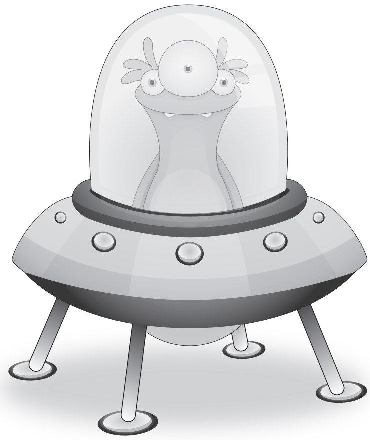
Level 1 Science
Demonstrate understanding of aspects of alien abductions

Credits: Four frontal lobotomies and a trip to Mars.

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

ALIEN MECHANICS

QUESTION ONE



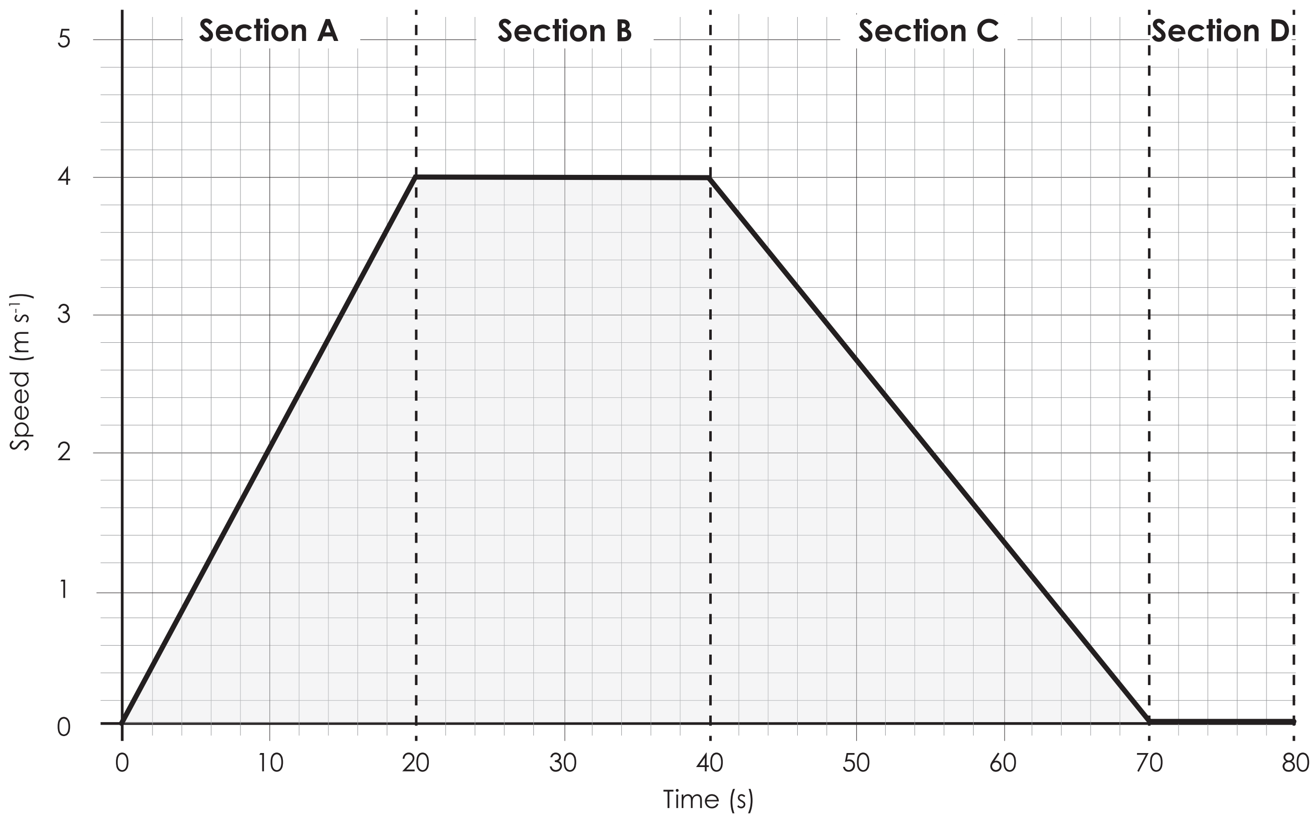
Zork the alien and his spaceship have a combined **mass** of 560 kg.

