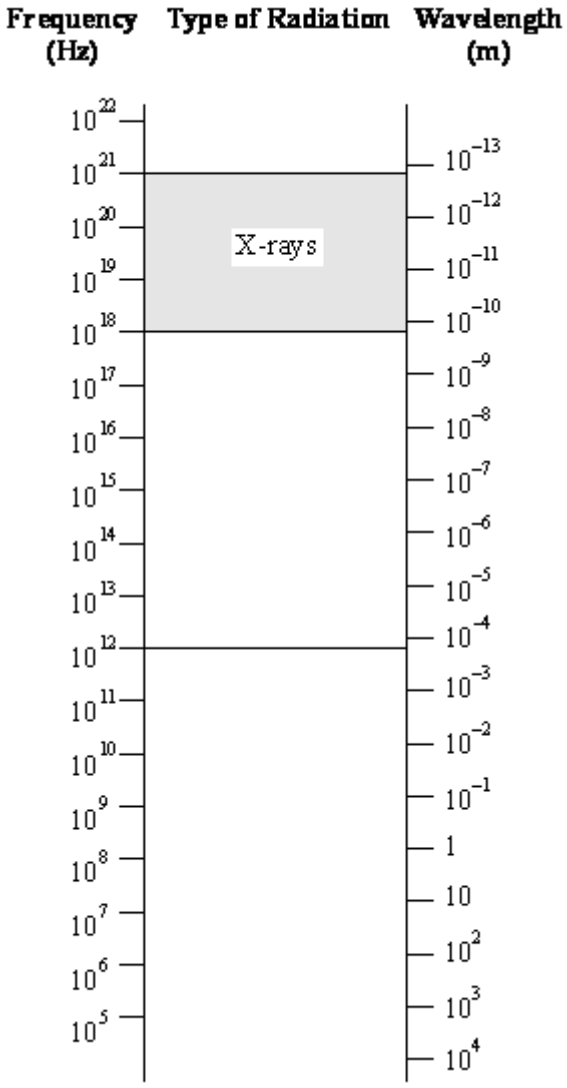
(2)

(Total 9 marks)

Q16.

The diagram below shows the range of wavelengths and frequencies for all the types of radiation in the electromagnetic spectrum.

X–rays, which have frequencies in the range 10^{18}–10^{21} Hz are already marked on the diagram.



Complete the diagram by adding the following:

(a) *gamma* radiation, which has shorter wavelengths than X–rays;

(b) *radio* waves which have wavelengths longer than 0.1m;

(c) the *visible* spectrum which has wavelengths from 400 nm (violet) to 700 nm (red);

(d) *ultraviolet* radiation (i.e. radiation with a higher frequency than violet light);

(e) *microwaves* which have a shorter wavelength than radio waves and *infrared* radiation which has a higher frequency than microwaves;

(f) an *FM* radio programme on 92MHz. (Show this with an arrow →)

(Total 7 marks)

Q17.

A note was played on an electric keyboard.

The frequency of the note was 440 Hz.

(a) (i) What does a frequency of 440 Hz mean?

_____

_____

(1)

(ii) The sound waves produced by the keyboard travel at a speed of 340 m / s.

Calculate the wavelength of the note.

Give your answer to **three** significant figures.

_____

_____

_____

Wavelength = _____ metres

(3)

(b) **Figure 1** shows a microphone connected to a cathode ray oscilloscope (CRO) being used to detect the note produced by the keyboard.

Figure 1

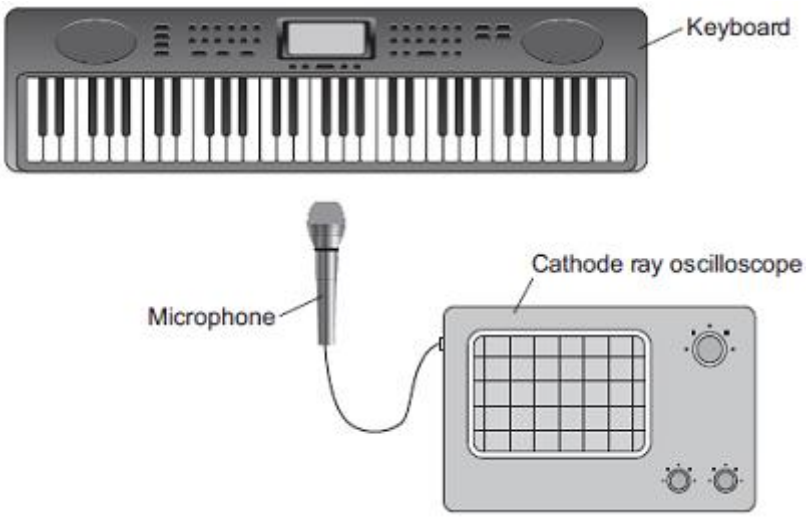
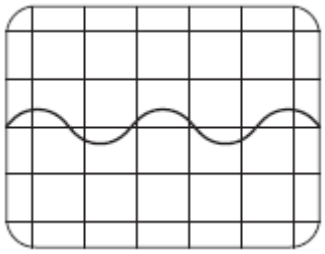


Figure 2 shows the trace produced by the sound wave on the CRO.

