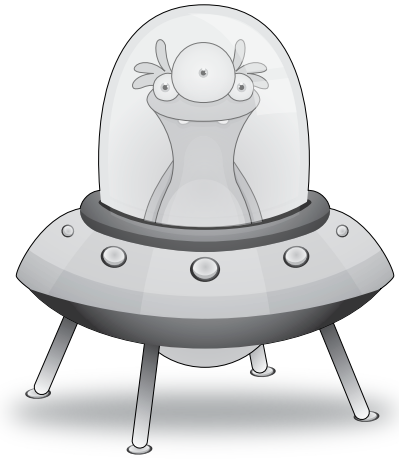
NZPQA

New Zealand Pretend Qualifications Authority

Level 1 Science AS 99999
Demonstrate Understanding of Aspects of
ALIEN ABDUCTION

For Assessor's use only	Achievement Criteria	
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Demonstrate understanding of aspects of alien abduction. ☐	Demonstrate in-depth understanding of aspects of alien abduction. ☐	Demonstrate comprehensive understanding of aspects of alien abduction. ☐
Overall Level of Performance ☐		

QUESTION ONE: ALIEN ENCOUNTERS



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

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

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

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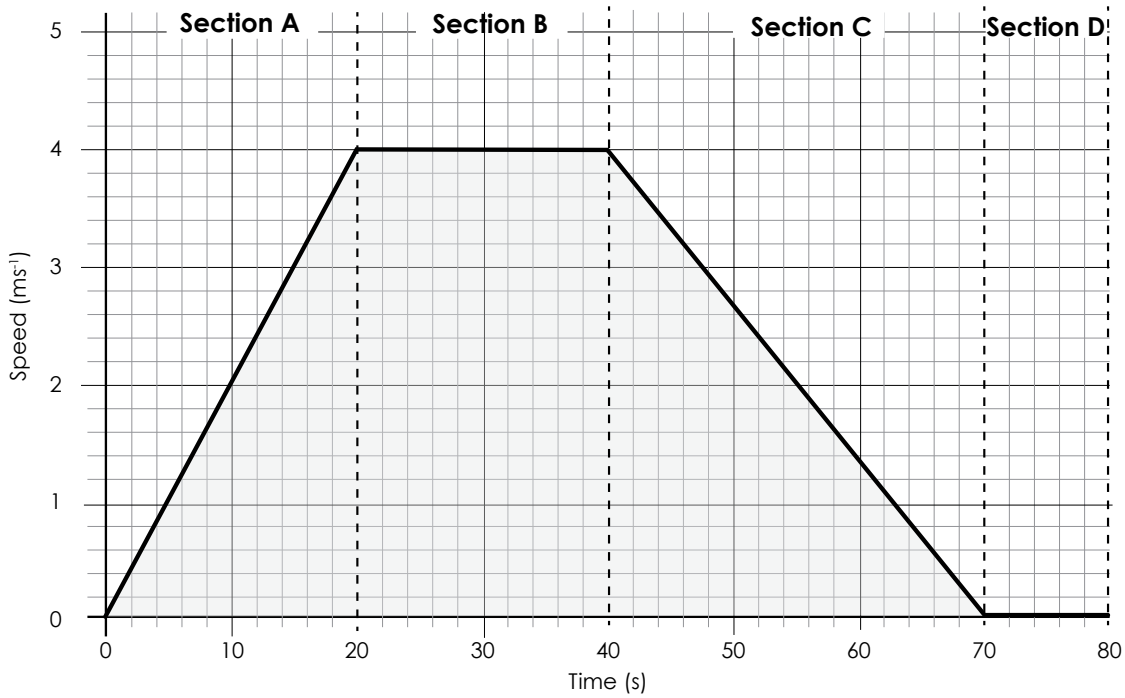
Zork, searching for human life forms, stumbles across Professor Beaker out for an evening stroll. The startled Professor starts to run for cover. The first 80 seconds of the Professor's run is shown by the speed-time graph below. Use the graph to answer the questions that follow:

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



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

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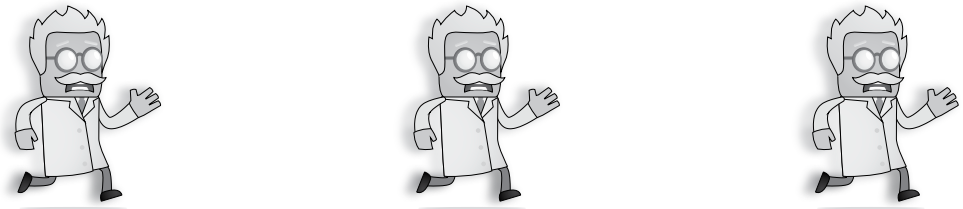
Professor Beaker's acceleration: _____

(d) On the diagrams on the following page, **draw** and **label** 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.