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

(b) Show that the combined **weight** of Zork and his spaceship is 5 600 N.

Zork, searching for human life forms, stumbles across Professor Beaker out for an evening stroll. The startled Professor starts to run for cover. The first 80 seconds of the Professor's run is shown by the speed-time graph below. Use the graph to answer the questions that follow.

Remember to show all working where possible to support your answer(s).

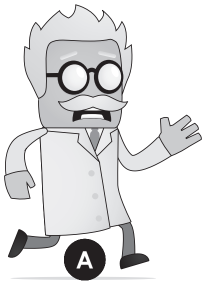


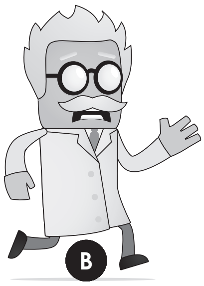
(c) Calculate Professor Beaker's acceleration in the first 20 seconds.

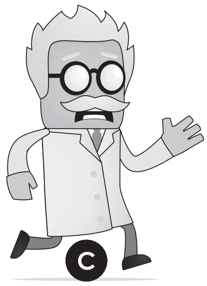
Professor Beaker's acceleration: ________________

(d) On the diagrams below, **draw** and **label** force arrows to show the directions of the **relative** size of thrust and friction forces acting on Professor Beaker in sections A, B, and C.

Do not worry about showing the support or gravity force on Professor Beaker.







(e) Referring to your force diagrams in part (d) above, explain the link between the **net force** acting on Professor Beaker in sections A, B, and C of the graph, and the **type of motion**.

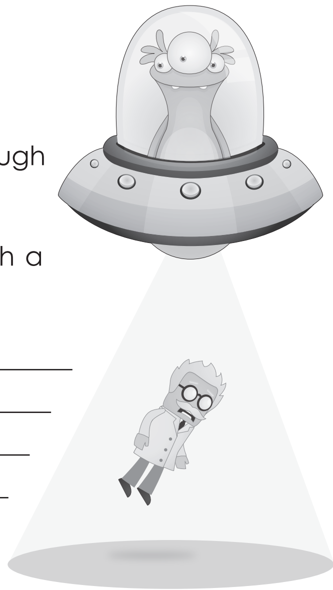
In your answer you should:

- Describe what is meant by net force.
- Explain the link between net force and the type of motion for EACH section.
- Compare the direction of the net force and the direction of the motion for EACH section.

(f) Calculate the total **distance** travelled by Professor Beaker in 80 seconds.

Total distance travelled: ________________

QUESTION TWO



Zork captures Professor Beaker with his tractor beam. The professor is levitated through a vertical path.

(a) Calculate the **work done** when lifting the Professor (mass = 75 kg) through a distance of 120 m.

Work done: ______________________

Zork suspends the Professor in a **stationary** position.

(b) Explain why there is **no work** being done on Professor Beaker when he is hanging in the air without moving.