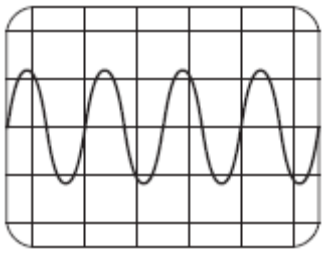
Figure 2



A second note, of different wavelength, was played on the keyboard.

Figure 3 shows the trace produced by the sound wave of the second note on the CRO.

Figure 3



The settings on the CRO were unchanged.

What **two** conclusions should be made about the **second** sound wave produced by the keyboard compared with the **first** sound wave?

Give a reason for each conclusion.

Conclusion 1 _____

_____

Reason _____

_____

Conclusion 2 _____

_____

Reason _____

_____

(4)

(Total 8 marks)

Q18.

A baby monitor has a sensor unit that transmits an image of the baby and the noises the baby makes to a monitor unit.

The monitor unit then displays an image of the baby and emits the noises the baby makes.

(a) Compare the properties of the waves that transmit images and noises from the monitor unit.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) The sensor unit can detect infrared and visible light.

Suggest **one** advantage of being able to detect infrared.

_____

_____

(1)

(c) Write down the equation that links frequency, wave speed and wavelength.

Equation _____

(1)

(d) The signals for the monitor unit are transmitted as electromagnetic waves with a wavelength of 0.125 m.

Wave speed of electromagnetic waves = 3×10^8 m / s

Calculate the frequency of the signal.

_____

_____

_____

_____

Frequency = _____ Hz

(3)

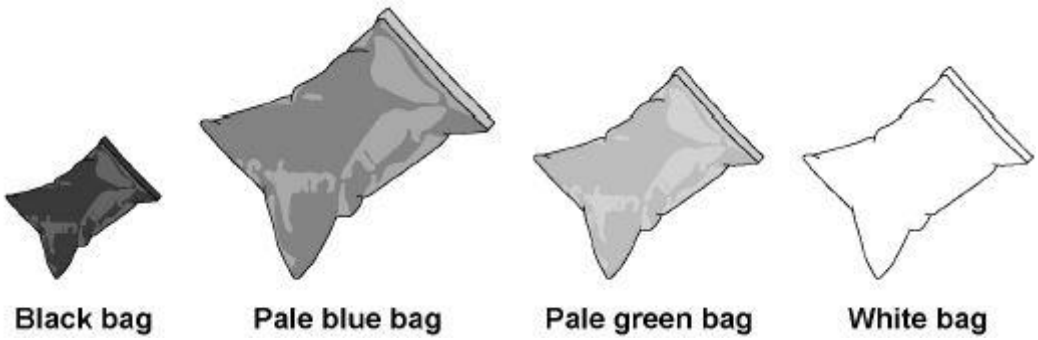
(Total 9 marks)

Q19.

A solar water bag can be used to heat water for an outdoor swimming pool.

A student wanted to find out if the colour of the solar water bag affects the temperature increase of the water inside the bag.

The diagram below shows some of the equipment used.



This is the method used.

1. Fill each bag with water.
2. Place the four bags on the ground outside.
3. After three hours, measure the temperature of the water inside each bag.
4. Repeat steps 1−3 on the next two days.

(a) Suggest three changes the student should make to this method to get valid results.

1. _____

_____

2. _____

_____

3. _____

_____

(3)

The student repeated the investigation using an improved method.

The results obtained were valid.

The table below shows the results.

Colour of bag	**Temperature increase in °C**			
	Day 1	**Day 2**	**Day 3**	**Mean**
Black	44.0	31.4	43.4	39.6
Pale blue	38.5	23.6	38.1	33.4
Pale green	37.9	23.7	37.7	33.1
White	25.3	23.4	24.2	**X**

(b) The student used a thermometer to measure the temperature of the water inside each bag.

What was the resolution of the thermometer?

Resolution = _____ °C

(1)

(c) Suggest **one** reason why the temperatures increased less on Day 2 than on Day 1 and Day 3.

_____

_____

(1)

(d) Calculate the mean temperature increase for the white bag.

_____

_____

Mean temperature increase = _____ °C

(1)

(e) Which colour of bag would be best to use to heat water?

Give a reason for your answer.

Colour _____

Reason _____

_____

_____

_____

(2)

(Total 8 marks)