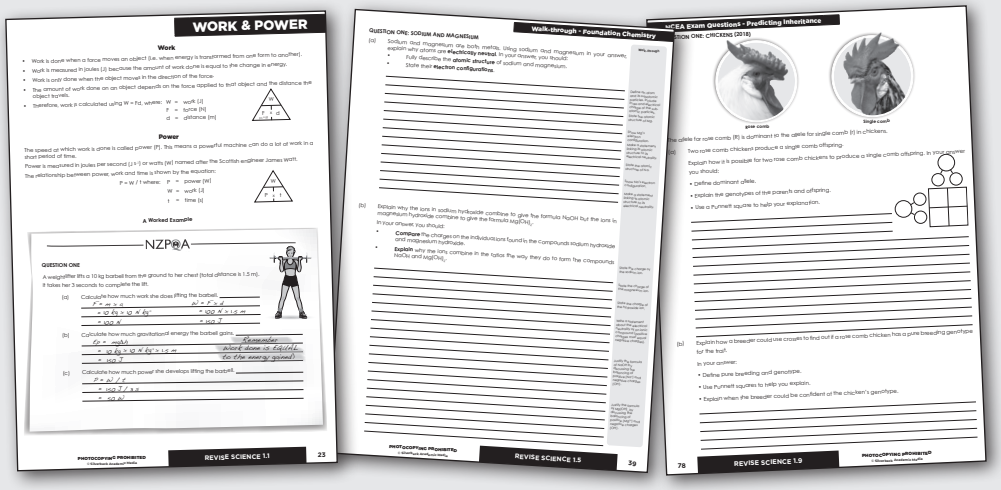
Level 1 Science

Demonstrate understanding of aspects of zombie apocalypses

Credits: A chainsaw, machete or samurai sword

KEY NOTES + WALK-THROUGHS + PREVIOUS EXAMS



Key notes and worked examples.

NCEA-style questions with walk-throughs, hints & tips.

Four years of previous NCEA exam questions.

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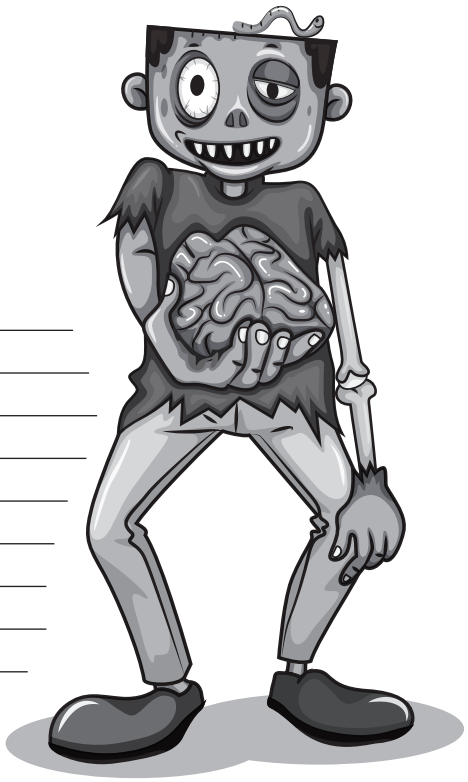
For Assessor's use only	**Achievement Criteria**			
Achievement		**Achievement with Merit**		**Achievement with Excellence**
Demonstrate understanding of aspects of zombie apocalypses.	☐	Demonstrate an in-depth understanding of aspects of zombie apocalypses.	☐	Demonstrate comprehensive understanding of aspects of zombie apocalypses. ☐

ZOMBIE MECHANICS



QUESTION ONE

Simon the zombie is carrying his brain. It has a **mass** of 2 kg.

(a) Explain the difference between **weight** and **mass**.

(b) Calculate the **weight** of his brain ($g = 10\ N\ kg^{-1}$).

Simon drops his brain on the floor. Deciding he needs to be more careful, he lifts his brain off the floor and puts it on a shelf that is 2 m high. It takes him 4 seconds to lift his brain from the floor at a constant rate.

(c) Calculate the **work** Simon does to lift his brain to a height of 2 m.

(d) Calculate the **power** needed by Simon to lift his brain to this height.

(e) Calculate the **gravitational potential energy** of the brain on the shelf.

Because his brain is quite slimy, it doesn't take long before it slides off the shelf. It takes 0.32 s to fall to the ground and hits it with a speed of $3.20\ m\ s^{-1}$.

