THE DUSTON SCHOOL
Knowledge itself is power
TDS 4-19

Year 9 Science Knowledge Booklet

Term 5

Name:	**Class:**
Homework 1 Due: 21st April	**Homework 3 Due: 19th May**
Homework 2 Due: 5th May	

Knowledge Booklet: **C2 Structure and Bonding**

Science Homework Task 1

Read all of this knowledge organiser.

Big Questions and Vocabulary

- How do atoms bond together?
- Why do atoms bond together?
- What's the difference between metals and non metal?
- If graphite and diamond are both made of Carbon, why do they have such different properties?
- Why is Sodium a very reactive metal, chlorine a very toxic substance but Sodium chloride is safe to eat?

. What are plastics and how are they made?

Atom The smallest particle of a chemical element that can exist	**Element** A substance that cannot be broken down into other substances. It made up of the same type of atoms	**Compound** A substances made up of atoms of 2 or more elements chemically bonded together
Electron A subatomic particle. It has a charge of -1 and a negligible mass	**Bond** A strong force of attraction between atoms or oppositely charged ions	**Properties** The characteristics or typical features, e.g melting point, density, conductivity.
Ionic bond The (electrostatic) force of attraction between oppositely charged ions. Typically a positive metal ion and negative non metal ion	**Covalent bond** The (electrostatic) force of attraction that occurs when 2 non metal atoms share a pair of electrons	**Metallic bond** The (electrostatic) force of attraction between positively charged metal ions and the delocalised electrons.
Electrical Conductivity The ability to allow a current to flow through the substance. Requires charges / delocalised electrons that are **MOBILE** (free to move)	**Molten** Term used to describe metals / ionic compounds in a liquefied state	**Intermolecular force** A weak attraction **between** molecules. The bigger the atom / molecule, the **MORE** intermolecular forces there are
Allotrope Two or more different physical forms in which an element can exist, e.g Diamond and Graphite are both allotropes of Carbon	**Aqueous** Dissolved in water	**Boiling point** The temperature at which a substance changes state from a liquid to a gas
Melting point The temperature at which a substance changes state from a solid to a liquid	**Monomer** A small molecule that contains a C=C double bond (an alkene)	**Polymer** A long chain molecule made up of a repeat unit of monomers
Fullerenes Molecules of carbon atoms with hollow shapes, e.g Buckyballs and carbon nanotubes	**Alloys** A mixture of metals, the quantities are typically carefully controlled to give specific properties	**Malleable** Can be bent or hammered into shapes.

Sample Extended Questions / Practical based questions

What are the typical properties of metals, and how do these compare to non-metals?

Compare the similarities and differences between ionic, covalent and metallic bonding

Give some typical properties of Sodium, Chlorine and Sodium Chloride and describe why they are different

Compare the structure and bonding in graphite and diamond, and explain the effect on their properties

The majority of elements found in the periodic table do not exist as single atoms, instead they gain, lose or share electrons to get to a more stable electron configuration. The only elements that exist as single atoms are the group 0 elements (the noble gases). This is because they already have a stable electron configuration (full outer shell

There are 3 types of bonding

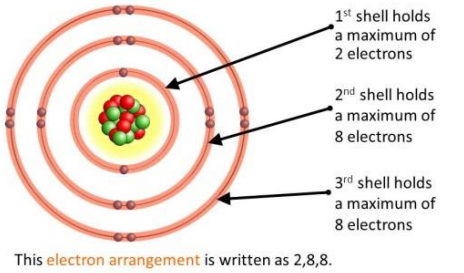
Ionic	***Occurs when metals form compounds with non metals***	The electrostatic force of attraction between oppositely charged ions
Covalent	***Occurs within non metal elements or compounds***	The electrostatic force of attraction between shared pair of electrons and the nuclei of the atoms
Metallic	***Occurs within pure metals or alloys***	The electrostatic force of attraction between positive metal ion and the sea of delocalised electrons

Within each type of bond, there is something positively charged, and something negatively charged, this is the electrostatic force of attraction.

Type of bond	Preamble	Positive charged thing	Negatively charged thing
Ionic	The electrostatic force of attraction between	Postive charged ion (typically the metal ion)	Negatively charged ion (the non metal ion)
Covalent		Positively charged nucleus	Shared pair of electrons
Metallic		Positively charged metal ion	Sea of delocalised electrons

How many electrons per shell?

Each shell has a maximum number of electrons that it can hold.
Electrons will fill the shells nearest the nucleus first.



This electron arrangement is written as 2,8,8.

E.g an atom of Chlorine.
A chlorine atom has 17 electrons.
1st shell max of 2
This leaves 15
2nd shell max of 8
This leaves 7
3rd shell max of 8
The 7 go in this shell
The configuration therefore is 2,8,7.

