S2 Examination Practise 5

Q and A

Q2

(4 marks)

Consider a bucket of water and a swimming pool both at the same temperature. Complete the following table using only the words same, less or more.

	Average kinetic energy	Internal energy
bucket		
pool		

(4 marks)

	Average kinetic energy	Internal energy
bucket	same	less
pool	same	more

Q3

(10 marks)

500 g of water at 25.0°C in a plastic beaker is placed in a freezer, which coverts it to ice in 8.00 minutes. (Assume the heat capacity of the plastic beaker is negligible.)

a Calculate the heat transfer, Q_1, from the water as its temperature falls from 25°C to 0°C. (1 mark)

$Q_1 = mc\Delta t = 0.500 \times 4.18 \times 10^3 \times 25 = 5.23 \times 10^4$ J

b Calculate the heat transfer, Q_2, from the water as it changes from 0° water to 0° ice. (2 marks)

$Q_2 = mL = 0.500 \times 3.34 \times 10^5 = 1.67 \times 10^5$ J

c Calculate the rate of heat transfer from the water. (3 marks)

$$\text{power} = \frac{\text{energy}}{\text{time}} = \frac{(5.23 \times 10^4 + 1.67 \times 10^5)}{(8 \times 60)} = 457 \text{ W}$$

Q3 continued

d An immersion heater rated at 1200 W is placed into 0.75 kg of water at 10°C for 2.00 minutes. What is the final temperature of the water? (4 marks)

power = $\frac{\text{energy}}{\text{time}}$ therefore energy = power × time

energy = 1200 × 120 = 144 000 J

$Q = mc\Delta T$

$144\ 000 = 0.75 \times 4.18 \times 10^3\ (T_{final} - 10)$

$T_{final} = 55.9°$

Q4

(4 marks)

State whether the following statements are true or false.

	Statement	True or False
a	Thermal energy is a measure of the average kinetic energy of the particles in a substance.	
b	Heat is the energy that transfers from a substance whose particles have a higher kinetic energy to a substance whose particles have a lower kinetic energy.	
c	In experiments, Scientists have been able to remove all the kinetic energy of atoms, and the motion of these atoms have ceased.	
d	During one stage of a heating process of turning ice into water, the temperature remained constant for a while. This was because during this period the internal energy of the material was not increasing.	

a False. The average kinetic energy of particles in a substance is related to temperature.

b True.

c False. Absolute zero, where all movement of atoms ceases, has never been reached.

d False. The internal energy (the sum of kinetic energy and potential energy) is increasing as the potential energy is increasing, even though the kinetic energy remains constant.

Q5

- A bath contains 75 L of water. Initially the water is at 50°C. Calculate the amount of energy that must be transferred from the water to cool the bath to 30°C.
- 1 L of water = 1 kg
- Volume = 75 L So mass of water = 75 kg
- ΔT = final temperature − initial temperature
  ΔT = 30 − 50 = −20°C
- cwater = 4180 J kg−1 K−1.
- Q = mcΔT.
- Q = mcΔT = 75 × 4180 × 20= 6 270 000
  = 6.27 × 106 J transferred from the water

Q6

(4 marks)

The estimated dose equivalent an individual might receive from one X-ray for a joint or limb is 6.0 mSv. Using the quality factor of 1.5, calculate the amount of energy absorbed by a patient of 50 kg receiving such an X-ray.

$$\text{dose equivalent} = \text{absorbed dose} \times \text{quality factor}$$

$$\text{absorbed dose} = \frac{\text{dose equivalent}}{\text{quality factor}}$$

$$\text{absorbed dose} = \frac{0.006}{1.5} = 4.00 \times 10^{-3}\ \text{J kg}^{-1}$$

$$\text{energy} = \text{absorbed dose} \times \text{mass} = 4.00 \times 10^{-3} \times 50 = 2.00 \times 10^{-1}\ \text{J}$$

Q7

(4 marks)

Not all of the elements of the periodic table are naturally occurring. Some have been synthesised, often by neutron bombardment. This is known as artificial transmutation.

Enrico Fermi was the first to perform this. He bombarded uranium-238 with high-energy neutrons.

a Write a nuclear equation to show the neutron absorption of a uranium-238 atom. (2 marks)

$$^{1}_{0}n + ^{238}_{92}U \rightarrow ^{239}_{92}U$$

This new nuclide is unstable and was found to undergo beta decay to form a new element.

b Write a nuclear reaction for the beta decay of this new nuclide. (2 marks)

$$^{239}_{92}U \rightarrow ^{239}_{93}Np + ^{0}_{-1}\beta$$

Q8

(4 marks)

Plutonium-239 is a fissile material. A plutonium-239 nucleus is struck by a fast moving neutron in a fast breeder reaction. It splits into barium-145 and strontium-93 and releases some neutrons. The nuclear equation for this is:

$^{1}_{0}n + ^{239}_{94}Pu \rightarrow ^{145}_{56}Ba + ^{93}_{38}Sr + X\,^{1}_{0}n$ + energy

a Determine the number of neutrons released. (1 mark)

Two neutrons

The energy released during the fission of this plutonium nucleus is 2.76×10^{-11} J.

b Calculate the loss in mass (the mass defect) during this fission reaction. (3 marks)

Two neutrons are released.