(f) Calculate the **acceleration** of the brain as it falls.

(g) Calculate the **net force** acting on the brain as it falls.

QUESTION TWO: GETTING TO WORK

Mike likes to skateboard to his office at "Undead-R-Us".

(a) On the diagrams below, draw and label the **thrust** and **friction** forces acting on Mike as he travels at a constant speed AND as he accelerates. In your answer you should use arrows to show the relative size and direction of the forces.

Travelling at a **constant speed**

Accelerating

(b) Describe what is meant by **net force**.

(c) Discuss the direction of the **net force** and the direction of **motion** when Mike is:

(i) Travelling at a constant speed:

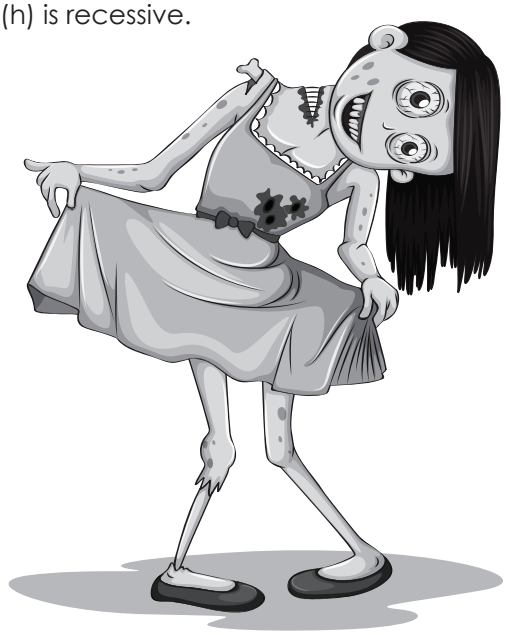
(ii) Accelerating:

(iii) Decelerating:

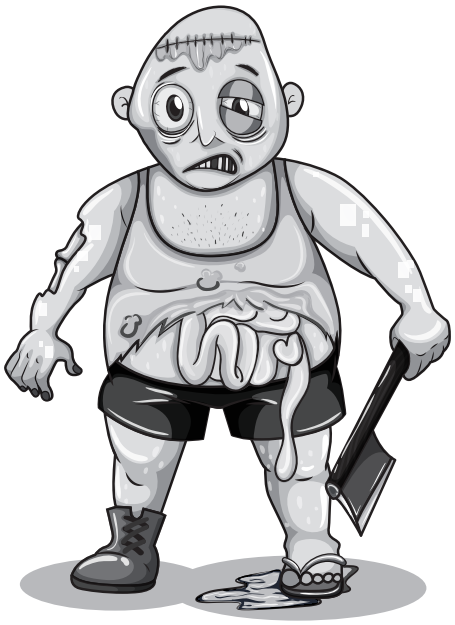
ZOMBIE GENETICS

QUESTION ONE

The presence of hair on zombies is a **trait** controlled by a **gene.** The **allele** for no hair (H) is dominant while the allele for hair (h) is recessive.