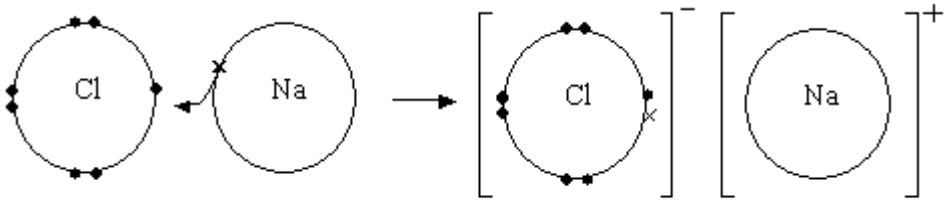
E.g Sodium ions.
A Sodium atom has 11 electrons
1st shell max of 2
This leaves 9
2nd shell max of 8
This leaves 1
3rd shell max of 8
The 1 goes in this shell
The configuration therefore is 2,8,1
To get a complete outer shell, it needs to lose the 1 outer electron
$[2,8]^+$

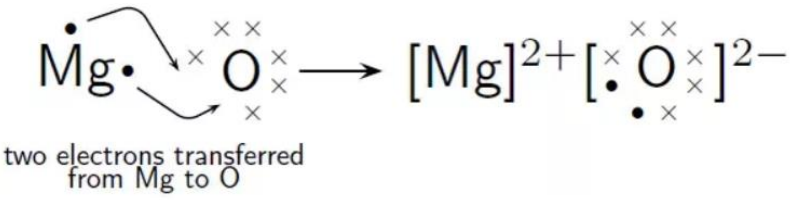
When considering the number of covalent bonds or the charge on the ions we need to know the number of outer shell electrons. The inner shells does not affect the bonding.

Ionic bonding → Charge on ions

Group 1 elements	Single positive charge, e.g Li^+ Na^+ K^+
Group 2 elements	Double positive charge, e.g Be^{2+} Mg^{2+} Ca^{2+}
Group 3 elements	Triple positive charge, e.g Al^{3+}
Group 5 elements	Triple negative charge, e.g N^{3-} P^{3-}
Group 6 elements	Double negative charge, e.g O^{2-} S^{2-}
Group 7 elements	Single negative charge, e.g F^- Cl^- Br^-

Drawing Ionic bonds	***Metal outer shell is shown empty, draw inside square bracket with the charge outside the brackets in top right hand corner;*** ***Non metal outer shell is shown full, drawn insider square brackets with the charge outside the bracket in top right hand corner. The non metals original outer shell electrons are drawn with one symbol, the extra electrons gained with another symbol.***



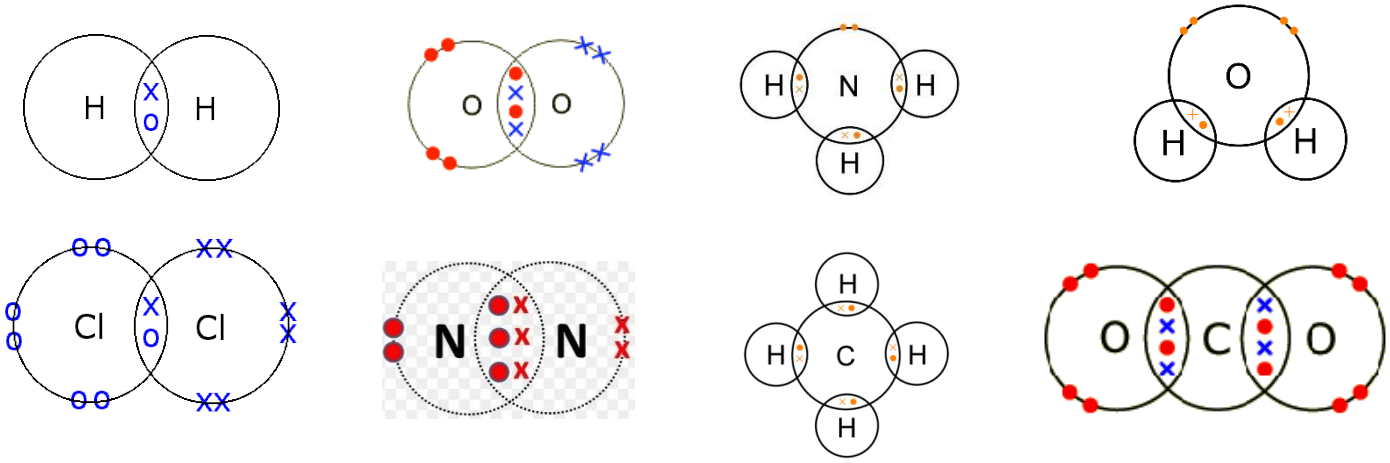


two electrons transferred from Mg to O

Covalent bonding → Number of bonds formed per element

Group 4 elements	4 single bonds overall formed per element (or 2 double bonds, or 1 double 2 single bonds)
Group 5 elements	3 single bonds overall formed per element (or 1 double 1 single)
Group 6 elements	2 single bonds overall (or 1 double bond)
Group 7 elements (and hydrogen)	1 single bonds.