$E = mc^2$

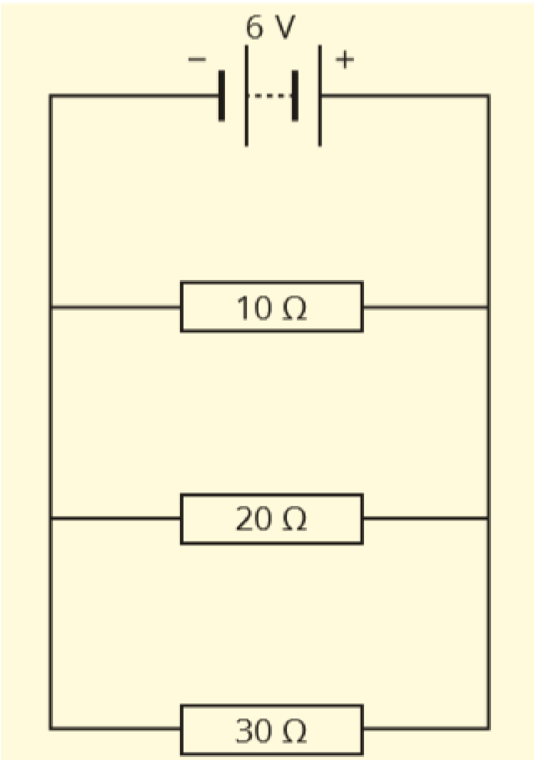
$$m = \frac{2.76 \times 10^{-11}}{(3 \times 10^{8})^2}$$

$$= 3.07 \times 10^{-28} \text{ kg}$$

Q9

(7 marks)

Three resistors are connected in parallel as shown in the diagram below:



Q9 continued

a What is the value of the ratio $\frac{\text{potential difference across the 20 }\Omega\text{ resistor}}{\text{potential difference across the 10 }\Omega\text{ resistor}}$? (1 mark)

= 1

b State Ohm's law. (1 mark)

The voltage across an ohmic conductor is directly proportional to the current through it provided the temperature is constant. (This can be mathematically expressed as $V = IR$.)

c What is the current, in amps, through the 30 Ω resistor? (2 marks)

$V = IR$ $6 = I \times 30$ $I = 0.2$ A

d What is the effective resistance of the circuit? (3 marks)

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \qquad \frac{1}{R_T} = \frac{1}{10} + \frac{1}{20} + \frac{1}{30}$$

$R_T = 5.45\ \Omega$

Q10

(3 marks)

A typical train on a rural railway line travels at 110 km h^{-1}. When the brakes are applied it will travel 1500 m before it stops. What is the average deceleration of such a train?

$$v^2 = u^2 + 2as$$

$$u = 110 \text{ km h}^{-1} = 30.556 \text{ m s}^{-1}$$

$$0^2 = (30.556)^2 + 2 \times a \times 1500$$

$$a = 0.311 \text{ m s}^{-2}$$

Q11

(2 marks)

The two largest male lions at Perth's zoo, Nelson and Mandela, have an approximate weight of 1764 N each. Calculate their individual approximate mass. Include the correct units in your answer.

$$W = mg$$

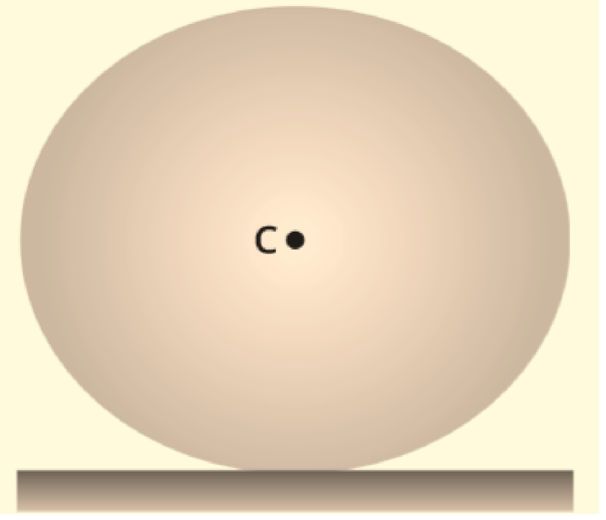
$$1764 = m \times 9.80$$

$$m = 180 \text{ kg}$$

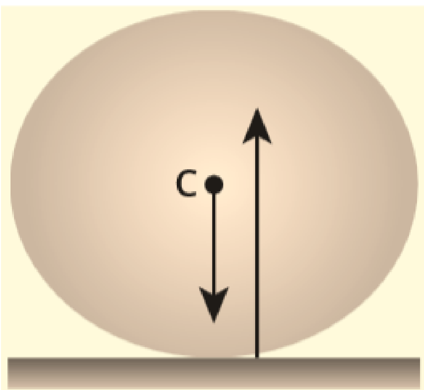
Q12

(3 marks)

Below is a ball that is in the process of bouncing. Its centre is marked with the letter C. It has been dropped from a certain height, made contact with the floor and is slowing down. The velocity is still downwards. However, the ball has deformed sufficiently such that the acceleration, *a*, is now upwards. Draw labelled vector arrows of the appropriate length on the diagram to show clearly the forces acting on the ball.