Section A **Section B** **Section C**



(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:

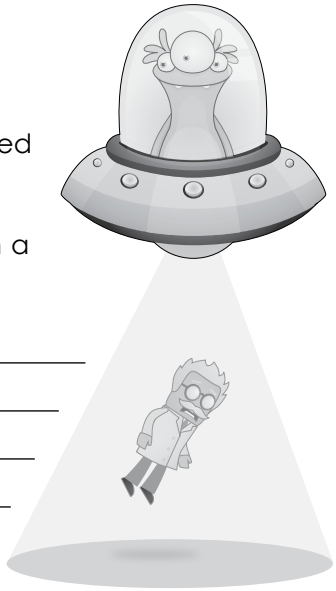
- Describe what is meant by net force.
- Explain the link between net force and motion for EACH section.
- Compare the direction of the net force and the direction of the motion for EACH section.

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

Total distance travelled: _____

QUESTION TWO: THE ABDUCTION

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



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

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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.

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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 from 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 hanging from 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.

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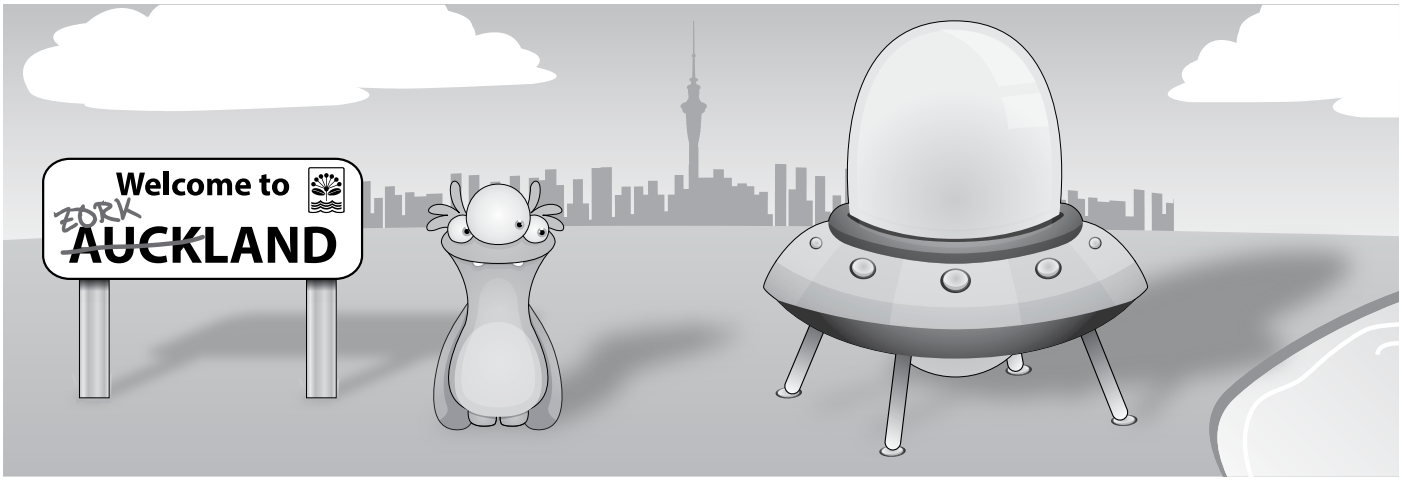
Zork lands his spaceship in an empty field next to the pond and jumps out. He notices that his spaceship, with four legs, is sinking slightly into the soft ground. Zork sinks deeper despite having a smaller mass than his spacecraft.



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) exerts 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 of both the spaceship AND Zork.
- Explain how pressure relates to how far both the spaceship and Zork sink into the ground.

QUESTION THREE: ALIEN GENETICS

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) in aliens. 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.

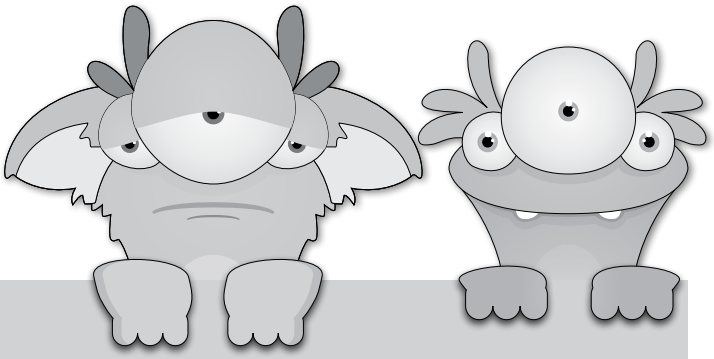
(c) Explain what the chances are of the FOURTH child having one eye also.

