How is the magnification of a light microscope calculated?

A DNA molecule forms the shape of a double helix.

What term is used to describe the shape of a DNA molecule?

What is the word equation for aerobic respiration?

What are the products of photosynthesis?

What is the process by which water molecules move across a partially permeable membrane from a dilute solution to a more concentrated one?

Osmosis is the movement of water molecules from a dilute to a more concentrated solution across a partially permeable membrane.

Total magnification is calculated by multiplying the magnification of the eyepiece lens by the magnification of the objective lens.

Glucose + oxygen → carbon dioxide + water (+ energy released)

The products of photosynthesis are glucose and oxygen.
Exchange surfaces allow efficient transport of materials. What are the three main features of an efficient exchange system?

An efficient exchange system should have: (1) a large surface-area-to-volume ratio; (2) thin membranes so the diffusion distance is short; (3) a good supply of transport medium (e.g. blood, air, etc.).

The three types of blood vessel are arteries, capillaries and veins.

Translocation is the movement of glucose from the leaf (where it is produced) to other parts of the plant (where it is needed) via the phloem.

The nervous system is composed of the central nervous system (the brain and the spinal cord) and the peripheral nervous system (all the other nerve cells that connect to the central nervous system).

Hormones are chemical messengers produced by glands. How do they reach their target organ?

Hormones are released directly into the blood, which transports them to their target organ.
**Hormones and Their Uses**

**Maintaining Internal Environments**

What two hormones are combined in most contraceptive pills?

Most contraceptive pills contain oestrogen and progesterone.

What triggers the pancreas to produce insulin?

High blood sugar levels cause the pancreas to produce insulin.

**Recycling**

Photosynthesis removes carbon dioxide from the atmosphere. What two processes release carbon dioxide to the atmosphere?

Respiration (animal, plant and microbial) and combustion release carbon dioxide to the atmosphere.

**Interdependence**

What is the name of the relationship between two organisms where both depend on each other and both benefit?

Mutualism. In a mutualistic relationship, both organisms depend on each other and both benefit.

**Genes**

The allele for brown eyes is dominant to the allele for blue eyes. What will be the phenotype of a person who is heterozygous for eye colour?

The person will have brown eyes.
For evolution to occur, there must be genetic variation in a population. How might genetic variation arise?

Variation can arise through mutations in genes.

What piece of equipment is used to sample the number of plant species in a field?

A quadrat is used to sample the number of plant species in a field.

In an investigation, how would you make sure your measurements are reliable and identify any that might be anomalous?

All measurements should be repeated. If a single reading is very different to the others (anomalous), this might indicate that an error has been made in measuring.

How is selective breeding different from genetic engineering?

Selective breeding is the traditional, natural process of breeding plants and animals with certain, desirable genetic features. Genetic engineering is a modern, faster way of bringing about changes in organisms. It is the artificial process of transplanting genes for a desired characteristic into an organism.
The following symbols describe two different substances. Deduce all the information you can from these symbols. 
\[ _{6}^{13}C \quad _{6}^{12}C \]

Antibiotics are used for bacterial infections. They have no effect on viruses, which are found inside the cell.

Cardiovascular disease can be treated with lifestyle changes (healthy eating and exercise, stopping smoking), surgery (heart transplants or stents) and medications (statins or aspirin).

The substances are isotopes of the same element, carbon. The atomic number of carbon is 6 and the mass numbers of the isotopes are 13 and 12. An atom of carbon-13 contains 6 protons and 7 neutrons. An atom of carbon-12 contains 6 protons and 6 neutrons.

Chromatography separates mixtures using a stationary phase and a mobile phase. Paper chromatography is used to separate mixtures of coloured dyes in solution. Thin layer chromatography uses a thin layer of an inert solid as the stationary phase. Gas chromatography separates mixtures of gases by passing them through a solid stationary phase.
Describe the two main types of chemical bond that can form between two different elements.

An ionic bond is formed when one or more electrons are donated from an atom of one element to an atom of another element, so both atoms have full outer electron shells. The atoms form electrically charged ions.

A covalent bond is formed when two atoms share electrons to complete the outer electron shells of both atoms.

Simple molecules are formed when two or more atoms share electrons and form covalent bonds.

Polymers are formed when repeated units of smaller molecules bond covalently to form a long chain. Metal atoms have outermost electrons that can move freely from one metal atom to another. They are held together by strong metallic bonds.

Intermolecular forces are the forces between molecules. Intramolecular forces are the forces between the atoms inside a molecule, such as covalent bonds.