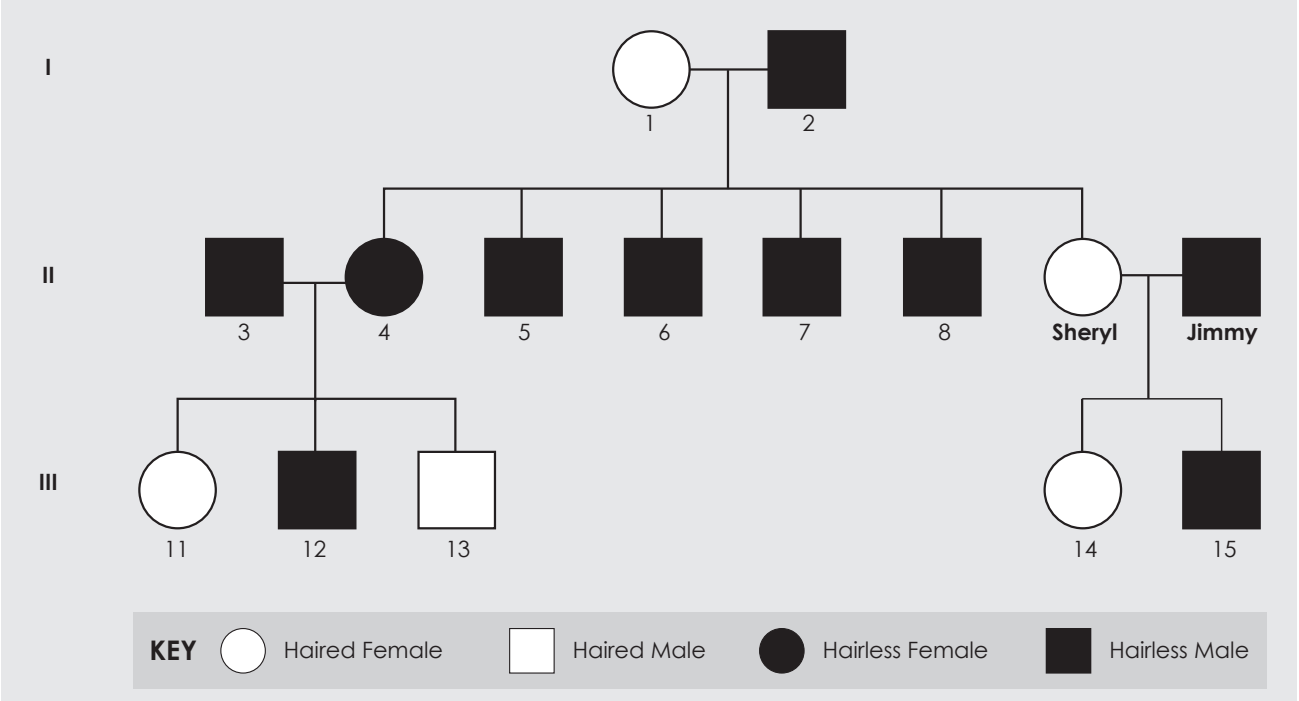
Sheryl - Hair ***present*** on head



Jimmy - Hair ***absent*** on head

(a) Explain the difference between a **trait**, a **gene** and an **allele**.

(b) The pedigree chart below shows the inheritance of hairlessness in Sheryl's family.



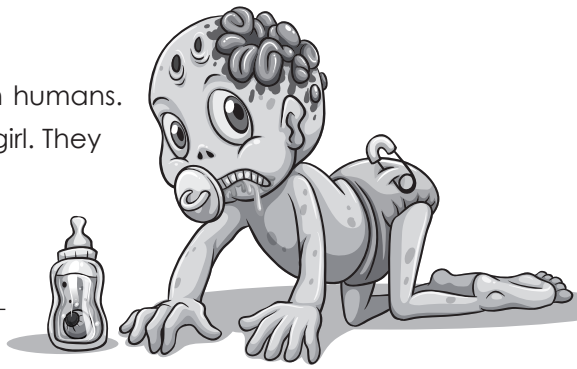
Demonstrate understanding of aspects of zombies

Explain how the pedigree chart can be used to show that the presence of hair is a **recessive trait**.

In your answer you should:

- Define the terms **dominant** and **recessive**.
- State the possible **genotypes** of a zombie with no hair and a zombie with hair.
- Complete a labelled **Punnett square** to support your answer.
- Explain how your Punnett square shows that the presence of hair is a **recessive trait**.

QUESTION TWO



The determination of the sex of zombie offspring is the same as it is in humans. Sheryl and Jimmy already have two zombie babies, one boy and one girl. They are expecting a third zombie baby.

(a) State the **genotypes** of their offspring.

Girl zombie baby: _____

Boy zombie baby: _____

(b) Explain how sex is determined in zombies/humans. You should complete a Punnett square as part of your answer.

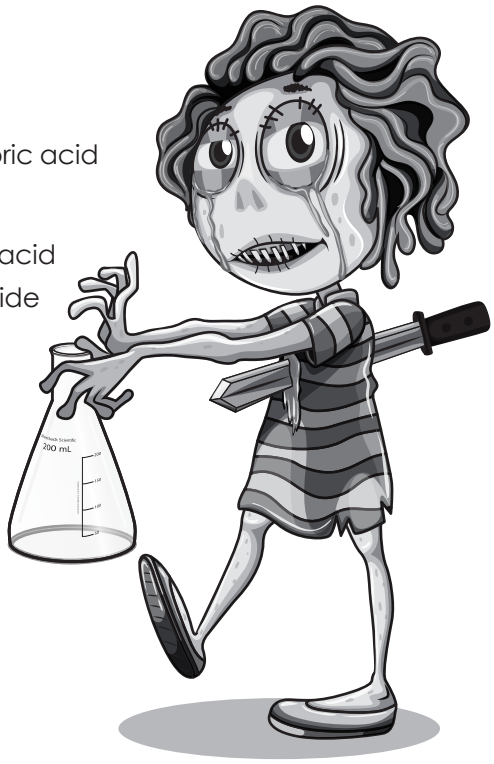
(c) Outline the likelihood of their third zombie child being a boy.