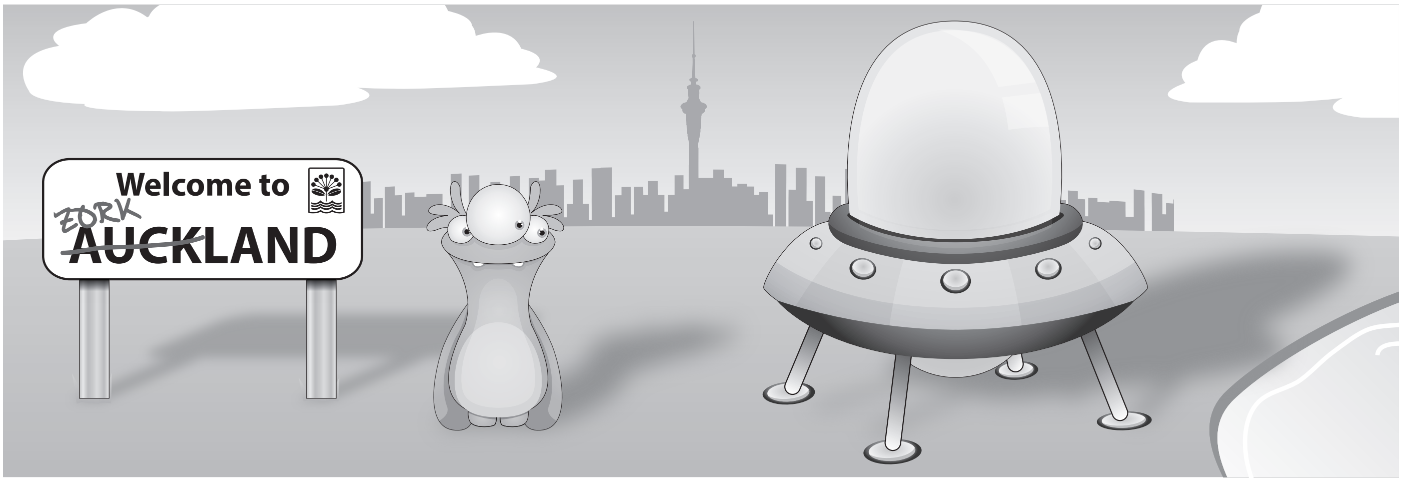
Professor Beaker is released from the tractor beam and his 75 kg mass falls 3.5 m into a small pond. The Professor has 2 500 J of kinetic energy just before he landed in the pond.
This was different from the amount of energy Professor Beaker had when he was suspended below the spaceship.

(c) Explain why there is a **difference** in the energy Professor Beaker had when he was suspended below the spaceship compared to just before he fell into the pond.

In your answer you should:

- Name the type of energy Professor Beaker had when he was suspended below the spaceship.
- Calculate how much energy Professor Beaker had when he was suspended below the spaceship.
- Calculate the difference between the kinetic energy Professor Beaker had just before landing in the pond and the energy Professor Beaker had when he was suspended below the spaceship.
- Justify the difference in energy of Professor Beaker when he was suspended below the spaceship and then just before he landed in the pond.

Zork lands his spaceship in an empty field next to the pond and jumps out. He notices that his spaceship, with four legs, is sinking slightly into the soft ground. Zork sinks deeper despite having a smaller mass than his spacecraft.



The area of each spaceship leg in contact with the ground is 0.04 m^2. Zork's feet have a combined area of 0.015 m^2.

(d) Calculate the **pressure** that the spaceship (mass 500 kg) and Zork (mass 60 kg) exert on the ground. In your answer you must determine:

- The area of the spaceship legs in contact with the ground.
- The weight force of both the spaceship AND Zork.
- The pressure acting on the ground for both the spaceship AND Zork.
- Explain how pressure relates to how far both the spaceship AND Zork sink into the ground.

QUESTION ONE

Patterns of inheritance for aliens are the same as it is in humans. The number of eyes an alien has is controlled by a **gene** with **alleles**.

(a) Explain the relationship between a **gene** and an **allele**, with reference to **how** different alleles arise.

Zork tells Professor Beaker that he is not a threat, but an extra-terrestrial scientist on a mission to understand humans. He shows the Professor a picture of his wife and son.

The allele for three eyes (E) is dominant over the allele for one eye (e). Zork and his wife Marla, have a son Kaden, who only has one eye.

(b) Discuss how it would be possible for Kaden to have one eye, even though both Zork and Marla have three eyes.

In your answer you should:

- Use labelled Punnett squares.
- Link the genotypes and phenotypes of the child, parents, AND grandparents.