Simple molecules are formed when two or more atoms share electrons and form covalent bonds.

Metal atoms have outermost electrons that can move freely from one metal atom to another. They are held together by strong metallic bonds.

Complete the table.

<table>
<thead>
<tr>
<th>State of substance</th>
<th>State symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>solid</td>
<td>(s)</td>
</tr>
<tr>
<td>liquid</td>
<td>(... )</td>
</tr>
<tr>
<td>gas</td>
<td>(g)</td>
</tr>
<tr>
<td>(aqueous) dissolved in water</td>
<td>(aq)</td>
</tr>
</tbody>
</table>

Simplify and balance the following ionic equation, which shows the reaction between copper sulfate and sodium hydroxide solutions to form solid copper hydroxide.

\[ \text{Cu}^{2+}(aq) + 2\text{OH}^-(aq) \rightarrow \text{Cu}(OH)_2(s) \]
Which of the following sentences are true and which are false?

A. Two moles of calcium atoms contain a total of just over $12 \times 10^{23}$ atoms.

B. Carbon has a lower relative atomic mass than calcium, so two moles of carbon atoms contain fewer than $12 \times 10^{23}$ atoms.

A is true: one mole is $6.022 \times 10^{23}$ atoms, so $2 \times 6.022 \times 10^{23} = 12.044 \times 10^{23}$ atoms.

B is false: one mole of any element always contains $6.022 \times 10^{23}$ atoms.

For most chemical reactions, energy is needed to break chemical bonds so the reaction can start. This is the activation energy. Any new bonds that form will cause some energy to be given out, so the total energy of the reaction is not the same as the activation energy.

In oxidation reactions, a substance often gains oxygen.

In reduction reactions, a substance often loses oxygen.

These two types of reaction always occur together.

A strong acid easily forms H⁺ ions, so the acids fully ionise.

A weak acid forms an equilibrium mixture, so that some of the ions formed can recombine into the original acid.

In electrolysis, the solution containing the ionic compound is called the electrolyte.

In solution, the ions in the compound dissociate.

The negative electrode is the cathode and attracts positive ions.

The positive electrode is the anode and attracts negative ions.
Improving Processes and Products

How is carbon useful in the extraction of metals?

Most metals are found naturally as minerals (compounds). Carbon can displace less reactive metals from their mineral oxides. The carbon is heated with the metal oxide, and the pure metal is extracted.

Controlling Chemical Reactions

A sample of solid calcium carbonate is divided precisely into two equal masses. One half is a single solid piece, which is then reacted with an acid. The other half is broken into small pieces and reacted with a fresh sample of the same acid. Which half will react faster, and why?

The half that is broken into small pieces will react faster. This is because small pieces have a large surface area in relation to their volume. More solid particles are exposed to contact with acid particles, so there are more collisions and a faster reaction.

Catalysts and Activation Energy

What is a catalyst?

A catalyst is a substance that speeds up the rate of a chemical reaction without being used up or changed in the reaction.

Equilibria

State Le Chatelier’s principle.

Le Chatelier’s principle: When the conditions of a system are altered, the position of the equilibrium changes to try and restore the original conditions.

Improving Processes and Products

How is carbon useful in the extraction of metals?

Most metals are found naturally as minerals (compounds). Carbon can displace less reactive metals from their mineral oxides. The carbon is heated with the metal oxide, and the pure metal is extracted.
According to a life cycle assessment, what are the four stages in the life of a product?

1. Obtaining raw materials.
2. Manufacture of the product.
3. Use of the product.
4. Disposal of the product when it is no longer useful.

Describe the conditions needed for the reaction called cracking, and explain why this reaction is useful.

Cracking requires a catalyst, high temperature and high pressure. Cracking breaks down some of the large molecules in crude oil to form smaller, more useful molecules.

Suggest three ways in which we could slow down climate change.

Any three from:
- Use less fossil fuels.
- Develop and use alternative energy sources.
- Improve energy efficiency/cut down on wasted energy.
- Plant new forests that can change carbon dioxide into oxygen.
- Reduce the amount of waste we produce, to cut down the amount of methane gas in the air.

Why have many governments passed laws restricting the amounts of particulates that can be emitted?

Particulates in the air can cause lung problems and respiratory diseases. They can coat buildings and trees. Laws to restrict their emissions aim to improve air quality.

What is a typical size of an atom? Choose from the following.