QUESTION THREE

(a) Mutations can occur in zombie DNA during cell division. Describe what a **mutation** is and explain how a mutation can be **inherited**.

(b) Genetic variation is important within all populations, including zombies. Describe what is meant by the term **genetic variation**, and explain its importance to a population.

ZOMBIE CHEMISTRY



QUESTION ONE

(a) Sarah the zombie carried out an experiment to **neutralise** hydrochloric acid by adding calcium hydroxide to it.

Discuss how Sarah could have determined when the hydrochloric acid had been neutralised and what effect adding the calcium hydroxide has on the pH of the solution.

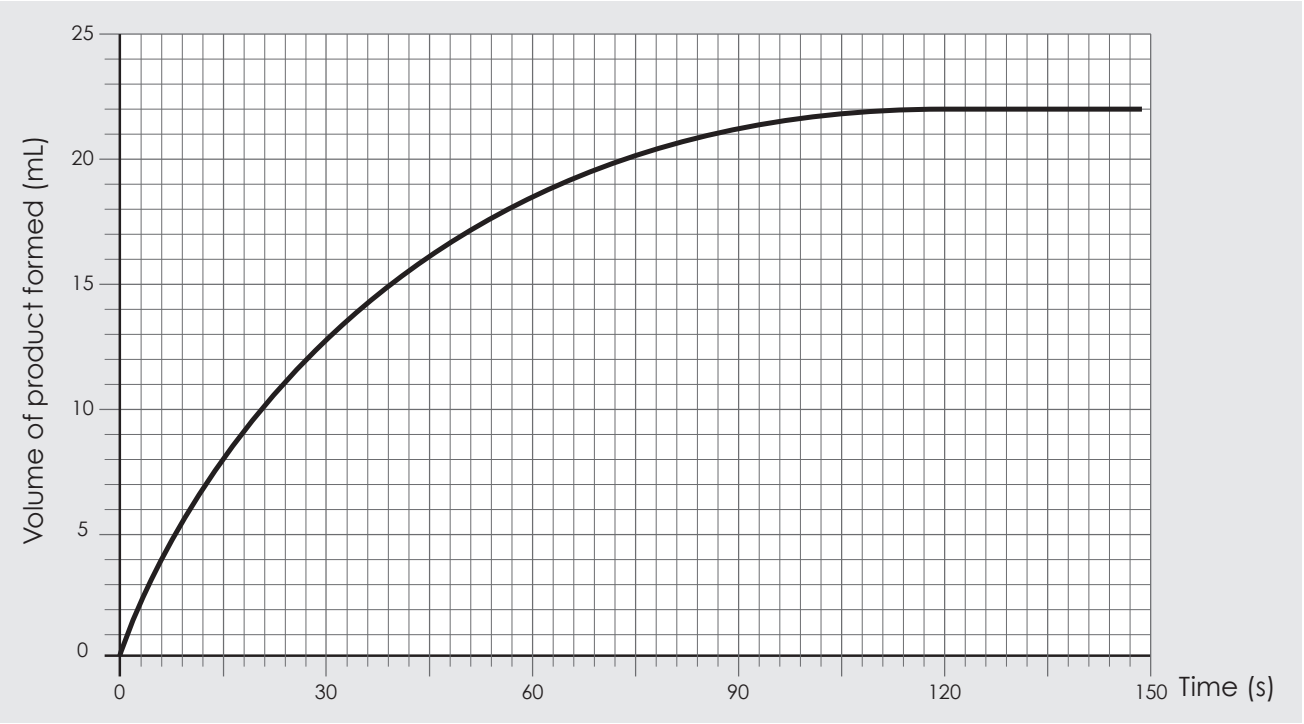
In your answer include:

- An explanation of *neutralisation* in terms of an acid-base reaction.
- The name of the *indicator* used.
- *Observations* that Sarah would make as the calcium hydroxide is added to the acid.
- A *word* and *correctly balanced symbol* equation for the reaction.