Q12 continued

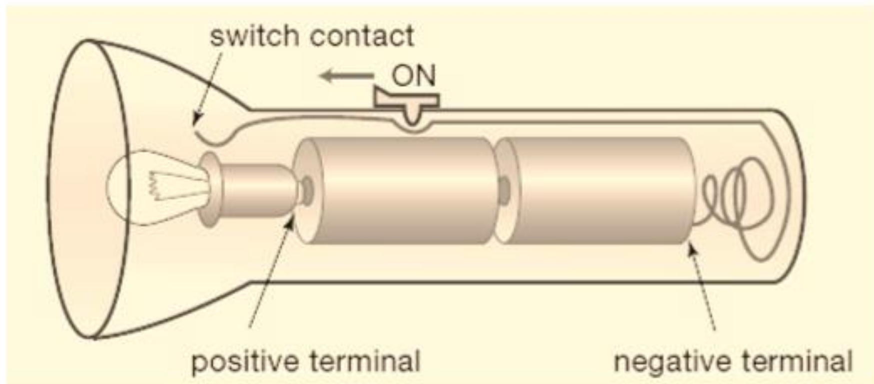


- The weight force must be labelled and drawn downwards from C.
- The normal reaction force must be labelled and drawn perpendicular from the surface.
- The normal force must be clearly larger in magnitude than weight force.

Q13

(2 marks)

A typical torch, shown in the diagram, uses two 1.50 V batteries in series and is rated 0.900 W. Calculate its resistance.



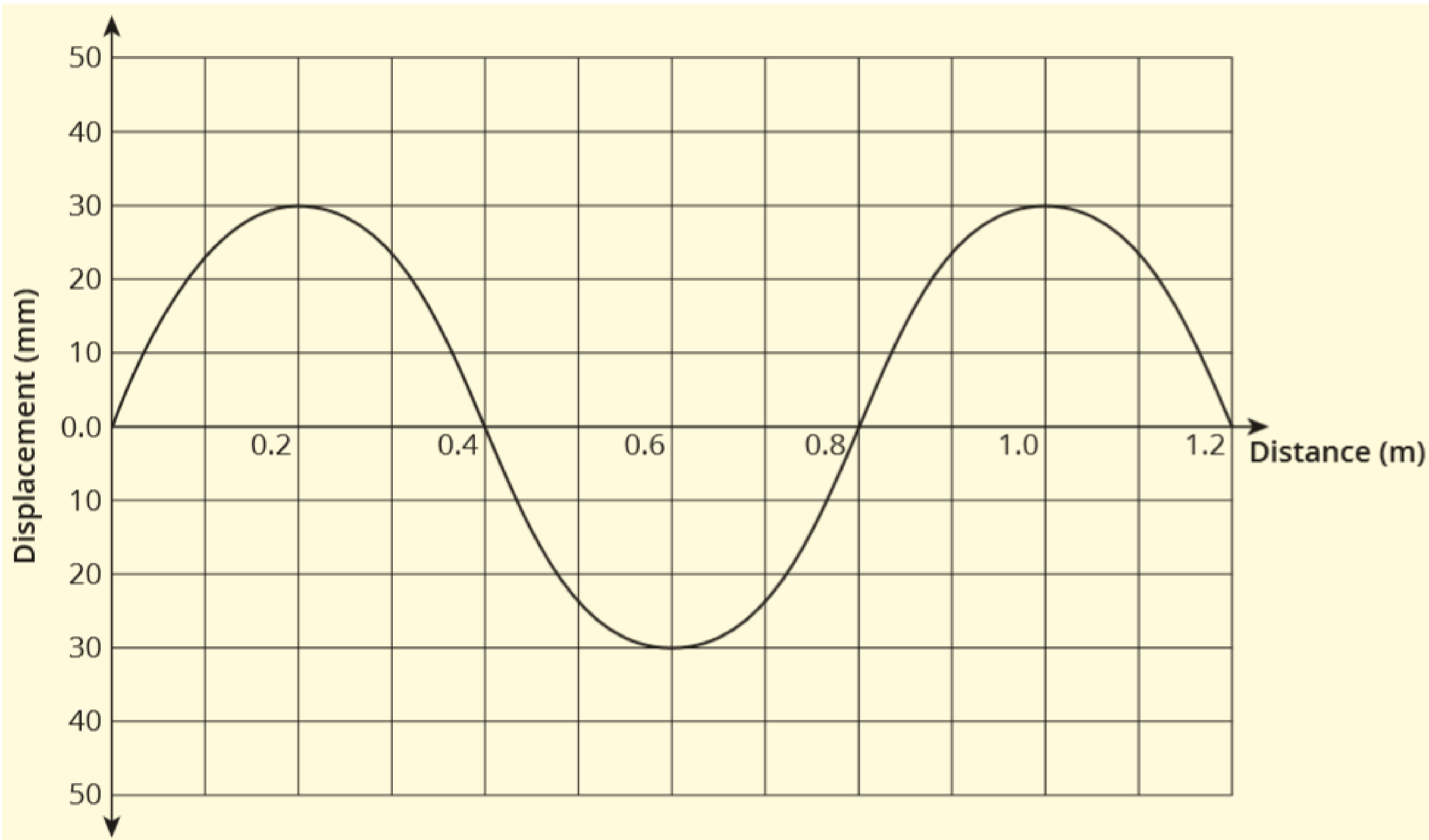
$P = \frac{V^2}{R}$ $\qquad$ $R = \frac{3.00^2}{0.900}$

$R = 10.0\ \Omega$

Q14

(8 marks)

A student sets up a ripple tank and uses data-logging equipment to produce the graph shown below.