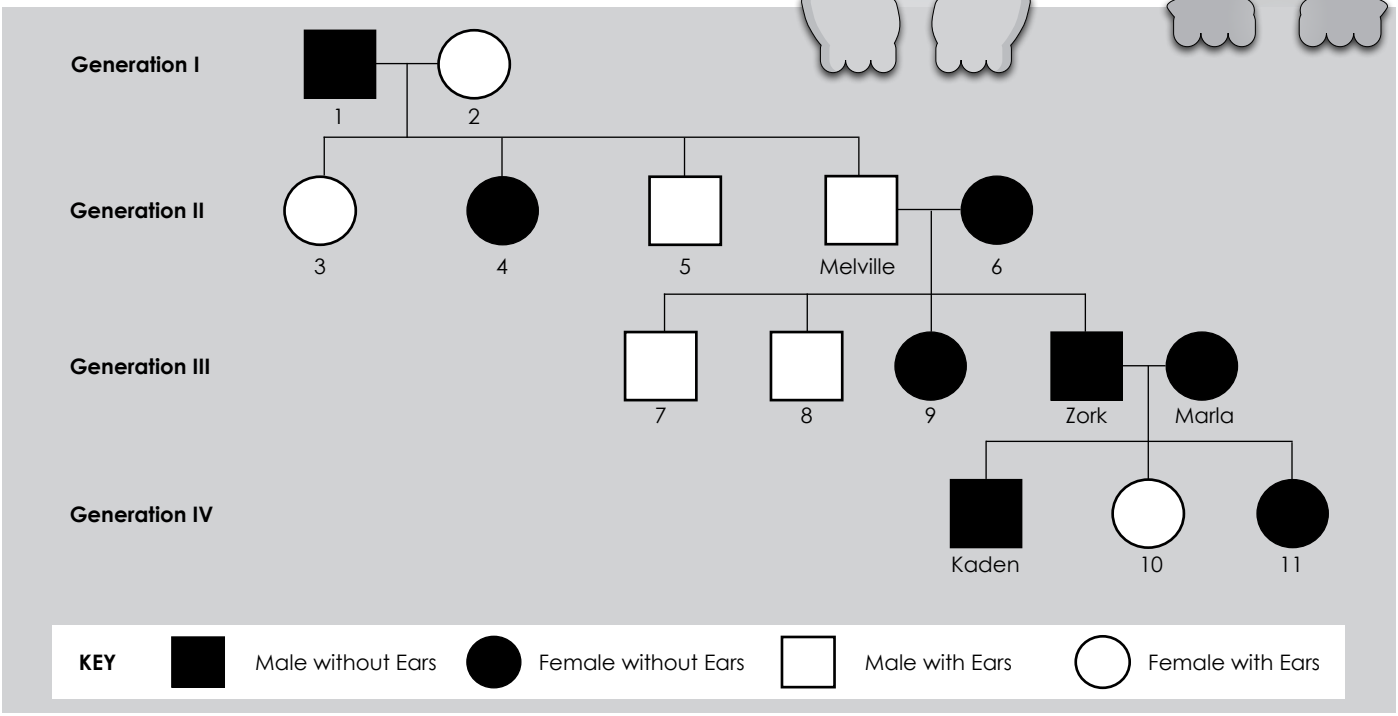
You should refer to your Punnett square in (b).

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).



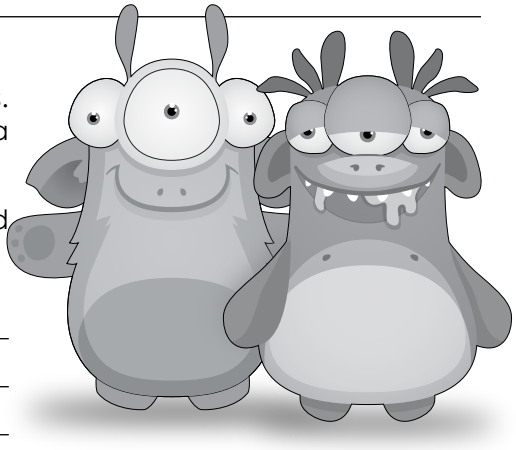


(d) Explain how the pedigree chart can be used to show that having ears is a recessive trait.