Word equation

Correctly balanced chemical equation

(b) Sarah measured the rate of the reaction by measuring the rate at which one of the products was produced. Her data was processed and she produced the following graph.



Discuss the shape of the graph with reference to **particles and collision theory**.

(c) Sarah wanted to increase the rate of the reaction. She decided to use the same volume of acid but with a higher concentration. Explain the difference this would make to the rate of reaction.
In your answer you should refer to:

- Particles.
- Collisions.
- Reaction rate.

QUESTION TWO

(a) Complete the table below for ions formed by Mg, N and K.

Atom	Atomic number	Electron arrangement of atom	Electron arrangement of ion	Ion symbol
Mg	12			
N	7			
K	19			

(b) Explain the **charges** on ALL three ions, in terms of electron arrangement and number of protons.

EXAMINATION RESOURCE SHEET

+1	+2	+3	−3	−2	−1
H^+ Hydrogen	Ca^{2+} Calcium	Al^{3+} Aluminium	P^{3-} Phosphide	O^{2-} Oxide	F^- Fluoride
Na^+ Sodium	Mg^{2+} Magnesium	Fe^{3+} Iron(III)	PO_4^{3-} Phosphate	S^{2-} Sulfide	Cl^- Chloride
Li^+ Lithium	Cu^{2+} Copper			CO_3^{2-} Carbonate	Br^- Bromide
K^+ Potassium	Pb^{2+} Lead			SO_4^{2-} Sulfate	I^- Iodide
NH_4^+ Ammonium	Fe^{2+} Iron(II)				OH^- Hydroxide
Ag^+ Silver	Be^{2+} Beryllium				HCO_3^- Hydrogen carbonate
	Zn^{2+} Zinc				NO_3^- Nitrate
	Ba^{2+} Barium				

1												13	14	15	16	17	18
1 H Hydrogen 1.0	2																2 He Helium 4.0
3 Li Lithium 6.9	4 Be Beryllium 9.0											5 B Boron 10.8	6 C Carbon 12.0	7 N Nitrogen 14.0	8 O Oxygen 16.0	9 F Fluorine 19.0	10 Ne Neon 20.2
11 Na Sodium 23.0	12 Mg Magnesium 24.3	3	4	5	6	7	8	9	10	11	12	13 Al Aluminium 27.0	14 Si Silicon 28.1	15 P Phosphorus 31.0	16 S Sulfur 32.1	17 Cl Chlorine 35.5	18 Ar Argon 40.0
19 K Potassium 39.1	20 Ca Calcium 40.1	21 Sc Scandium 45.0	22 Ti Titanium 47.9	23 V Vanadium 50.9	24 Cr Chromium 52.0	25 Mn Manganese 54.9	26 Fe Iron 55.9	27 Co Cobalt 58.9	28 Ni Nickel 58.7	29 Cu Copper 63.5	30 Zn Zinc 65.4	31 Ga Gallium 69.7	32 Ge Germanium 72.6	33 As Arsenic 74.9	34 Se Selenium 79.0	35 Br Bromine 79.9	36 Kr Krypton 83.8
37 Rb Rubidium 85.5	38 Sr Strontium 87.6	39 Y Yttrium 88.9	40 Zr Zirconium 91.2	41 Nb Niobium 92.9	42 Mo Molybdenum 95.9	43 Tc Technetium 98.9	44 Ru Ruthenium 101	45 Rh Rhodium 103	46 Pd Palladium 106	47 Ag Silver 108	48 Cd Cadmium 112	49 In Indium 115	50 Sn Tin 119	51 Sb Antimony 122	52 Te Tellurium 128	53 I Iodine 127	54 Xe Xenon 131
55 Cs Caesium 133	56 Ba Barium 137	71 Lu Lutetium 175	72 Hf Hafnium 179	73 Ta Tantalum 181	74 W Tungsten 184	75 Re Rhenium 186	76 Os Osmium 190	77 Ir Iridium 192	78 Pt Platinum 195	79 Au Gold 197	80 Hg Mercury 201	81 Tl Thallium 204	82 Pb Lead 207	83 Bi Bismuth 209	84 Po Polonium 210	85 At Astatine 210	86 Rn Radon 222

$$v = \frac{\Delta d}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t} \qquad P = \frac{F}{A}$$

$$W = Fd \qquad F_{net} = ma \qquad E_K = \tfrac{1}{2}mv^2$$

$$g = 10\ N\ kg^{-1} \qquad P = \frac{W}{t} \qquad \Delta E_P = mg\Delta h$$

SUGGESTED ANSWERS

ZOMBIE MECHANICS

QUESTION ONE

(a) Weight is the downward force due to gravity that an object experiences, while mass is a measure of the amount of matter that an object has. Weight is measured in newtons (N), mass is measured in kilograms (kg).