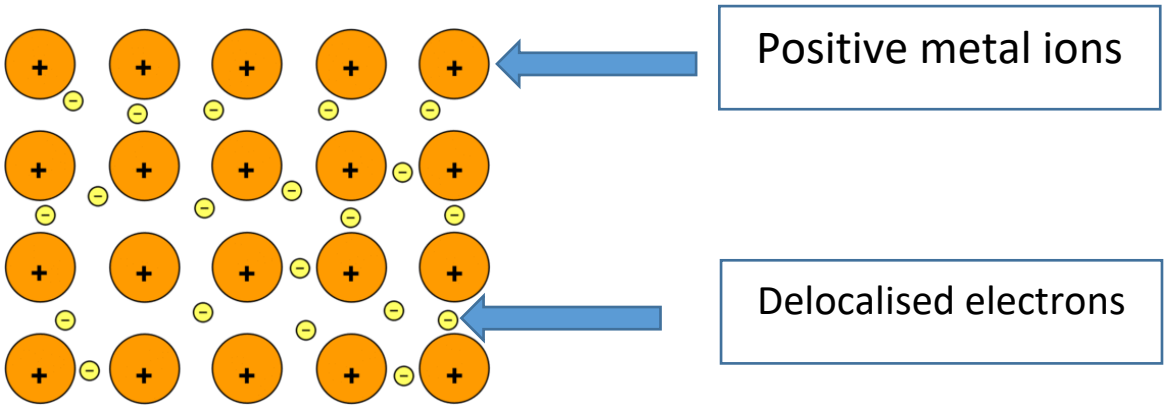
Drawing Covalent bonds	***Drawn like a Venn diagram, the unpaired outer electrons of the central atom pair up with unpaired electrons of the other atoms. Each overlap is where the bond forms, 1 pair of electrons is a single bond, 2 pairs of electron is a double bond.***



Metallic bonding → Charge on ions

Group 1 elements	Single positive charge, e.g Li^+ Na^+ K^+
Group 2 elements	Double positive charge, e.g Be^{2+} Mg^{2+} Ca^{2+}
Group 3 elements	Triple positive charge, e.g Al^{3+}

Drawing metallic bonds	***Regular arrangement of the metal ions, labelled, along with electron (represented with e^- randomly arranged around the ions. The number of electrons should be equal to the charges on the ions.***



Feature	Type of Bonding			
	Ionic	**Simple Covalent**	**Giant Covalent**	**Metallic**
Type of elements	Metal – Non metal	Non metal – Non metal	Non metal – Non metal	Metals
Interaction	Positive (metal) ion to Negative (non metal) ion	nucleus attracted to shared pair of electrons	nucleus attracted to shared pair of electrons	Positive metal ions to the DELOCALISED electrons
Melting point	High	Low	High	Normally High
Conductivity	Not when solid but does when molten or aqueous as ions are mobile	Doesn't conduct, no mobile ions or delocalised electrons	Doesn't conduct (except graphite which has delocalised electrons)	Good conductors of heat and electricity as they have delocalised electrons to transfer energy
Examples	NaCl, MgO	O_2, CO_2, H_2O	Graphite, Diamond, Silicon dioxide	Fe, Au, Na, Cu

<u>Properties</u>

Melting point → The temperature needed to get a change in state from a solid to a liquid.

The temperature needed depends on the strength of the interactions that need to be broken / weakened.

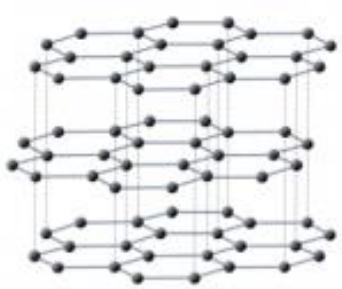
Ionic, Covalent and Metallic bonds are very strong, and need a large amount of energy to be broken.

Intermolecular forces occur between all molecules, these are very weak by comparison and don't need a lot of energy to break.

In simple covalent structures, only the intermolecular forces are broken, NOT the covalent bonds. This is why they are often gases and liquids at room temperature

Graphite

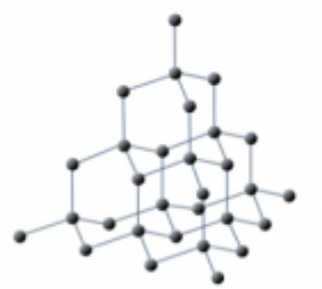
- Each carbon forms 3 bonds
- Soft / slippery as it has layers held together by weak forces
- Can conduct electricity (1 electron free per carbon



Graphite (solid lines are strong covalent bonds, dotted lines are weak inter-layer bonds)