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 FOUR: ALIEN GENETIC VARIATION



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**, and explain its importance to a population.

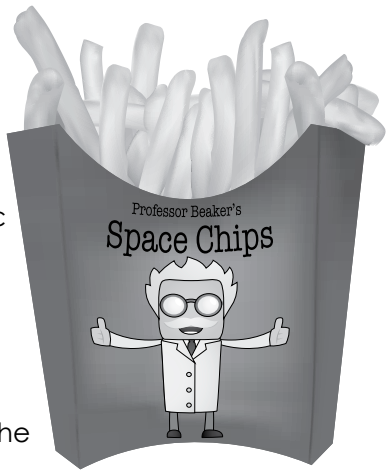
(b) One process that produces genetic variation is mutation.

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 FIVE: SPACE CHIPS AND OTHER SUCH CHEMISTRY



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 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 sodium chloride in a school lab from hydrochloric acid and solid sodium oxide (this may be done by drawing labelled diagrams).

Word Equation:

Balanced Symbol Equation:

Diagram(s) for collection of solid sodium chloride:

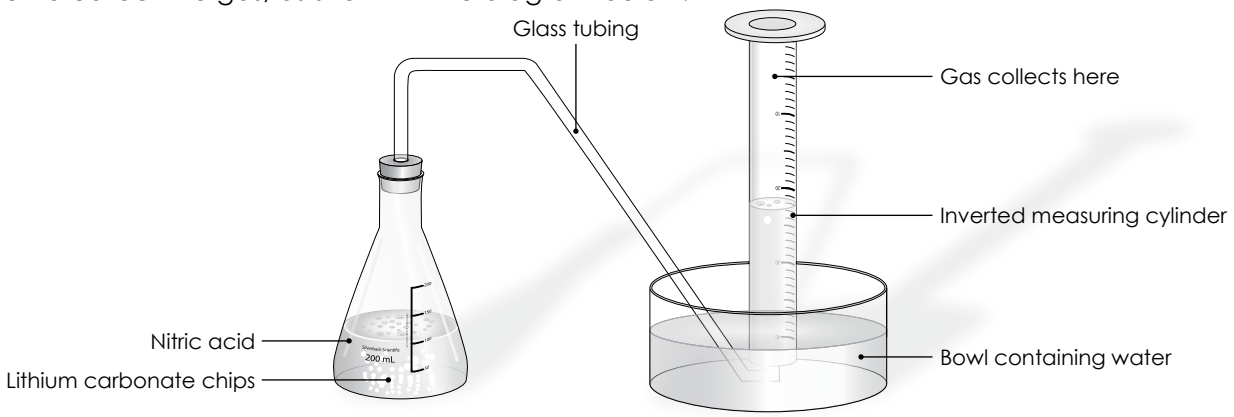
Zork and Professor Beaker find three unlabelled beakers in the laboratory, each containing a colourless liquid. He knows that each of the three beakers must contain either pure water, citric acid solution or magnesium hydroxide solution.

(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:

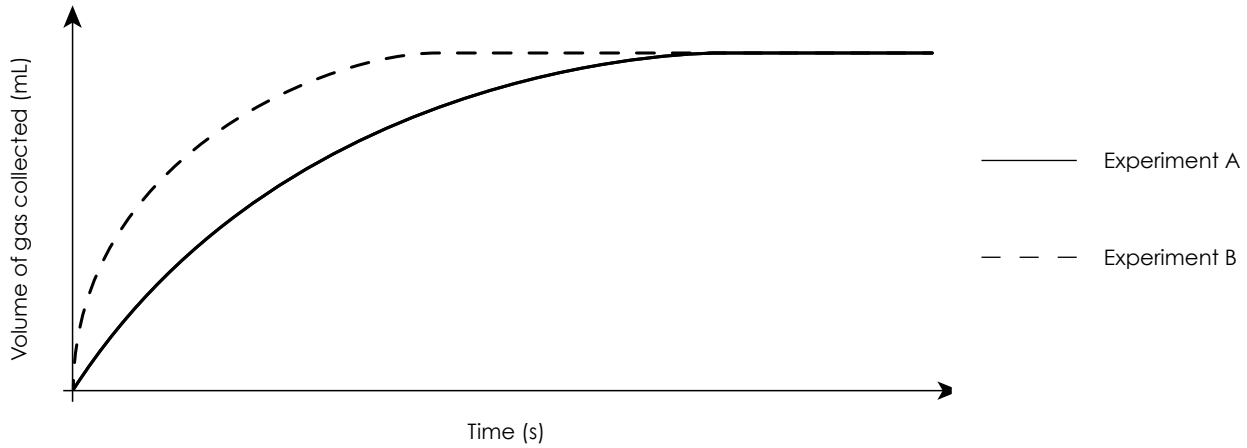
- State the observations for both red and blue litmus for each beaker.
- Describe each solution as either acidic, basic or neutral.
- Estimate the pH and colour universal indicator would be in each solution.
- Compare the relative amounts of hydrogen ions AND hydroxide ions in the **identified** solutions.