(b) $F = ma = 2\ kg \times 10\ N\ kg^{-1} = 20\ N$

(c) $W = Fd = 20\ N \times 2\ m = 40\ J$

(d) $P = W/t = 40\ J / 4\ s = 10\ W$

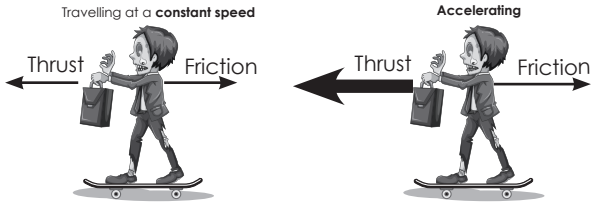
(e) $E_p = mg\Delta h = 2\ kg \times 10\ N\ kg^{-1} \times 2\ m = 40\ J$

(f) $a = \Delta v/\Delta t = 3.20\ m\ s^{-1} / 0.32\ s = 10\ m\ s^{-2}$

(g) $F = ma = 2\ kg \times 10\ m\ s^{-1} = 20\ N$

QUESTION TWO

(a)



(b) A net force is the resultant force when multiple forces interact. If the forces are pointing in the same direction, the forces add, giving a larger net force. If the forces are in the opposite direction, the forces subtract, giving a smaller net force (including a zero net force).

(c)(i) Constant speed: Both the thrust and friction forces point in the opposite direction to each other. These forces are subtracted from each other. As the are both the same size (i.e. he is not accelerating or decelerating) there is no net force. Therefore, he will remain travelling at a constant speed.

(ii) Accelerating: Both the thrust and friction forces point in the opposite direction to each other. These forces are subtracted from each other. As the thrust force is larger than the friction force there is a net force in the forward direction. Therefore, he will accelerate.

(iii) Decelerating: Both the thrust and friction forces pointing in the opposite directions to each other. These forces are subtracted from each other. As the friction force is larger than the thrust force there is a net force in the backward direction. Therefore, he will decelerate.

ZOMBIE GENETICS

QUESTION ONE

(a) A *trait* is a genetically determined characteristic. A section of DNA within a chromosome that codes for a trait is called a *gene*. An *allele* is an alternative form of a gene. In this example, one allele codes for hair present, the other allele codes for absence of hair.

(b) *Dominant* means the trait will be expressed, even if only one allele is present in a pair of alleles (heterozygous). *Recessive* means the trait will only be expressed if two alleles are present (homozygous). It would be masked in the presence of one dominant allele (heterozygous).

A zombie without hair would either be homozygous dominant (HH) or heterozygous (Hh). A zombie with hair would be homozygous recessive (hh).

The presence of hair is a recessive trait. This can be established using the generation II zombies 3 and 4. These two hairless individuals have two offspring (zombies 11 and 13) with hair, and one offspring without hair (zombie 12).

The only way this is possible is for these two zombies to produce haired offspring phenotypes is if they are both heterozygous, Hh. When the two h alleles come together, a homozygous recessive hh (haired) offspring is produced (refer to the Punnett square).

Zombie 3

Zombie 4	H	h
H	HH	Hh
h	Hh	**hh**

hh — Possible genotype for zombies 11 & 13

If hairlessness was recessive, then both parents (zombies 3 and 4) would have the alleles hh and there would be no way of producing the two offspring with hair requiring an H in their genotypes.

Zombie 3

Zombie 4	h	h
h	hh	hh
h	hh	hh

No possibility of producing haired offspring (zombies 11 & 13) due to the absent of H alleles in parents.

QUESTION TWO

(a) Phenotype of girl zombie baby = Haired.

Phenotype of boy zombie baby = Hairless.