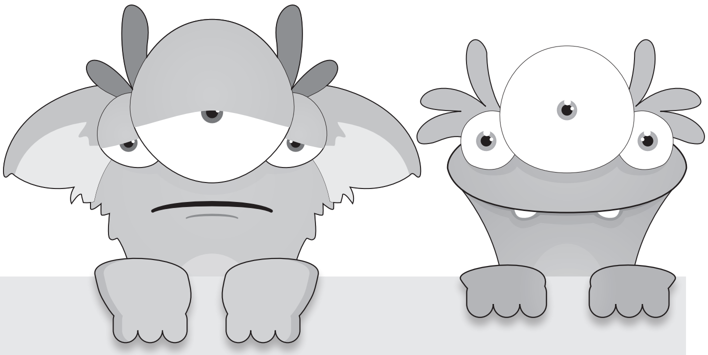
Zork and Marla have two more children, both with one eye. They are expecting their fourth child.

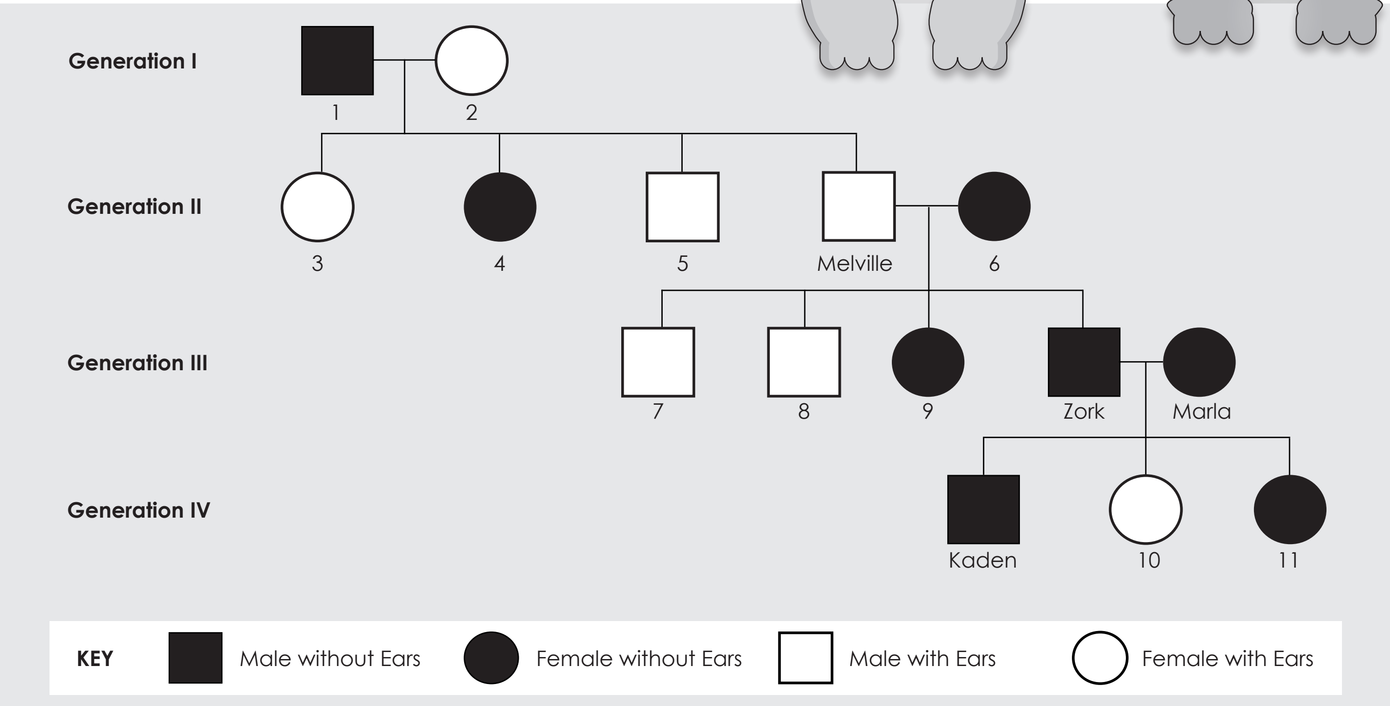
(c) Explain what the chances are of the FOURTH child also having one eye.

The presence of ears on aliens is controlled by a gene.

Zork's father Melville has ears whereas Zork has no ears.

The pedigree chart below shows the inheritance of ears in Zork's family. No ears is the dominant allele (N), while having ears is recessive (n).