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.



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

Word Equation:

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.

Suggested Answers - Alien Abduction Exam

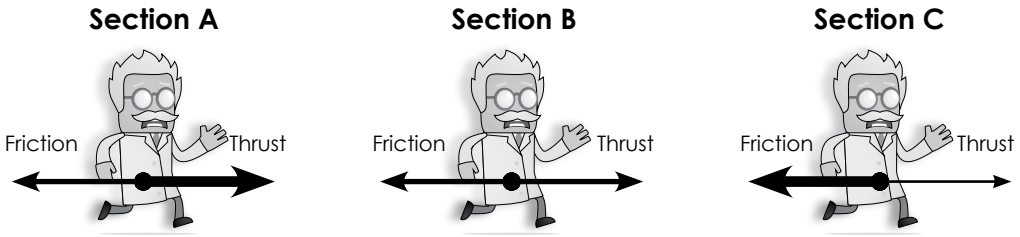
QUESTION ONE - ALIEN ENCOUNTERS

(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) $F = m\,a = 560\text{ kg} \times 10\text{ N kg}^{-1} = 5\,600\text{ N}$

(c) $a = \Delta v / \Delta t = (4\text{ m s}^{-1} - 0\text{ m s}^{-1}) / (20\text{ s} - 0\text{ s}) = 0.2\text{ m s}^{-1}$

(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 : $\frac{1}{2} \times 4\text{ ms}^{-1} \times 20\text{ s} = 40\text{ m}$

Section B : $4\text{ ms}^{-1} \times 20\text{ s} = 80\text{ m}$

Section C : $\frac{1}{2} \times 4\text{ ms}^{-1} \times 30\text{ s} = 60\text{ m}$ Total Distance = 180 m

QUESTION TWO - THE ABDUCTION

(a) $F = m\,a = 75\text{ kg} \times 10\text{ N kg}^{-1} = 750\text{ N}$

$W = F\,d = 750\text{ N} \times 120\text{ m} = 90\,000\text{ J}$

(b) Work is done when a force causes an object to move in the direction of the force over a distance. Here 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:

$W = F \times d = 750\text{ N} \times 0\text{ m} = 0\text{ J}$

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

$E_p = mg\Delta h = 75\text{ kg} \times 10\text{ N kg}^{-1} \times 3.5\text{ m} = 2\,625\text{ J}$

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: $= 4 \times 0.04\text{ m}^2 = 0.16\text{ m}^2$

Weight force of spaceship: $F = m\,a = 500\text{ kg} \times 10\text{ N kg}^{-1} = 5\,000\text{ N}$

Weight force of Zork: $F = m\,a = 60\text{ kg} \times 10\text{ N kg}^{-1} = 600\text{ N}$

Pressure of Spaceship: $P = F / A = 5\,000\text{ N} / 0.16\text{ m}^2 = 31\,250\text{ Pa}$

Pressure of Zork: $P = F / A = 600\text{ N} / 0.015\text{ m}^2 = 40\,000\text{ Pa}$

$P_{Zork} > P_{Spaceship}$ 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.

QUESTION THREE - ALIEN GENETICS

(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	
		E	e
Zork	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 (albino) 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.

		Marla	
		N	n
Zork	N	NN	Nn
	n	Nn	**nn**

Individual 10

QUESTION FOUR - ALIEN GENETIC VARIATION

(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.

QUESTION FIVE - SPACE CHIPS AND OTHER SUCH CHEMISTRY

(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: Dissolve the sodium oxide in the hydrochloric acid. Take the resulting solution and put it in an evaporating dish. It could be heated using a Bunsen burner or left somewhere warm for a few days. The water would evaporate off leaving behind the neutral salt sodium chloride. The solution will be neutral when red and blue litmus papers both stay the same colour. When blue paper changes to red the solution is acidic. When red paper changes to blue the solution is basic.

(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.

Citric acid 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 more hydrogen ions than hydroxide ions.

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

Magnesium hydroxide 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 more hydroxide ions than hydrogen ions.

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

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

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.