Q14 continued

a What is the amplitude of the wave? (1 mark)

amplitude = 0.0300 m

b What is its wavelength? (1 mark)

wavelength = 0.8 m

c The speed of the wave is 1.5 m s^{-1}. What is the period of this wave? (2 marks)

$v = f\lambda$

$1.5 = f \times 0.8$

$f = 1.875$ Hz $\quad T = \frac{1}{f} \quad T = 0.533$ s

d Explain the difference between a transverse and longitudinal wave, and give an example of each. (4 marks)

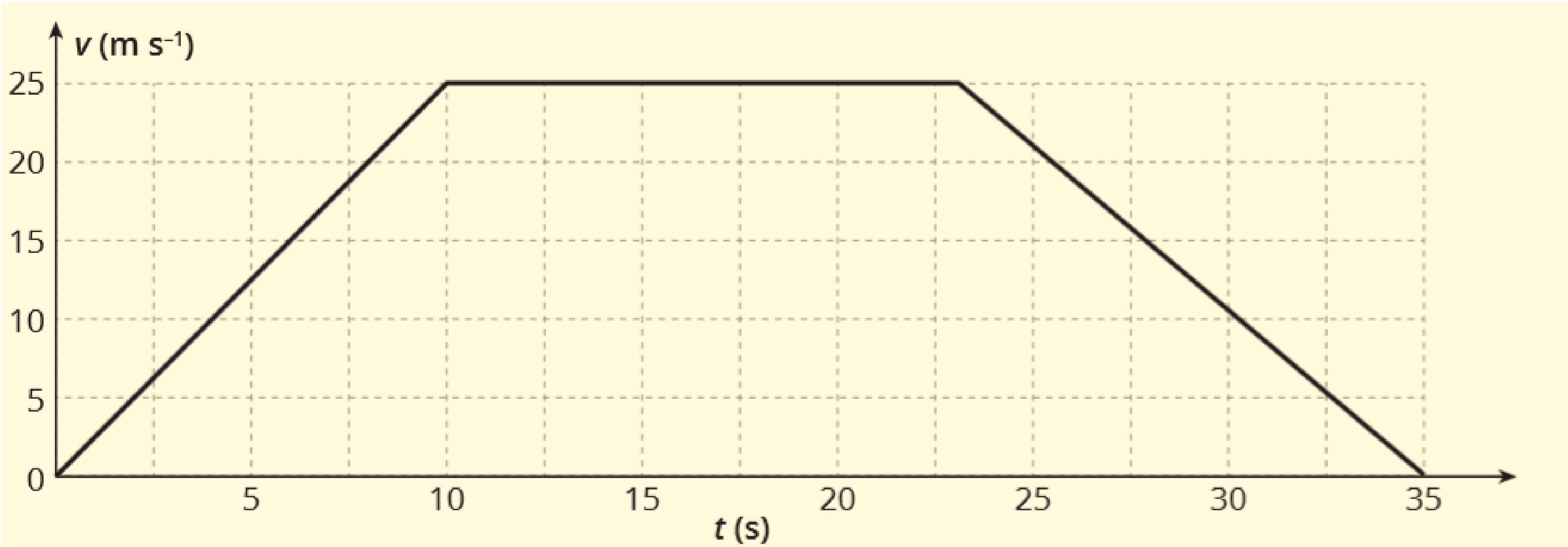
Longitudinal waves occur when particles of the medium vibrate in the same direction as the direction of travel of the medium; for example, sound waves.

Transverse waves are created when the direction of the particle of the medium is perpendicular to the direction of travel of the wave energy itself; for example, water waves.

Q15

Question 15 **(12 marks)**

A driver accelerates uniformly away from a set of traffic lights in her 1200 kg car. The velocity versus time graph for this motion is shown below:



a What is the initial acceleration of the car? Give appropriate units with your answer. (3 marks)

a = gradient = 2.50 m s^{-2}

b What is the total distance travelled, in metres, in the 35 s? (3 marks)

s = area under curve = $\frac{1}{2} \times 10 \times 25 + 13 \times 25 + \frac{1}{2} \times 25 \times 12 = 600$ m

Q15 continued

c What is the net force acting on the car at time $t = 30$ s? (3 marks)

$F_{net} = ma = 1200 \times (-2.08) = -2500$ N

d What is the net force acting on the car at time $t = 20$ s? Explain your answer. (3 marks)

$F_{net} = ma = 0$ N as the car is travelling at a constant speed. The gradient of the v–t graph is 0.