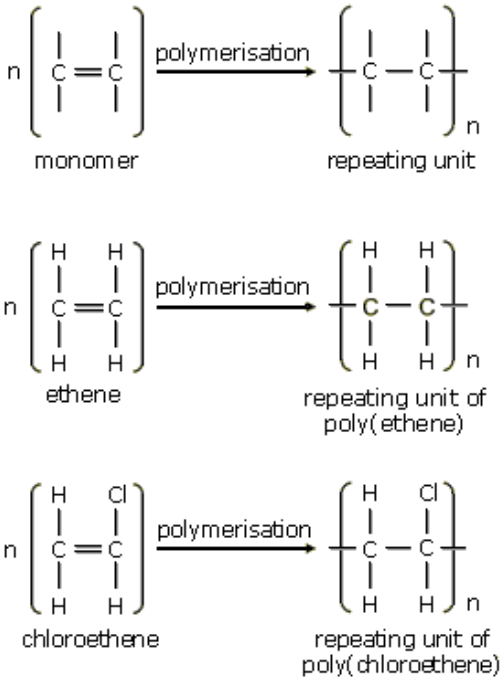
Diamond

- Each carbon forms 4 bonds
- Very hard as held together by strong covalent bonds
- Can't conduct electricity because ALL of the electrons are in bonding



Diamond (all bonds are strong covalent bonds)

Polymers are long chain molecules formed from monomers. The monomers are alkenes, containing a double bond. During polymerisation, the double bond breaks and a single long chain molecule is formed. Due to the very long chains, the intermolecular forces are stronger so they have higher melting points than the monomers.



Explain how copper conducts electricity.

Link to the delocalised electrons and how they are delocalised by describing structure of metal

(2)

Explain why diamond is hard.

Typical question linked to diamond. Discuss the number of bonds each carbon atom forms and what you would need to do to break them

(2)

Describe the structure and bonding in sodium chloride.

Describe first how the ions form then link to the arrangement.

No need to link to properties as its not in the question

As it is 4 marks, key words / phrases are vital here

(4)

Science Homework 2

Pillar

Literacy – Learn these spellings

Electrostatic

Covalent

Intermolecular

Fullerene

Polymer

Delocalised

Allotrope

Lattice

Memory – Learn the definitions for

Ionic bonding → Electrostatic force of attraction between oppositely charged ions
Covalent bonding → Electrostatic force of attraction between shared pair of electrons and nuclei of the atoms
Metallic bonding → Electrostatic force of attraction between possible metal ions and sea of delocalised electron
Diamond → Allotrope of Carbon, atoms are arranged in giant covalent lattice (tetrahedral arrangement) with each carbon atom bonded to **FOUR** others
Graphite → Allotrope of Carbon, atoms are arranged in giant covalent lattice (hexagonal arrangement) with each carbon atom bonded to **THREE** others

Video - Watch these videos
Ionic bonding 1 →
https://www.youtube.com/watch?v=Biq-e9hsbiI
Ionic bonding 2 →
https://www.youtube.com/watch?v=-DZR0OLQC9w
Properties Ionic bonding →
https://www.youtube.com/watch?v=leVxy7cjZMU
Covalent bonding 1 →
https://www.youtube.com/watch?v=lenvZEcMc60
Covalent bonding 2 →
https://www.youtube.com/watch?v=lhEm7aAKIDg
Properties covalent bonding →
https://www.youtube.com/watch?v=DECGNvC-x_s

Exam Practice (turn over)

BUG the question (draw a **Box** around the instruction word, **Underline** scientific key words, **Go** for the right number of marks)

Complete the exam questions on the back of this page.

Research

Use the internet to find out how the properties of iron are changed when other elements are added when forming the alloy steel

Question

Read through the four slides on this website https://www.bbc.co.uk/bitesize/guides/z9twsrd/revision/1 and make a summary table comparing the similarities and differences in the giant covalent compounds Silicon dioxide, diamond, graphite and graphene

Skills you are working on

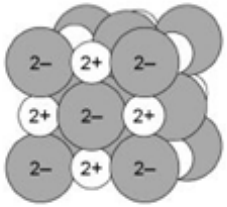
Learning spellings using look, cover, write, check.
Making notes from the video.
Using memory techniques to learn the definitions.
Understand what the exam questions are asking.
Using key words in your answers.

Exam Question

Q1. This question is about structure and bonding.

(a) **Figure 1** shows part of the structure of calcium oxide (CaO).

Figure 1

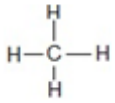


What type of bonding is present in calcium oxide? Tick **one** box.

Covalent	☐	Macromolecular	☐
Ionic	☐	Metallic	☐

(b) **Figure 2** shows a particle of methane (CH_4).

Figure 2



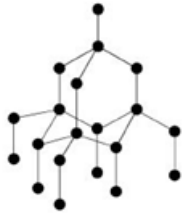
What type of particle is present in **Figure 2**? Tick **one** box.

An ion	☐	A molecule	☐
A lattice	☐	A polymer	☐

This question is about structure and bonding.

