THE DUSTON SCHOOL
Knowledge itself is power
4-19

Year 9 Science Knowledge Booklet

Term 3

Name:	**Class:**
Homework 1 Due: 13/01/2025	**Homework 2 Due: 27/01/2025**
Homework 3 Due: 12/02/2025	

Science Homework 1

Read all of this knowledge organiser. The work covered will be in the first knowledge quiz of the term.

Big questions:

1. What are the differences between prokaryotic and eukaryotic cells?
2. What organelles do cells have?
3. Do all cells perform the same functions?
4. How can we see cells?
5. How do we calculate magnification?
6. What are stem cells?
7. How can we use stem cells?
8. What are chromosomes?
9. What is the cell cycle?
10. How do substances move in and out of cells (Diffusion)?
11. Why do organisms need exchange surfaces?
12. How do substances move in and out of cells (Osmosis)?
13. How do substances move in and out of cells via active transport?

Key vocabulary

Cell	The building block of living things.
Nucleus	Controls the activities of the cell. Contains chromosomes made of DNA.
Cytoplasm	Jelly-like contents of the cell where many chemical reactions take place.
Cell membrane	A thin layer around the cell that controls the movement of substances in and out of the cell.

Cell wall	Rigid layer outside the cell membrane of a **plant** (cellulose), fungi (chitin) or a **bacterial** (peptidoglycan) cell.
Chloroplast	Small disc in the cytoplasm of **plants** containing chlorophyll.
Active Transport	The movement of particles against a concentration gradient using energy transferred during respiration.
Mitochondria	The site of aerobic respiration in plant and animal cells.
Specialised cell	A cell that has a structure well suited to its function.
Prokaryote	A small simple cell that contains no membrane bound organelles.
Eukaryote	A unicellular or multicellular organism that has a nucleus.
Phloem	A type of plant tissue which transports dissolved sugars around the plant.
Xylem	A type of plant tissue which transports water and mineral ions around the plant.
Stem cell	An undifferentiated cell that can become specialised into any **type** of cell.
Diffusion	The spreading out of particles from an area **of high concentration** to an area **of low concentration**.
Osmosis	The movement of water molecules across a partially permeable membrane from a dilute solution to a more concentrated solution.
Ribosome	Site of protein synthesis.
Mitosis	A form of cell division which produces 2 identical daughter cells.
Permanent vacuole	Fluid-filled area in plant cell containing sap.
Chromosome	A long molecule of DNA found in the nucleus, which carries genes.
Resolution	Ability of a microscope to distinguish between 2 points.

What are the differences between prokaryotic and eukaryotic cells?

There are two types of cells:

1. Eukaryotic cells make up multicellular organisms such as animals, plants and fungi.
2. Prokaryotes are single celled organisms comprised of only cytoplasm such as bacteria.
3. Prokaryotic cells, such as bacteria, are far smaller than eukaryotic cells such as plant, animals and fungal cells.
4. On top of their difference in size there are other notable differences in the structures of these two types of cell.

What organelles do cells have?

Animal cells:

Ribosomes, mitochondria, cytoplasm, nucleus, cell membrane.

Plant cells:

Cell wall, vacuole, chloroplast, nucleus, ribosomes, cell membrane, cytoplasm, mitochondria.

Do all cells perform the same functions?

In a **single-celled organism** the one cell has to do **ALL** of the jobs.

In **multicellular organisms,** the tasks that need to be complete can be shared out between many, **specialist cells.**

How can we see cells?

Magnification is the degree to which the size of an image is larger than the image itself.

Resolution is the degree to which it is possible to distinguish between two objects that are very close together.

How do we calculate magnification?

- I Kilometre (Km) = 1000 metre (m)
- 1m =100cm
- 1cm = 10mm
- 1mm= 1000 micrometres (µm)
- 1µm = 1000 nanometres (nm)
- 1 nm = 1 x 10^{-9} m

What are stem cells?

Stem cells are undifferentiated cells of an organism which is capable of giving rise to many more cells of the same type, and from which certain other cells can arise from differentiation.

How can we use stem cells?

- Meristems contain stem cells. These differentiate into any type of plant cell. They do this throughout the plants life
- Stem cells are used to create clones of plants quickly and cheaply.
- Therapeutic cloning
- Cloning

What are chromosomes?

Unit of inheritance that are made out of DNA, they determine our physical characteristics.

What is the cell cycle?

A cell that is actively dividing goes through a series of stages called the cell cycle. The cycle involves the growth of the cell and the production of new cell components and division for growth, repairing tissue and replacing cells. The cell cycle has 3 main phases: interphase, mitosis and cytokinesis

Mitosis = A form of cell division in which genetically identical cells are produced from the parent cell.