Q16

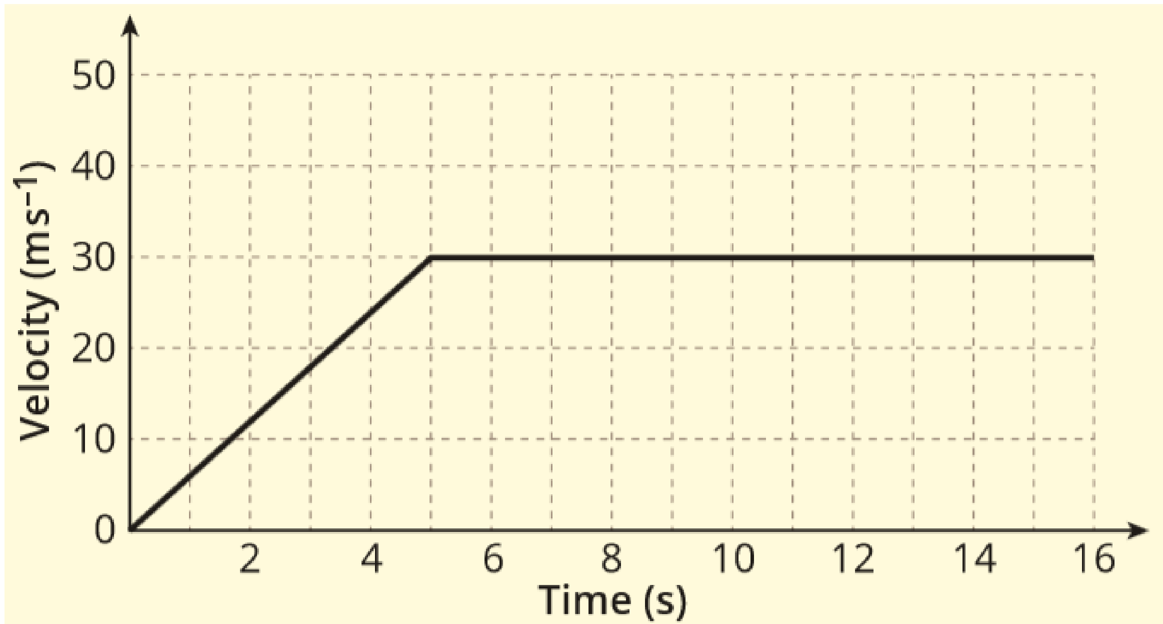
- A lion with a mass of 155kg begins to accelerate as a zebra runs by at its top speed of 20 m s−1. The lion reaches its top speed of 30 m s−1 after accelerating constantly for 5 s. The lion maintains this speed until it catches the zebra. Draw a graph and calculate the following:

a How long does it take the lion to catch the zebra? (3 marks)

b What distance has the zebra travelled before the lion catches up? (2 marks)

Q16 continued

a



Area under curve

$20t = \frac{1}{2} \times 30 \times 5 + (t - 5) \times 30$

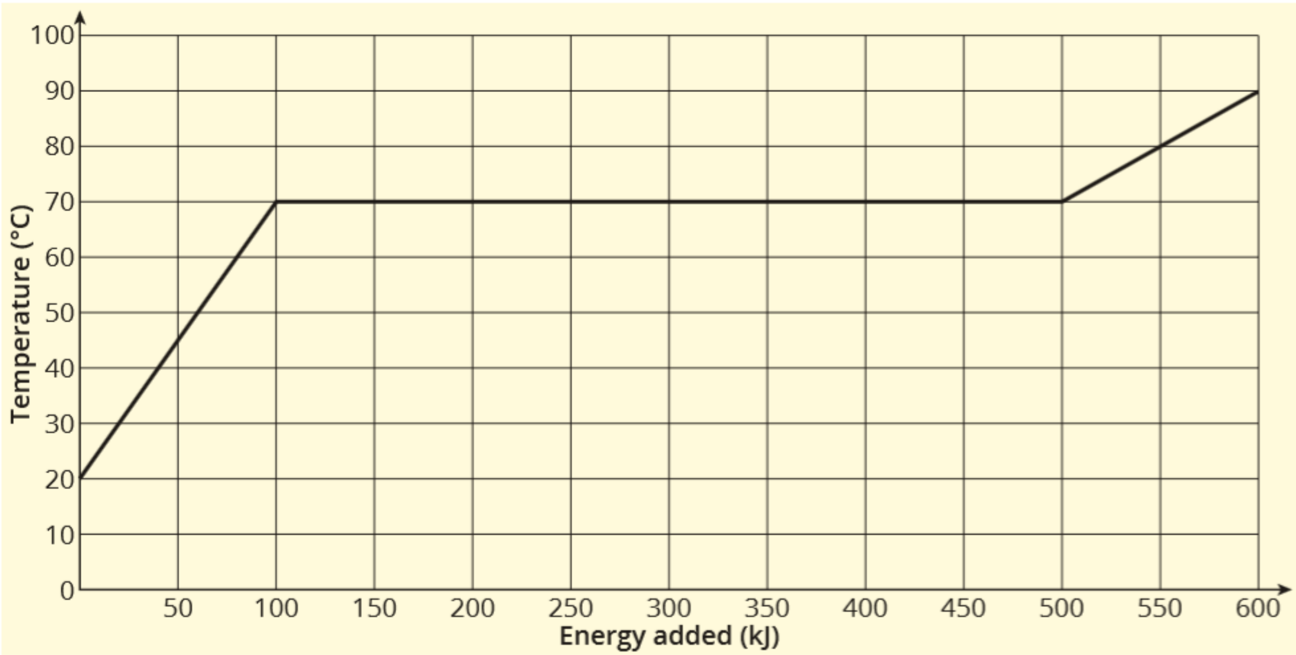
$t = 7.5$ s

b distance = 20 × 7.5 = 150 m

Q17

(9 marks)

The graph below shows the curve for a 2.0 kg sample of material that begins as a solid at room temperature and finishes as a hot liquid. Energy is added at a constant rate.



a What is the temperature at which the substance melts? (1 mark)

70°C

b What is the specific heat capacity of the material in its solid form? (3 marks)

$$Q = mc\Delta T$$

$$c = \frac{100 \times 10^3}{2 \times (70 - 20)}$$

$$= 1.00 \text{ kJ kg}^{-1} \text{ °C}^{-1}$$

Q17 continued

c What is the specific latent heat of fusion of the material? (2 marks)

$$Q = mL$$

$$L = \frac{Q}{m} = \frac{400 \times 10^3}{2}$$

$$= 200 \text{ kJ kg}^{-1}$$

d Explain why the temperature remained constant for a while during one stage of the heating process. (3 marks)

The average random kinetic energy of the molecules was not increasing. The energy is used to overcome the forces holding the particles together rather than increasing the temperature.