(a) **Figure 1** shows part of the structure and bonding in diamond.

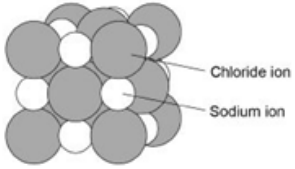
Figure 1



Explain why diamond has a high melting point.

Figure 2 shows part of the structure and bonding in sodium chloride (NaCl).

Figure 2



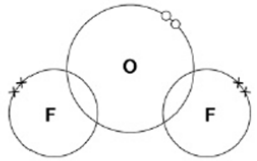
Explain the conditions needed for sodium chloride to conduct electricity.

This question is about oxygen.

(a) One oxygen atom shares one pair of electrons with each fluorine atom in oxygen difluoride (OF_2).

Complete the dot and cross diagram of oxygen difluoride below.

You should show only the electrons in the outer shells.



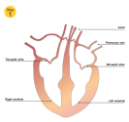
(b) Oxygen difluoride (OF_2) has a melting point of – 224 °C and a boiling point of –145 °C

What is the state of oxygen difluoride at room temperature?

Explain your answer in terms of structure and bonding.

(3)

Knowledge Booklet: **Paper 1 B2 Organisation**



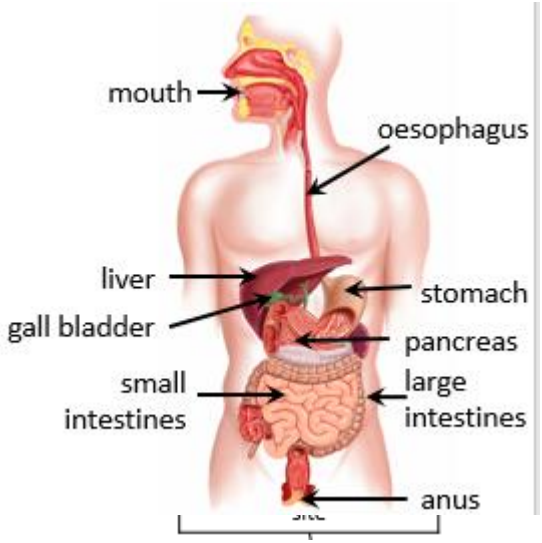
Big Questions and Vocabulary

- What is blood?
- How does the heart work?
- What do stomata do?
- How do substance move around a plant?
- How do we break down food?

Active site **Region of an enzyme where substrate molecules bind and undergo a chemical reaction.**	**Alveolus** **A tiny air sac in the lungs, where gas exchange occurs**	Amylase **An enzyme that catalyses the hydrolysis of starch into sugars.**
Benign Normally slow growing tumours that do not spread to other parts of the body.	**Blood** A tissue which transports substances around the body in the circulatory system.	**Blood Vessels** Structure specially adapted to carry the blood around the body
Denature The active site of an enzyme changes shape and the enzyme is no longer able to function.	**Enzyme** Protein molecule that catalyses chemical reactions inside cells and the body.	**Malignant** A tumour that can spread through the body for example via the blood stream (metastasise).
Non-communicable disease A disease that cannot be transferred from organism to organism.	**Organ** A group of similar tissues working together to perform a particular function.	**Organ System** A group of organs working together to perform a particular function.
Pacemaker A group of cells located in the right atria of the heart that regulates the heart rate.	**Risk Factor** Something that increases a chance of developing a disease. Risk factors can be caused by lifestyle factors or substances in a person's body or their environment.	**Statin** A drug used to reduce cholesterol in the blood. Can be used to treat CHD.
Stent Stents are made from metal alloys and are used to widen the coronary arteries if they have been blocked due to CHD.	**Stoma** A pore on the underside of a leaf.	**Substrate** The molecule that fits into the active site of an enzyme.
Tissue A group of similar cells working together to perform a particular function.	**Translocation** Is the movement of sugar produced in photosynthesis to all other parts of the plant for respiration and other processes. This occurs in phloem cells.	**Transpiration** Is the evaporation of water at the surfaces of the spongy mesophyll cells in leaves, followed by loss of water vapour through the stomata.

Organisation	
Tissue	A **group of cells** with a **similar structure and function** e.g. muscle tissue
Organ	A **group of tissues** performing a specific **function** e.g. heart, leaf
Organ System	A **group of organs** that perform a specific **function** e.g. digestive system.

The Digestive system

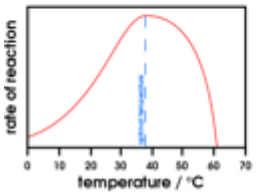
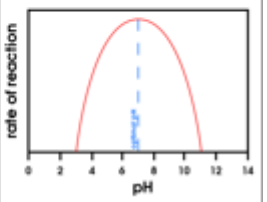


Enzymes Key Terms	
Enzyme	A **biological catalyst** that can **speed up the rate of reaction** without being used itself. Made of a large **protein molecule**.
Substrate	The **chemical that fits into** the **active site** of an enzyme.
Lock and Key Model	Only **one type of substrate** can **fit into the active site** of an enzyme, like a key fits into a lock.
Denatured	When the **active site of an enzyme changes shape** and the **substrate can no longer fit in**. Can be caused by **pH** or **temperature**.