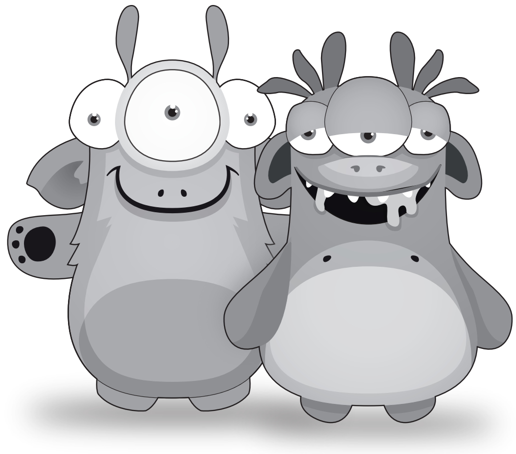


(d) Explain how the pedigree chart can be used to show that having ears is a recessive trait.

In your answer you should:

- Define the terms *dominant* and *recessive*.
- State the genotype(s) of aliens with no ears and with two ears.
- Complete a labelled Punnett square to support your answer.
- Explain how your Punnett square shows that having ears is a recessive trait.

QUESTION TWO



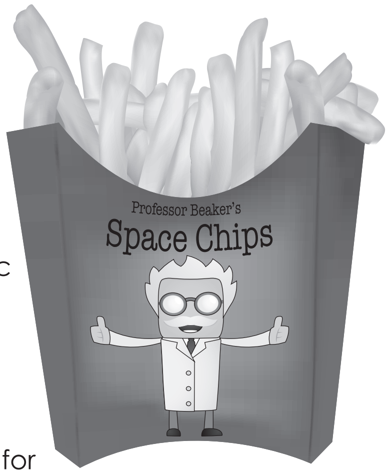
Genetic variation is important in a population, even to aliens. Characteristics such as body-hair length, height and amount of saliva produced can vary from individual to individual.

(a) Describe what is meant by the term **genetic variation**.

(b) One process that produces genetic variation is **mutation**. Explain what mutations are and how they contribute to genetic variation.

In your answer you should include:

- What a mutation is.
- The effect of mutations on genes, alleles and DNA.
- Whether all mutations are passed on to the next generation.



QUESTION ONE

Professor Beaker makes Zork the Earth delicacy 'hot chips' but has run out of salt. He knows he can make table salt (sodium chloride) from hydrochloric acid and sodium oxide.

(a) Discuss how the Professor would make sodium chloride salt from hydrochloric acid and sodium oxide.

In your answer you should:

- State what **type of reaction** occurs.
- Write a word equation AND a correctly balanced symbol equation for the reaction between hydrochloric acid and sodium oxide.
- Explain how litmus paper could be used during the process described to show the salt being produced is **neutral**.
- Explain how Zork could make solid sodium chloride in a school lab from hydrochloric acid and sodium oxide (this may be done by drawing labelled diagrams).

Word equation:

Correctly balanced symbol equation:

Diagram(s) for collection of solid sodium chloride:

Zork and Professor Beaker find three unlabelled beakers in the laboratory, each containing a colourless liquid. He knows that each of the three beakers must contain either pure water, citric acid solution or magnesium hydroxide solution.