Q18

Question 18 **(9 marks)**

There are four naturally occurring stable isotopes of strontium. Many unstable isotopes of strontium are known to exist, the longest-lived of which is strontium-90 which decays through beta emission and has a half-life of 29 years.

a Explain what is meant by the term 'isotope'. (2 marks)

All isotopes of a particular element have the same number of protons, but different numbers of neutrons. All strontium atoms have 38 protons, but different isotopes of strontium have different numbers of neutrons.

b Write a beta decay equation for strontium-90. (2 marks)

$$^{90}_{38}\text{Sr} \rightarrow {}^{90}_{39}\text{Y} + {}^{0}_{-1}\beta + v + \text{energy}$$

Q18 continued

The 1986 Chernobyl nuclear accident contaminated a vast area with strontium-93, $^{93}_{38}Sr$. Beta radiation is dangerous to the human body, as it is ionising radiation.

c Explain what is meant by the term 'ionising radiation'. Why would the main concern regarding strontium-90 (beta decay) be the inhalation or ingestion of this isotope, rather than external exposure. (2 marks)

Beta particles are not strongly penetrating. If the strontium-90 exposure was only external, the damage would be minimal as beta particles have poor penetrating ability. If the exposure is internal, however, a much larger dose is absorbed by the body (usually in gastrointestinal tract), which can lead to mutations and cancers.

d Another radioisotope of strontium, strontium-89, is an artificial radioisotope that is used in the treatment of bone cancers. Typically, cancer treatments will be treated with a dose of 150 MBq. Pellets of this isotope are embedded near the tumour. Strontium-89 has an approximate half-life of 50.5 days. A particular patient feels relief from such a dose for 202 days. Calculate the activity of this dose after 202 days. (2 marks)

202 days is 4 half-lives

activity = $\frac{150}{2^4}$ = 9.38 MBq

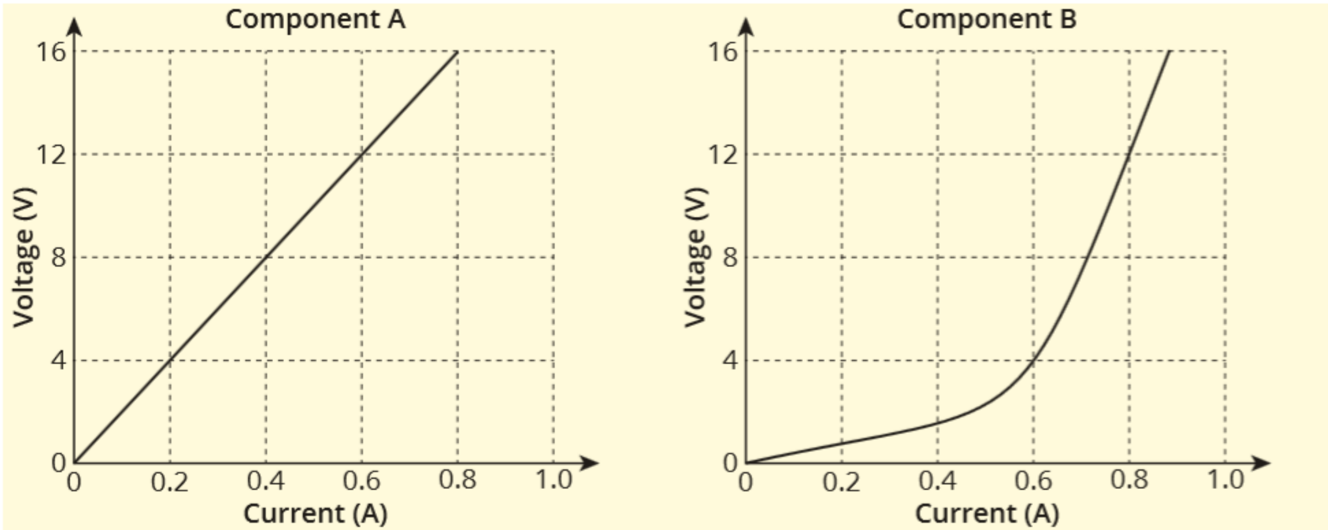
e Why is radioactive decay often referred to as a random process? (1 mark)

The overall decay pattern is predictable but which individual atom will decay at any given time is unpredictable—therefore it is a random process.

Q19

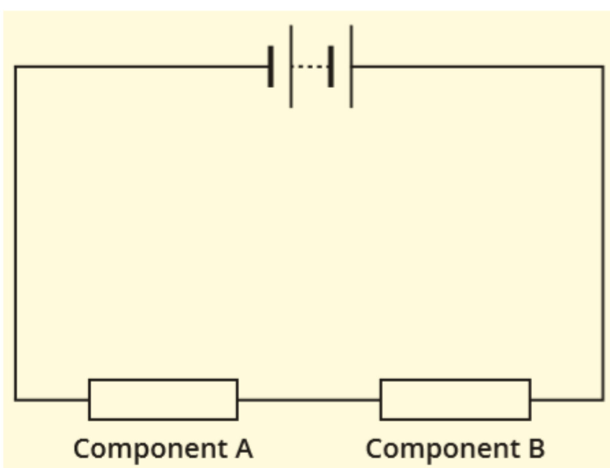
Question 19 **(7 marks)**

The two graphs below show current–voltage characteristics for two circuit components, A and B.



a Which of the components (A, B or neither) is ohmic? (1 mark)

Component A is ohmic.