The 'lock and key theory' is a simplified model to explain enzyme action

Enzymes catalyse specific reactions in living organisms due to the shape of their active site

The activity of enzymes is affected by changes in temperature and pH

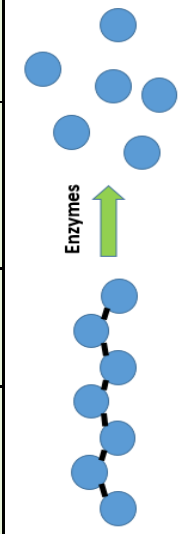
Enzymes activity has an optimum temperature	*Enzyme activity has an optimum pH*
	

Large changes in temperature or pH can stop the enzyme from working (denature)

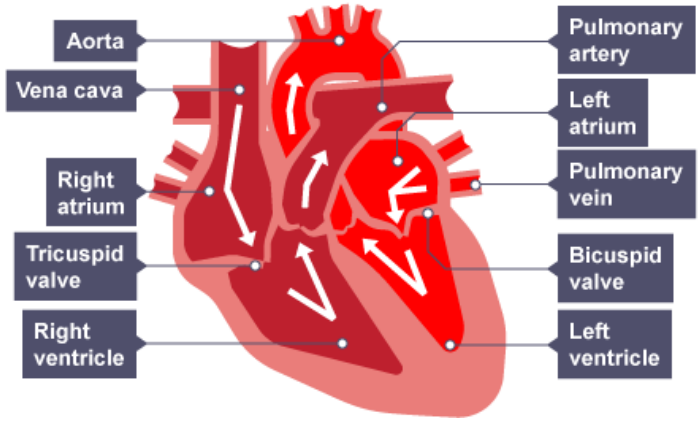
Temperature too high	*pH too high or too low*

Enzyme changes shape (denatures) the substrate no longer fits the active site.

Testing for Biological Molecules Molecule	Chemical Test	Positive Result
Starch	Add orange/brown **iodine solution**.	Colour turns to **blue/black**.
Sugar	Add blue **Benedict's solution**. Place in a **boiling water bath for 5 minutes**.	Colour turns **green/ yellow/ orange/ brick red**.
Protein	Add blue **Biuret solution**.	Colour turns to **lilac/ purple**.
Lipid	Add **Sudan III**.	**2 layers form, red layer on top**.

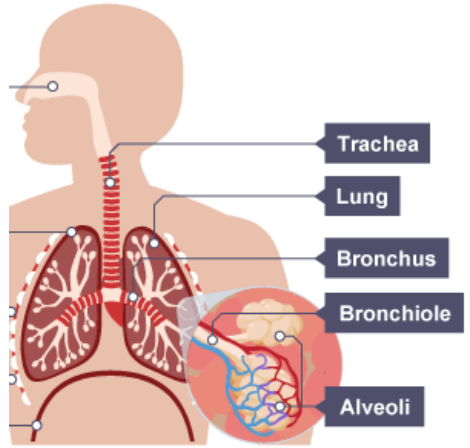
Carbohydrases (e.g. amylase)		***Made in salivary glands, pancreas, small intestine***	Break down carbohydrates to simple sugar (e.g. amylase breaks down starch to glucose).
Proteases		***Made in stomach, pancreas***	Break down protein to amino acids.
Lipases		***Made in pancreas (works in small intestine)***	Break down lipids (fats) to glycerol and fatty acids).
Bile (not an enzyme)		***Made in liver, stored in gall bladder.***	Emulsifies lipids to increase surface area to increase the rate of lipid break down by lipase. Changes pH to neutral for lipase to work

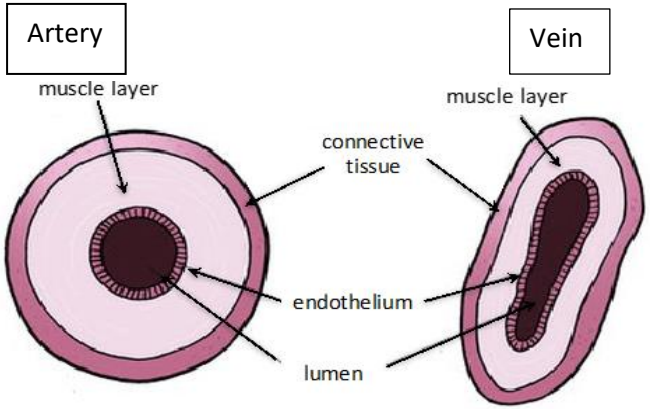
Different structure in the heart have different functions		
	Right ventricle	Pumps blood to the lungs where gas exchange takes place.
	Left ventricle	Pumps blood around the rest of the body.
	Pacemaker (in the right atrium)	Controls the natural resting heart rate. Artificial electrical pacemakers can be fitted to correct irregularities.
	Coronary arteries	Carry oxygenated blood to the cardiac muscle.
	Heart valves	Prevent blood in the heart from flowing in the wrong direction.