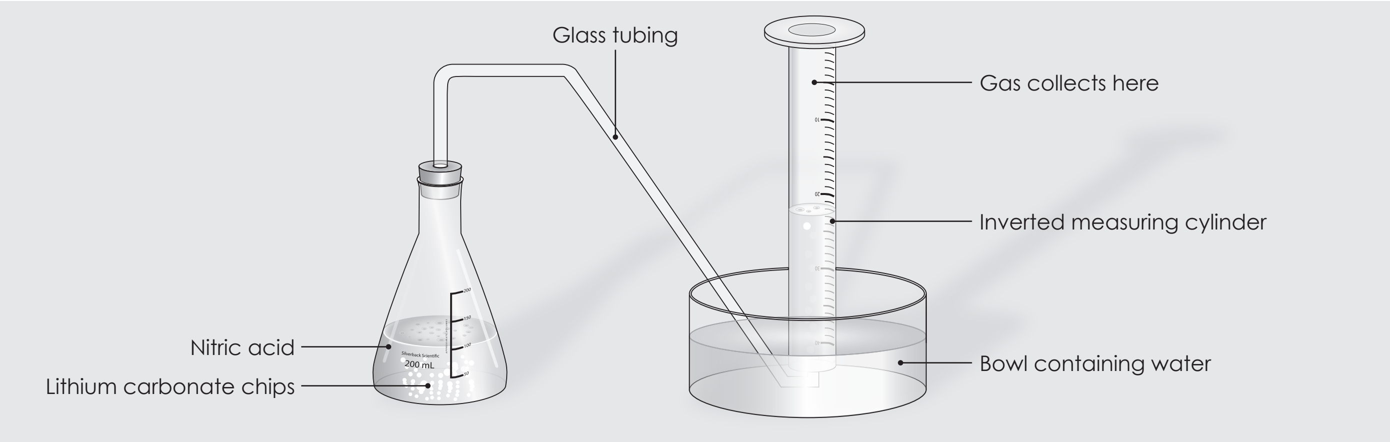
(b) Using only red and blue litmus paper devise a method that they could use to positively identify each of the solutions.

In your answer you should:

- State the observations for **both** red and blue litmus for each beaker.
- **Describe** each solution as either acidic, basic or neutral.
- Estimate the **pH** and **colour** universal indicator would be in each solution.
- Compare the relative concentrations of hydrogen ions AND hydroxide ions in the **identified** solutions.

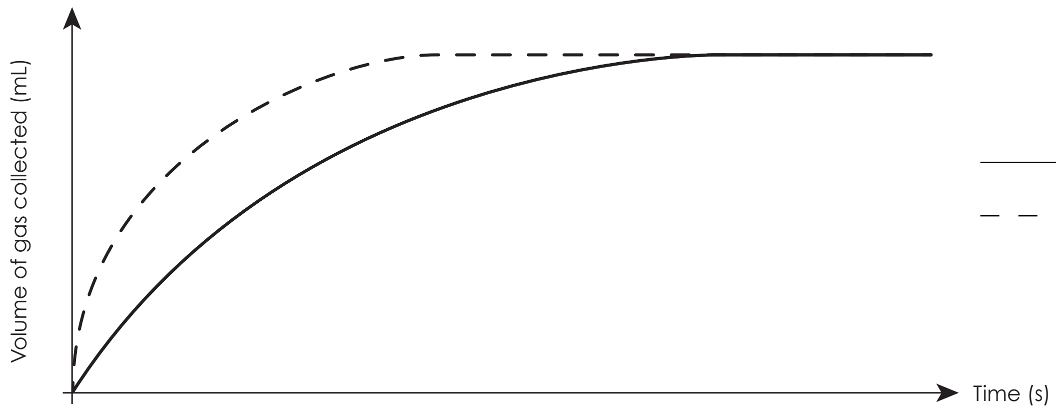
QUESTION TWO

Professor Beaker and Zork were investigating rates of reaction. Lithium carbonate chips were added to a solution of nitric acid in a conical flask. The flask was then connected to an inverted measuring cylinder in order to collect the gas, as shown in the diagram below:



The reaction was carried out twice using **different concentrations** of nitric acid, 1.0 mol L^{-1} and 2.5 mol L^{-1}. The mass and size of the lithium carbonate chips, and the volume of nitric acid used, were the same for both experiments.

The volume of gas produced for the two concentrations was measured for a few minutes and the results were used to sketch the graph shown below.



(a) Write a word equation AND a correctly balanced symbol equation for the reaction between nitric acid and lithium carbonate.

Word equation:

Correctly balanced symbol equation:

(b) State which line (Experiment A or Experiment B) on the graph represents the reaction for 2.5 mol L^{-1} nitric acid and explain how you worked this out.

In your answer you should:

- Identify which line represents the reaction using 2.5 mol L^{-1} nitric acid.
- Explain why the line you have identified is the reaction using 2.5 mol L^{-1} nitric acid.
- Give reasons for the different rates of reaction in terms of particles and their collisions.
- Explain why both lines end up horizontal.