Q19 continued

The potential difference across component A is measured to be 12 V.

b Determine the current through component A. Include units in your answer. (3 marks)

From the graph of component A the resistance is the gradient which is 20 Ω.
$I = V/R = 12/20 = 0.6\ \Omega$

c Find the voltage supplied by the battery. (3 marks)

The voltage across component A is 12 V, and because both resistors are in series, both have a current of 0.6 A flowing through them. From the second graph, the voltage across component B for a current of 0.6 A is 4 V. Therefore the voltage supplied by the battery is 16 V.

Q20

- 3 L of water is heated from a fridge temperature of 4°C to its boiling point at 100°C. It is boiled at this temperature until it is completely evaporated. How much energy in total is required to raise the temperature and boil the water?
- 3 L of water = 3 kg
- c = 4180 J kg−1 K−1
- Q = mcΔT change the temperature of water from 4°C to 100°C.
- Q = mcΔT = 3 × 4180 × (100 − 4) = 1 203 800 J
- Lvapour = 22.5 × 105 J kg−1
- Q = mLvapour to calculate the latent heat required to boil water.
- Q = mLvapour = 3 × 22.5 × 105 = 6 750 000 J
- Total Q = 1 203 800 + 6 750 000 = 8 × 106 J

Q21

(7 marks)

A 150 g ice puck collides head on with a 100 g ice puck, initially stationary, on a smooth, frictionless surface. The initial speed of the 150 g puck is 2 m s^{-1}. After the collision, the 150 g ice puck moves off at 0.5 m s^{-1} in the same direction as its initial direction of motion.

a What is the velocity of the 100 g puck after the collision? (2 marks)

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$0.15 \times 2 + 1.0 \times 0 = 0.15 \times 0.5 + 0.1v_2$$

$$v_2 = 2.25 \text{ m s}^{-1}$$

b Is this collision elastic or inelastic? Use calculations to justify your answer. (5 marks)

$E_{\text{k before}} = \frac{1}{2} \times 0.15 \times 2^2 + 0$

$= 0.300$ J

$E_{\text{k after}} = \frac{1}{2} \times 0.15 \times (0.5)^2 + \frac{1}{2} \times 0.10 \times (2.25)^2$

$= 0.272$ J

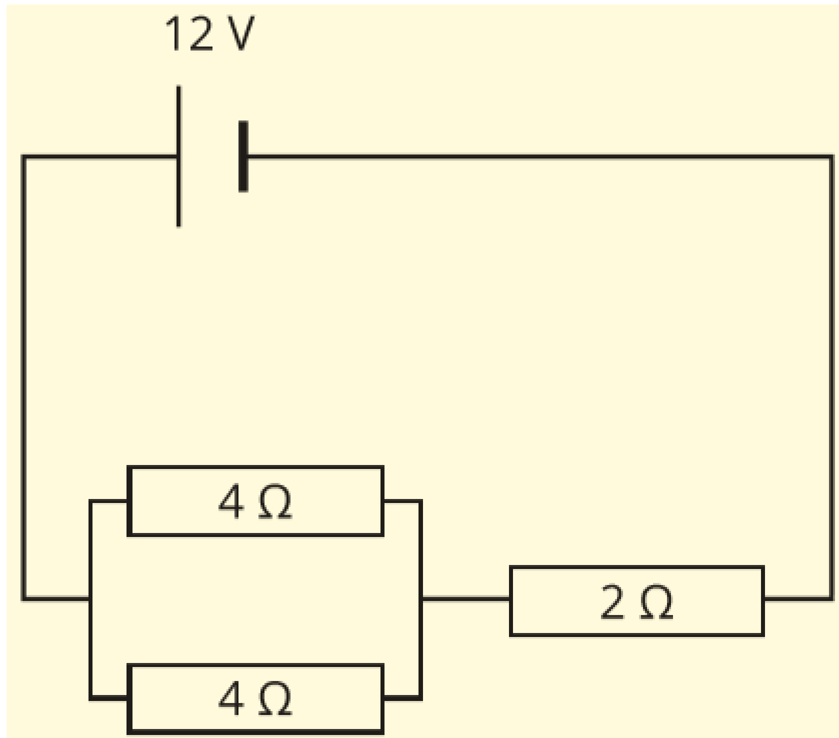
Kinetic energy is not conserved (kinetic energy before collision > kinetic energy after collision) so the collision is inelastic.

Q22

(10 marks)

Two resistors of 4 Ω are connected in parallel, and are then connected in series with a 2 Ω resistor. The voltage supplied to this circuit is 12 V.

a Draw the circuit. (3 marks)



Q22 continued

b Calculate the total resistance of the circuit. (3 marks)

parallel component: $\frac{1}{R_T} = \frac{1}{4} + \frac{1}{4}$ $R_T = 2\ \Omega$

total resistance: $R_T = 2 + 2 = 4\ \Omega$

c Calculate the current flowing through the 2 Ω resistor. (2 marks)