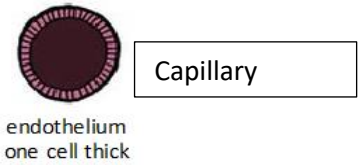
Plasma (55%)	***Pale yellow fluid***	Transports CO_2, hormones and waste.
Red blood cells (45%)	***Carries oxygen***	Large surface area, no nucleus, full of haemoglobin.
White blood cells (<1%)	***Part of the immune system***	Some produce antibodies, others surround and engulf pathogens.
Platelets (<1%)	***Fragments of cells***	Clump together to form blood clots.

Trachea	***Carries air to/from the lungs***	Rings of cartilage protect the airway.
Bronchioles	***Carries air to/from the air sacs (alveoli)***	Splits into multiple pathways to reach all the air sacs.
Alveoli	***Site of gas exchange in the lungs***	Maximises surface area for efficient gas exchange.
Capillaries	***Allows gas exchange between into/out of blood***	Oxygen diffuses into the blood and carbon dioxide diffuses out.





	Artery	**Vein**	**Capillary**
Purpose	Takes blood **away from the heart**.	Takes **blood back to the heart**.	**Exchange of substances between blood and cells.**
Adaptations	**Thick wall** to **withstand high pressure**	Thin wall. **Valves to prevent backflow of blood**.	Wall is **one cell thick** to allow **quick diffusion** of substances.



Heart Disease			
Coronary Heart Disease	Build-up of **fatty material in coronary arteries**. Can lead to a **blood clot** and a **heart attack**.		
Treatment	**What it is**	**Advantage**	**Disadvantage**
Stent	**Wire mesh** that **opens up** a **blocked artery**.	Keeps artery open. Low-risk surgery.	Fatty material can rebuild.
Statin	Drug that **reduces cholesterol**.	Reduces fat being deposited in arteries.	Side effects e.g. liver damage.
Heart transplant	**Replacement heart** from a donor.	Long-term.	Major surgery. Could be rejected.
Artificial heart	**Man-made heart** used while **waiting for a transplant**.	Not rejected. Keeps patient alive.	Short life-time. Battery has to be transported. Limited activity.
Mechanical heart valve	Mechanical replacement of faulty heart valve.	Can last a life-time.	Can damage red blood cells.
Biological heart valve	Biological replacement of faulty heart valve.	Don't damage red blood cells.	Valve hardens and may need replacing.

Cancer — The result of changes in DNA that lead to uncontrolled growth and division

Benign tumour	Contained in one area of the body (usually by a membrane) – not cancer.
Malignant tumour	Invade tissues and spread to different parts of the body to form secondary tumours.

Some cancers have genetic risk factors.

Carcinogens and ionising radiation increase the risk of cancer by changing/ damaging DNA

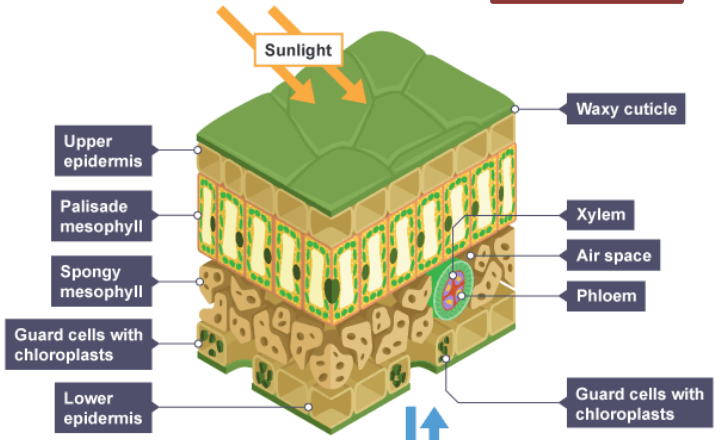
Risk factors for heart/lung disease and certain types of cancer include drinking alcohol, diet, obesity and smoking

These risks factors can also affect the brain, liver and the health of unborn babies

Movement within Plants	
Transpiration	The **loss of water vapour** from the leaves by **evaporation from cells** and then out through the **stomata**.
Transpiration Stream	The **movement of water** from the **roots**, up the stem to the **leaves**.
Translocation	The **movement** of **dissolved sugars** around the plant.