Each new cell contains 46 chromosomes (in humans).

During mitosis, the double chromosomes are pulled apart as each new set of 46 chromosomes moves to opposite ends of the cell. Two nuclei then form. The cytoplasm and cell membrane then divides and two identical cells are produced.

How do substances move in and out of cells (Diffusion)?

Diffusion is the name we give to the movement of particles down a concentration gradient.

The movement of particles of a gas, or any substance in solution, resulting in the net movement of particles from an area of high concentration to an area of low concentration.

Why do organisms need exchange surfaces?

Exchange surfaces are tissues specialised for the exchange of substances in the body and are adapted for this function.

Some common features of an exchange surface are the following:

1. A large surface area over which exchange can take place
2. A thin membrane or being thin to provide a short diffusion path
3. In animals, an efficient blood supply moves the diffusing substances away from the exchange surface to maintain a steep concentration gradient.
4. In animals, being ventilated makes gas exchange more efficient by maintaining a steep concentration gradient.

How do substances move in and out of cells via osmosis?

Osmosis = The net movement of water molecules from a dilute solution to a more concentrated solution through a partially permeable membrane. It is a passive process like diffusion as it doesn't require energy from respiration. These membranes are called 'partially permeable' as they only let certain types of particles pass through.

- Osmosis in plant and animals cells is different because of their different structures.
- Plant cells can take on lots of water because of the tough cell wall which resists bursting.
- Animal cells can burst if they take on too much water- they have no cell wall.
- If animal cells lose lots of water they shrink.
- When plant cells lose lots of water they become plasmolysed- the vacuole pulls away from the cell membrane. This does not shrink the overall cell.

Science Homework 2

Try to answer all of these key knowledge questions. Then check your answers using the last page. These are some of the questions that will be in the knowledge quizzes and the end of term tests.

Questions in *italics* are from older work.

Key knowledge question	**Answer**
What is a cell?	
What is the name given to the structures inside cells?	
What is the function of the cell membrane?	
What is the function of the nucleus?	
What is the function of the chloroplast?	
What is the function of the mitochondria?	
What type of organisms have eukaryotic cells?	
How is DNA stored in a prokaryotic cell?	
What stain would you use on an onion cell slide?	
Describe how a red blood cell is adapted to its function.	
If a small leaf is 10 millimetres in diameter what is its diameter in micrometres?	
What type of organisms have prokaryotic cells?	
What is the function of a sperm cell?	
What are unspecialised cells in a plant cell called?	
What two structures are found in eukaryotic cells but not found in prokaryotic cells?	
What is the function of a nerve cell?	
What is mitosis?	
What is active transport?	
What diffuses in and out of leaf cells?	
Why do epithelial cells have many mitochondria?	

How do substances move in and out of cells via active transport?

Active transport is an ***active*** process, this means substances are moved ***against*** their concentration, from an area of low concentration to an area of high concentration.

Active transport results in the pumping of nitrate ions against their concentration gradient from the soil into the root hair cells.

We need to absorb nutrients from food to survive (ie glucose).

These nutrients transport from the gut to the blood.

- Higher concentration of nutrients in the gut compared to the blood, they DIFFUSE to the blood.
- Lower concentration of nutrients in the gut compared to the blood, they use ACTIVE TRANSPORT to move into the blood.

<u>WHAT DOES THIS MEAN?</u>

Glucose can be taken into the blood by active transport against the concentration gradient. Then the glucose can be transported to the cells to be used in respiration.

In humans, an example of active transport is the active absorption of glucose from your gut and kidney tubules into your blood. This is often done against a large concentration gradient.

Glucose is needed for respiration so it is important to get as much as possible from the gut.