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	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 **H** Hydrogen 1.0																	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											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

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

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

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

SUGGESTED ANSWERS

ALIEN MECHANICS

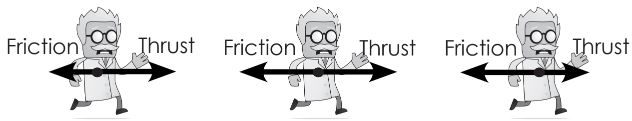
QUESTION ONE

(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 = 560 kg x 10 N kg^{-1} = 5 600 N

(c) a = $\Delta v/\Delta t$ = 4 m s^{-1}/20 s = 0.20 m s^{-2}

(d)



(e) 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 opposite direction, the forces subtract, giving a smaller net force.

Net forces determine whether the runner is accelerating, decelerating or maintaining constant speed. If the net force is pointing in the same direction as the direction of motion, the object accelerates. If the net force is pointing in the opposite direction to the direction of motion, the object decelerates. If there is no net force, the object maintains constant speed or is stationary.

Section A: Professor Beaker is accelerating. This is because there is a net force pointing forwards. This occurs when the thrust force is greater than friction.

Section B: Professor Beaker is running at a constant speed. This is because there is no net force. This occurs when the thrust force is equal to friction.

Section C: Professor Beaker is decelerating. This is because there is a net force pointing in the opposite direction to the motion.

(f) Section A : ½ x 4 ms^{-1} x 20 s = 40 m

Section B : 4 ms^{-1} x 20 s = 80 m

Section C : ½ x 4 ms^{-1} x 30 s = 60 m

Total Distance = 180 m

QUESTION TWO

(a) F = ma = 75 kg x 10 N kg^{-1} = 750 N

W = Fd = 750 N × 120 m = 90 000 J

(b) Work is done when a force causes an object to move in the direction of the force over a distance. The force holding Professor Beaker suspended is not moving him, despite the tractor beam holding him above the ground. Therefore, no work is being done nor has he gained any gravitational potential energy. This can be proved by the following work calculation:

W = F x d = 750 N x 0 m = 0 J

(c) Type of energy the Professor has dangling is *gravitational potential energy*.

E_p = mgΔh = 75 kg × 10 N kg^{-1} × 3.5 m = 2 625 J

Energy difference = 2 625 - 2 500 = 125 J

Some of the gravitational potential energy of Professor Beaker at the 3.5 m height is lost due to due to friction / air resistance. This means that some of the initial gravitational potential energy is converted into heat and sound as well as kinetic energy. As a consequence the kinetic energy is less than the gravitational energy he had at the start. By the time he reaches the pond's surface, 125 J of energy has been lost through this friction.

(d) Total area of spaceship leg's: = 4 x 0.04 m^2 = 0.16 m^2

Weight force (ship) = 500 kg x 10 N kg^{-1} = 5 000 N

Weight force (Zork) = 60 kg x 10 N kg^{-1} = 600 N

Pressure (ship) = F/A = 5 000/0.16 = 31 250 N m^{-1} (Pa)

Pressure (Zork) = F/A = 600/0.015 = 40 000 N m^{-1} (Pa)

$P_{Zork} > P_{Spaceship}$ so Zork sinks further into the soft ground.

Pressure is represented by the formula P = F / A. A 'lighter' Zork will have less weight force than a 'heavier' spaceship. However, Zork's weight force is spread over a smaller area, therefore producing greater pressure on the ground than the spaceship. With more pressure, Zork will sink further into the ground than his spaceship.

ALIEN GENETICS

QUESTION ONE

(a) A section of DNA within a chromosome that codes for a trait / phenotype is called a gene. The gene in this example controls the number of eyes an alien has. An allele is an alternative form of a gene. In this case three eyes or one eye. Genes can differ slightly in their sequence of bases in the DNA strand in the section of the gene in question, this is how different alleles arise.