(b) Females are XX, so when they create eggs with half the number of chromosomes, both eggs will contain an X chromosome. Males are XY so when they create sperm, half will have the X chromosome and half will have the Y chromosome. When the gametes come together (an egg is fertilised), there is a 50% probability they will have a female offspring and a 50% chance they will have a male offspring. The sex of the baby is determined by whether it is a sperm cell carrying an X or a Y that fertilises the egg. If it is X it will be female; if it is Y it will be male.

Male

Female	X	Y
X	XX	XY
X	XX	XY

(c) The fact that they already have one girl and one boy has no effect on what the next baby will be. Fertilisation is random at each event, and previous fertilisations have no effect. There is always a 50 % chance the baby would be a boy or a girl.

QUESTION THREE

(a) A mutation is a permanent change in the base sequence of a DNA molecule / genetic material / DNA / genes of an organism. When a mutation occurs, the base sequence of the gene changes, potentially resulting in completely new alleles. If mutations occur in the gametes (sex cells - sperm and ova), these new alleles have the possibility of being passed on to offspring. If mutation occurs in body (somatic) cells, it will only affect the individual and will not be passed on to any of its offspring.

(b) Genetic variation is a measure of the variety within a population, e.g. the different alleles possible for each gene. The amount of genetic variation within a population affects the survivability of that population. A high level of genetic variation increases the probability that the population could survive an environmental change, i.e. because of variation, not all individuals will be wiped out. Those with favourable alleles / traits / phenotypes will survive and be able to pass on genetic material to offspring.

ZOMBIE CHEMISTRY

QUESTION ONE

(a) Neutralisation occurs when a reaction between an acid and base produce a salt and water. Since the amount of acid particles (H^+) is equal to the amount of base particles (OH^- ions), the resulting solution has a pH of 7.

She could see when neutralisation had occurred by using Universal Indicator.

When no $Ca(OH)_2$ has been added, the solution is red with a pH of 1–2 and there is an excess of H^+ ions (from the acid). As $Ca(OH)_2$ is added she would also observe the solution becoming orange /yellow as the pH rises. At this point there would still be an excess of H^+ ions but not as big an excess as when the pH was lower. When more $Ca(OH)_2$ is added, and the solution would become neutral, it would appear green. The pH at this point would be 7, which is neutral. At this point, the number of H^+ ions and OH^- ions is equal and they cancel each other out to form water.

Calcium hydroxide + hydrochloric acid ⟶ calcium chloride + water.

$Ca(OH)_2 + \mathbf{2}\ HCl \longrightarrow CaCl_2 + \mathbf{2}\ H_2O$

(b) Collision theory states that in order for a chemical reaction to occur, two or more particles must collide with sufficient energy and in the correct orientation.

Initially (0 - 30 seconds) the rate is fastest as there are more collisions between the HCl and $Ca(OH)_2$. This is because at the start of the reaction there are more particles available for collision. This means there will be more successful collisions per second.

Between 30 - 110 seconds the rate of reaction is slowing down as the number of particles available for collision is becoming fewer. Some of the HCl and $Ca(OH)_2$ have already collided and have been used up. Therefore, there are fewer particles and fewer successful collisions per second.

Between 110 -150 seconds the reaction has stopped, as all of the reactants (or one of them) have reacted, and therefore there are no particles present that can collide and react.

(c) When more concentrated acid is used, there are more acid particles in the same volume of the acid. Because of this, there are more particles to collide with the calcium carbonate and these particles are closer together. Because there are more to collide, the rate of reaction is faster.

QUESTION TWO

(a)

Atom	Atomic number	Electron arrangement of atom	Electron arrangement of ion	Ion symbol
Mg	12	**2,8,2**	**2,8**	**Mg^{2+}**
N	7	**2,5**	**2,8**	**N^{3-}**
K	19	**2,8,8,1**	**2,8,8**	**K^+**

(b) Magnesium has 12 protons and an electron arrangement of 2,8,2. In order to obtain a full shell of electrons, magnesium loses 2 electrons. The magnesium ion has a charge of 2+ as it now has 12 protons (+) and 10 electrons (-).

Nitrogen has 7 protons and an electron arrangement of 2,5. In order to obtain a full shell of electrons, nitrogen gains 3 electrons. The nitrogen ion has a charge of 3- as it now has 7 protons (+) and 10 electrons (-).

Potassium has 19 protons and an electron arrangement of 2,8,8,1. In order to obtain a full shell of electrons, potassium loses 1 electron. The potassium ion has a charge of 1+ as it now has 19 protons (+) and 18 electrons (-).

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