Key knowledge question	**Answer**
What is a cell?	The smallest unit of an organism.
What is the name given to the structures inside cells?	Organelles
What is the function of the cell membrane?	To control what enters or leaves the cell
What is the function of the nucleus?	To control the cells activities, hold genetic information
What is the function of the chloroplast?	Site of photosynthesis
What is the function of the mitochondria?	Site of aerobic respiration
What type of organisms have eukaryotic cells?	Plants, animals, fungi and protists
How is DNA stored in a prokaryotic cell?	In loops in the cytoplasm
What stain would you use on an onion cell slide?	Iodine
Describe how a red blood cell is adapted to its function.	Small, rounded, big surface area, full of haemoglobin
If a small leaf is 10 millimetres in diameter what is its diameter in micrometres?	10,000 micrometres
What type of organisms have prokaryotic cells?	Bacteria, cyanobacteria
What is the function of a sperm cell?	It has a tail so that it can swim towards an egg cell to fertilise it.
What are unspecialised cells in a plant cell called?	Meristem.
What two structures are found in eukaryotic cells but not found in prokaryotic cells?	Membrane-bound organelles and the nucleus.
What is the function of a nerve cell?	To carry electrical nerve impulses around the body.
What is mitosis?	A type of cell division.
What is active transport?	An active process where substances are moved against a concentration gradient from an area of lower concentration to high concentration
What diffuses in and out of leaf cells?	Carbon dioxide and oxygen
Why do epithelial cells have many mitochondria?	Why do epithelial cells have many mitochondria?

P1 Energy

Big questions:

What are the energy stores and transfers?
How is energy transferred?
How can we calculate work done?
How can we calculate kinetic energy?
How can we calculate gravitational potential energy?
How can we calculate elastic potential energy?
How much energy is needed to heat a substance?
How can we measure specific heat capacity?
How can we determine the specific heat capacity from results?
What is power?
What does efficiency mean?
What are the advantages and disadvantages of different energy stores?

Key vocabulary

Kinetic Energy Store	The energy stored in a moving object.
Gravitational Potential Energy Store	The energy stored in an object lifted up in a gravitational field.
Elastic Potential Energy Store	The energy stored in a stretched or compressed spring or elastic band
Chemical Energy Store	The energy stored in bonds between atoms in a substance e.g. fuels, food, batteries.
Thermal Energy Store	The energy stored in an object based on its temperature.
Nuclear Energy Store	The energy stored in the nucleus of an atom.
Conduction	Heat transfer through a solid.
Convection	Heat transfer through a liquid or gas.
Radiation	Heat transfer by waves e.g. infrared radiation.
Work Done	Energy transferred when a force moves an object.
Specific Heat Capacity	The amount of energy needed to raise the temperature of 1kg of a substance by 1°C.
Power	The amount of energy transferred per unit time.
Efficiency	The ratio of useful energy output to the total energy input.
Energy Resource	A method of generating electricity e.g. coal power stations, wind turbines, solar panels.

What are the energy stores and transfers?

Energy Stores:

Kinetic Energy Store	The energy stored in a moving object.
Gravitational Potential Energy Store	The energy stored in an object lifted up in a gravitational field.
Elastic Potential Energy Store	The energy stored in a stretched or compressed spring or elastic band
Chemical Energy Store	The energy stored in bonds between atoms in a substance e.g. fuels, food, batteries.
Thermal Energy Store	The energy stored in an object based on its temperature.
Nuclear Energy Store	The energy stored in the nucleus of an atom.

Energy Transfers:

Heat	Energy transferred from a hot object to a cooler object.
Mechanical Work (Work Done)	Energy transferred when a force moves an object.
Electric Current	Energy transferred in an electrical circuit.
Radiation	• EEnergy transferred by waves.

How can we calculate work done?

Work done = force x distance moved $W = Fs$

How can we calculate kinetic energy?

Kinetic energy = 0.5 x mass x speed^2 $E_k = ½ mv^2$

How can we calculate gravitational potential energy?

Gravitational Potential Energy = mass x gravitational field strength x height $E_p = mgh$

How can we calculate elastic potential energy?

Elastic potential energy = 0.5 x spring constant x extension^2 $E_e = ½ ke^2$

How much energy is needed to heat a substance?

Energy transferred = mass x specific heat capacity x temperature change $\Delta E = mc \Delta\Theta$

How can we measure specific heat capacity?

To determine the specific heat capacity we use an electric heater to heat a metal block or a liquid in a beaker. We need to measure:

- Energy transferred using an energy meter
- Mass of the substance using a balance
- Temperature change (final temperature – starting temperature) using a thermometer

Specific heat capacity can then be calculated using $c = \frac{\Delta E}{m\Delta\theta}$

Limitations:

- Only half of the heater fits in the metal block so energy is transferred to the surroundings.
- Energy will be transferred from the metal block/beaker to the surroundings. Wrapping it in insulation will reduce this.

What is power?

Power is the energy transferred per unit time.

Power = $\frac{Energy}{time}$ $P = \frac{E}{t}$

What does efficiency mean?

Efficiency = $\frac{useful\ energy\ output}{total\ energy\ input}$

Science Homework 3

Try to answer all of these key knowledge questions. Then check your answers using the last page. These are some of the questions that will be in the knowledge quizzes and the end of term tests.