$10^{-15}$ m $10^{-12}$ m $10^{-10}$ m

The size of an atom is of the order of $10^{-10}$ m.
What is the difference between the **specific heat capacity** and the **specific latent heat** of a material?

**Specific heat capacity** is the energy needed to raise the temperature of 1 kg of the material by 1 °C, with no change of state.

**Specific latent heat** is the energy needed to change the state of 1 kg of the material, with no change in temperature.

State the equation for calculating the **kinetic energy** of a moving object, and give the **unit** of each quantity.

**Kinetic energy**

\[ KE = 0.5 \times m \times (v)^2 \]

Unit of kinetic energy: **joule** (J)

Unit of mass: **kilogram** (kg)

Unit of speed: **metres per second** (m/s)

Which equation is a statement of **Newton's second law**?

**Force** = **mass** \( \times \) **acceleration**

is a statement of **Newton's second law**.

What is meant by **work** in physics?

**Work** is done on an object when a **force** causes the object to move through a distance.

**Work done** = **force** \( \times \) **distance**

(along the line of action of the force)

The work done is equal to the **energy transferred**.

What is the difference between **elastic deformation** and **plastic deformation**?

**Elastic deformation**: forces make an object change shape, but it returns to its original shape when the forces are removed.

**Plastic deformation**: forces make an object change shape, and the object keeps its new shape when the forces are removed.
Electric Charge

How does friction cause objects to become charged?

Friction transfers electrons between two objects that are rubbed together. This leaves one object with an excess of electrons (making it negatively charged) and the other object with a shortage of electrons (making it positively charged).

Circuits

What is the relationship between the potential difference across, the current through and the resistance of a component in a circuit?

Potential difference = current × resistance

Resistors and Energy Transfers

State the equation for calculating the electrical power of a device in terms of its resistance and the current through it, and state the unit of power.

Power = (current)² × resistance
The unit of power is the watt, W (equivalent to J/s).

Magnetic Fields and Motors

Describe the basic structure of an electromagnet and how it works.

An electromagnet is a coil of wire of many turns wound on an iron core. When current is passed through the coil, a strong magnetic field is set up through the core and around the coil.

Wave Behaviour

What is a wavelength and what is its unit?

A wavelength is the distance from one point on a wave to the equivalent point on the next wave. Its unit is metre (m).
Electromagnetic Radiation

List the types of radiation in the electromagnetic spectrum, in order of increasing frequency.

In order of increasing frequency:
- radio waves, microwaves,
- infrared radiation, visible light,
- ultraviolet (UV) radiation,
- X-rays, gamma rays.

Nuclei of Atoms

Which type of radioactive emission is least penetrating, and why?
- alpha
- beta
- gamma

Alpha radiation is least penetrating because it loses its energy in the shortest distance, by strongly ionising the atoms of a material.

Half-Life

Define the half-life of a radioactive material, and explain why radioactive decay can be considered random.

The half-life of a radioactive material is the time taken for the number of undecayed nuclei in a sample of the material to reduce by half. The decay of a particular nucleus is unpredictable, so the decay is described as random.

Systems and Transfers

True or false? If all of the electrical energy supplied to an efficient kettle is used to heat the water, this equation determines the change in temperature of the water.

\[ \text{potential difference} \times \text{current} \times \text{time} = \text{mass of water} \times \text{specific heat capacity of water} \times \text{change in temperature} \]

Energy is said to be wasted when the useful output energy of a device is less than the input (supplied) energy. This does not contravene the law of conservation of energy because the ‘wasted’ energy is dissipated to the surroundings, raising the temperature.
Physics on the Road

What is a typical speed for a cyclist on a clear flat road? Choose from:

1 m/s  10 m/s  100 m/s

A typical speed for a cyclist on a clear flat road is 10 m/s.

A person walking slowly would have a speed of about 1 m/s.

A plane, or an extremely fast train, might have a speed of 100 m/s.

Energy for the World

Give some types of bio-fuel, and explain whether bio-fuels are renewable or non-renewable energy resources.

Types of bio-fuel include: wood; oils and ‘bio-diesels’ from crops such as rape and palm; also ‘bio-ethanol’ from crops such as sugar cane.

Bio-fuels are renewable energy resources, because we can plant more trees and crops.

Energy at Home

Why are transformers used in the national grid?

Transformers are used in the national grid to increase (step up) the generated voltage to a high value for transmission around the country, because there is then less energy loss from the cables. Transformers are then used to reduce (step down) the voltage to a safer and more convenient voltage for the user.