Factors Affecting Transpiration	
Temperature	Increasing temperature **increases the transpiration rate** as water evaporates quickly.
Humidity	Increasing humidity **decreases the rate of transpiration** as water evaporates slowly.
Wind speed	Increasing wind speed **increases the transpiration rate** as water evaporates quickly.
Light	Increasing light **increases the rate of transpiration** as **stomata open**.

Epidermis	**Cover** the **surfaces** of the leaf; lets **light penetrate**.59
Xylem	**Carries water** and **minerals** from the roots around the plant.
Phloem	**Carries dissolved sugars** made through photosynthesis around the plant. 6
Palisade mesophyll	Where **most photosynthesis** takes place. Cells contain **many chloroplasts**. **Absorbs light**.
Spongy mesophyll	**Some photosynthesis**. Has **air spaces** for **diffusion** of CO_2 and O_2.
Guard cells	Cells that **open** and **close stomata**.
Stoma	**Opening** that allows **CO_2 and O_2** to **diffuse** in and out of the leaf.



Leaf Structure

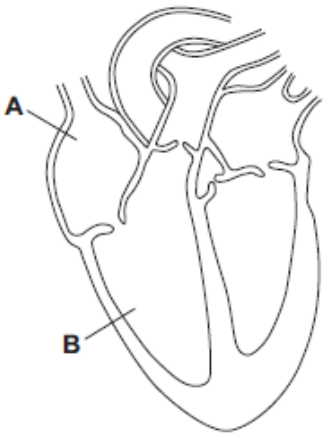
Cell Adaptations for Movement Within Plants			
			
Root hair cell **Extension** gives a **large surface area** to **absorb water and minerals**.	Xylem Vessels are **strengthened by lignin** to **withstand pressure.** Cell walls are **waterproof.**	Phloem End of cells **contain pores to allow dissolved sugars to move** between cells.	Guard Cells and Stoma Guard cells can **open** the stoma to allow **gas exchange** or **close** to **prevent water loss.**

Q1.

Diagram 1 shows a section through the heart.

Diagram 1

This is a common question on exam papers



They don't always provide names for you to pick from

(a) Use words from the box to name the structures labelled **A** and **B** on **Diagram 1**.

aorta	**atrium**	**pulmonary artery**	**ventricle**

A _____

B _____

(2)

(b) Draw arrows on **Diagram 2** to complete the route taken by <u>deoxygenated blood</u> through the heart.

Key part – can you remember which side of the heart this travels through??

Diagram 2

Another common question related to structure and applying knowledge to the situation given

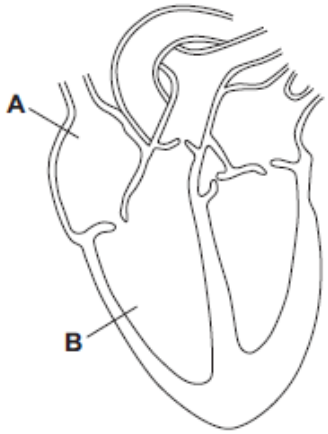
(2)

Q2.

Diagram 1 shows a section through the heart.

Diagram 1

This is a common question on exam papers



They don't always provide names for you to pick from

(a) Use words from the box to name the structures labelled **A** and **B** on **Diagram 1**.

aorta	atrium	pulmonary artery	ventricle

A Atrium

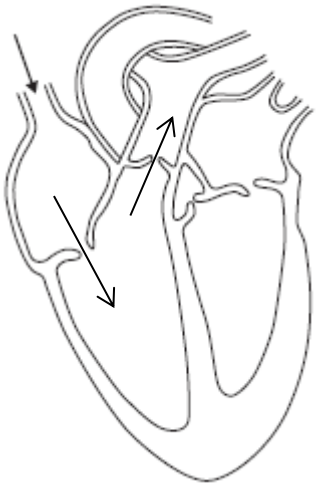
B Ventricle

(2)

(b) Draw arrows on **Diagram 2** to complete the route taken by deoxygenated blood through the heart.

Diagram 2

Another common question related to structure and applying knowledge to the situation given



(2)

Science Homework Task 3

Read all of this knowledge organiser and revise ready for the end of term Pillars test, there will be questions on Bonding, Organisation and Energy. Make sure you can answer these questions.

Question	Answer
Which 2 particles are found in the nucleus of an atom?	
What type of bond forms between two non-metals?	
What type of bond forms within metals?	
What type of bond forms between a non-metal and a metal?	
What type of bond is found in diamonds?	
What ion if formed when sodium loses an electron?	
How are atoms arranged in a metal?	
Two muscles working in pairs are called?	
What do we call 2 or more different tissues working together to carry out a function?	
How long is an average human pregnancy?	
What 4 things does your skeleton/ bones do?	
What is the definition of a tissue?	
Give the definition of osmosis	
Give the definition of active transport	
What is the unit of energy?	
What term describes energy that has spread out to the surroundings?	
What is the name of the energy store in a battery?	
What is the name of the energy store in a stretched spring?	
What do we call energy transferred to where it is wanted?	