Questions in *italics* are from older work.

Key knowledge question	Answer
Write the equation that links kinetic energy, mass and speed	
Write the equation that links gravitational potential energy, mass, gravitational field strength and height	
Write the equation that links elastic potential energy, spring constant and extension	
Write the equation that links power, energy and time	
Write the equation that links work done, force and distance moved	
Write the equation to calculate efficiency	
Which energy store is increased when a person climbs a ladder?	
Which energy store is stored in a hot cup of tea?	
Which energy store is stored in a moving car?	
Which energy store is stored in a stretched spring?	
Which energy store is stored in a battery?	
What happens to dissipated energy?	
State the law of conservation of energy	
Name 3 fossil fuels	
Name 2 non-renewable energy sources	
Name 2 renewable energy sources	

What are the advantages and disadvantages of different energy stores?

Energy Resource	Advantages	Disadvantages
Fossil fuels (Coal, Oil and Gas)	• Reliable – fossil fuel power stations can run 24 hours a day, 365 days a year to generate electricity.	• Non-renewable - fossils fuels will eventually run out. • Burning fossil fuels produces carbon dioxide which is a greenhouse gas so increases global warming. • Impurities in fossil fuels can produce sulphur dioxide which causes acid rain. • Incomplete combustion of fossil fuels produces carbon monoxide which is poisonous and carbon particulates (soot) which causes breathing problems and can make buildings look dirty.
Wind	• Renewable. • Does not produce carbon dioxide. • Can be built out at sea (offshore windfarms). • Land around wind turbines can be used for animal grazing.	• Not–reliable – does not generate electricity if there is no wind/too windy. • Cause noise pollution. • Some people argue they spoil views.
Solar	• Renewable • Does not produce carbon dioxide. • Solar panels can be fitted to roofs.	• Not – reliable – does not generate electricity at night or if it is too cloudy. • Solar farms take up a lot of land.
Nuclear	• Does not produce carbon dioxide. • Reliable – fossil fuel power stations can run 24 hours a day, 365 days a year to generate electricity. • A lot of energy is released from a small amount of fuel.	• Produces radioactive waste that needs to be stored for a long time. • High profile nuclear disasters e.g. Chernobyl and Fukushima
Hydroelectric	• Does not produce carbon dioxide. • Reservoirs can provide new habitats. • Generally reliable.	• Limited locations that are suitable. • Reservoirs cause flooding of habitats. • Dams disrupt the movement of animals. • Can be affected by droughts.
Tidal	• Does not produce carbon dioxide. • Reliable – two tides per day.	• Limited suitable locations on river estuaries. • Tidal barrages can disrupt movement of animals.

Wave	• Does not produce carbon dioxide.	• Expensive to set up.
Geothermal	• Does not produce carbon dioxide.	• Limited suitable locations with geothermal activity e.g. Iceland. •
Biomass	• Carbon neutral because the carbon dioxide that is released when plants are burned was taken out of the atmosphere when the plant was growing.	• Large amounts of land required to grow plants for biomass fuel.

Key knowledge question	Answer
Write the equation that links kinetic energy, mass and speed	$E_k = ½ mv^2$ Kinetic Energy = 0.5 x mass x $(speed)^2$
Write the equation that links gravitational potential energy, mass, gravitational field strength and height	$E_p = mgh$ Gravitational Potential Energy = mass x gravitational field strength x height
Write the equation that links elastic potential energy, spring constant and extension	$E_e = ½ ke^2$ Elastic Potential Energy = 0.5 x spring constant x $(extension)^2$
Write the equation that links power, energy and time	E= Pt Energy = Power x time
Write the equation that links work done, force and distance moved	W = Fs Work Done = Force x distance moved
Write the equation to calculate efficiency	Efficiency = useful energy output / total energy input or Efficiency = useful power output / total power input
Which energy store is increased when a person climbs a ladder?	Gravitational potential energy store
Which energy store is stored in a hot cup of tea?	Thermal energy store
Which energy store is stored in a moving car?	Kinetic energy store
Which energy store is stored in a stretched spring?	Elastic potential energy store
Which energy store is stored in a battery?	Chemical energy store
What happens to dissipated energy?	it is transferred to thermal energy store of the surroundings
State the law of conservation of energy	energy cannot be created or destroyed, only transferred from one energy store to another
Name 3 fossil fuels	coal, oil and gas
Name 2 non-renewable energy sources	coal, oil, gas, nuclear
Name 2 renewable energy sources	wind, solar, hydroelectric, geothermal, biomass, wave, tidal