(b) For Kaden to have one eye, he must have a genotype of ee (i.e. have both recessive alleles). If a dominant allele, E is present then three eyes would be seen. In order to have a genotype of ee, both Zork and Marla must have given an e (recessive allele). Both parents have three eyes so therefore, they both must have a dominant allele (E) and because each parent passes on a recessive allele the genotype of each parent must be Ee.

The grandparents could have a genotype of ee, Ee, or EE. It is not possible to say for sure, but at least one of the grandparents on each side must pass on a recessive allele (e) in order for each parent to have a recessive allele to pass on to Kaden.

Marla

Zork	E	e
E	EE	Ee
e	Ee	**ee** — Kaden's genotype

(c) Each child / fertilisation has an equal one in four chance of producing a child with one eye. This is because in the process of gamete formation / during meiosis alleles are randomly assorted. Previous conceptions have no effect on future offspring; each is a separate event. Chances their fourth child having one eye is still one in four, as previous conceptions have no effect on this child; it is a new random event.

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

Having ears is a recessive trait. This can be established using Generation III and Generation IV. In Generation III - Zork and Marla, two no-eared individuals have two offspring with no ears and one with ears. The only way this is possible is for Generation III to both be Nn. When two n alleles come together, a homozygous recessive nn offspring forms. If no ears was recessive, Gen III individuals would be nn. There is no way of forming an individual with N in its genotype.

QUESTION TWO

(a) 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.

(b) 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 DNA 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.

ALIEN CHEMISTRY

QUESTION ONE

(a) The mixing of hydrochloric acid and sodium oxide is a *neutralisation reaction*.

Word Equation:

Hydrochloric acid + Sodium oxide ⟶ Sodium chloride + Water

Balanced Chemical Equation:

$2HCl + Na_2O \longrightarrow 2NaCl + H_2O$

How to make it: Gradually dissolve sodium oxide into hydrochloric acid and test with red and blue litmus paper. If both litmus papers are red, add a little more sodium oxide. If the litmus papers are both blue, add a little more hydrochloric acid. Repeat this process until red litmus paper stays red and blue litmus paper stays blue - this means that the resultant solution is neutral and contains only sodium chloride and water. To remove the water, leave the solution in an evaporating basin in a warm place or heat it over a Bunsen burner. The resultant solid which is left behind will be sodium chloride.

(b) Add red litmus paper to all three beakers. Two solutions will make the litmus remain red, one will turn the litmus blue. The solution that turns the red litmus blue is magnesium hydroxide. Of the two remaining unidentified solutions, add blue litmus paper. One solution will make the litmus remain blue, this is water and the other solution will turn the litmus paper red, this is citric acid.

<u>Citric acid</u> would turn universal indicator red / orange and would have an approximate pH of 2-4 (any 'acidic' values / colours are acceptable as long as they match up with each other). As an acidic solution, it has a higher concentration of hydrogen ions than hydroxide ions.

<u>Water</u> would have no effect on universal indicator (stays green) and have a pH value of 7. As a neutral solution, it has an equal concentrations of hydrogen ions and hydroxide ions.

<u>Magnesium hydroxide</u> would turn universal indicator blue and has an approximate pH value of 10 (any 'basic' values / colours are acceptable as long as they match up with each other). As a basic solution, it has a higher concentration hydroxide ions than hydrogen ions.

QUESTION TWO

(a) Word Equation: Nitric acid + Lithium carbonate ⟶ Lithium nitrate + Carbon dioxide + Water

Balanced Chemical Equation: $Li_2CO_3 + 2HNO_3 \longrightarrow 2LiNO_3 + CO_2 + H_2O$

(b) Line B represents the faster reaction, as it is steeper at the start. This represents the reaction carried out with nitric acid at 2.5 mol L^{-1}. The reaction is faster at the higher concentrations, because the H^+ ions are present in more particles per unit volume, resulting in reactants colliding more frequently, per unit of time.

Both lines become horizontal at the same point on the Y-axis, as this is when both reactions have finished, i.e. all of the lithium has been completely used up and therefore no more gas is produced. Both finished with same amount of gas produced, as both reactions had the same amount of lithium carbonate to start with.