$I_{total} = \frac{V}{R_{total}} = \frac{12}{4} = 3.00\ \text{A}$

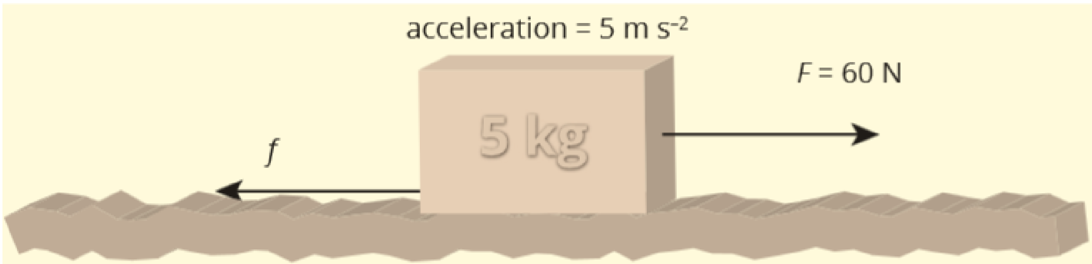
d Calculate the power dissipated by the 2 Ω resistor. (2 marks)

$P = I^2R = 3^2 \times 2 = 18\ \text{W}$

Q23

Question 23 **(14 marks)**

The diagram below shows a 5.0 kg object accelerating at 5 m s^{-2} on a rough horizontal surface.



a What is the net force acting on the 5 kg mass? (2 marks)

$F_{net} = ma = 5.0 \times 5 = 25$ N

b What is the magnitude of the force of friction, f? Include units in your answer. (3 marks)

$F_{net} = ma$

$25 = 60 - f$

$f = 35$ N

c The 5 kg mass accelerates from rest for 2 s. How far did the 5 kg mass travel? (3 marks)

$$s = ut + \frac{1}{2}at^2$$

$$= 0 \times 2 + \frac{1}{2} \times 5 \times 2^2$$

$$= 10 \text{ m}$$

Q23 continued

d What is the work done by the applied force on the mass? Include units in your answer.

(3 marks)

$$W = F_{\text{applied}} s$$

$$= 60 \times 5$$

$$= 300 \text{ J}$$

e How much energy has been dissipated as heat during this time? Include units in your answer.

(3 marks)

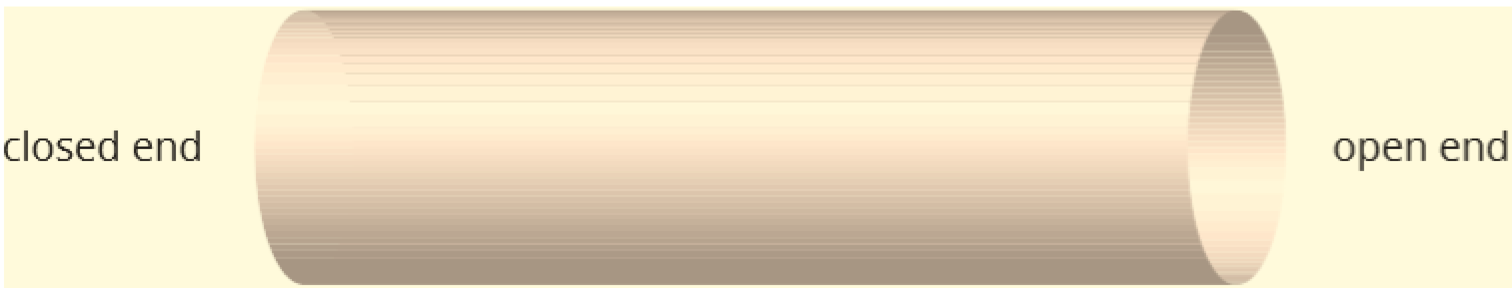
$$W = fs$$

$$= 35 \times 5$$

$$= 175 \text{ J}$$

Q24

- The Smoke Energy pop band were studying resonance in an air column using a narrow tube of length 40 cm that was closed at one end and open at the other, as shown in the diagram. They used an audio signal generator and loudspeaker to generate a range of sound frequencies.



- The group begin at 0 Hz and increase the frequency until the first resonant frequency (fundamental frequency) is identified. Take the speed of sound to be 340 m s−1.

a What is the first resonant frequency (fundamental frequency)? (4 marks)

$$40 \text{ cm} = 0.4 \text{ m}$$

$$\lambda = 4 \times 0.4 = 1.60 \text{ m}$$

$$v = f\lambda$$

$$f = \frac{340}{1.6}$$

$$= 213 \text{ Hz}$$

Q24 continued

b What is the next resonant frequency? (2 marks)

$f = 3 \times 213 = 638$ Hz

c How will the students know they have identified a resonant frequency? (2 marks)

Resonance occurs when the forcing frequency equals the natural frequency of the pipe resulting in a louder sound.

Q25

(13 marks)

Technetium-99m is the most widely used radioisotope in nuclear medicines. It is used for diagnosing cancer. However, this radioisotope decays relatively quickly and so usually needs to be produced close to where it is to be used. Technetium-99m is produced in small nuclear generators near hospitals around the country. In this process, the radioisotope molybdenum-99, obtained from Lucas Heights in NSW, is used as the parent nuclide, and is transported quickly and efficiently to the smaller generators near the hospital. Molydenum-99 decays by beta emission to form a relatively stable (or metastable) isotope of technetium, technetium-99m. The half-life of technetium-99m is approximately 6 hours; molydenum-99 has a half-life of approximately 67 hours.

The technetium-99m is flushed from the generator using a saline solution. The radioisotope is then diluted and attached to an appropriate chemical before being administered to the patient as a tracer. Technetium-99m is purely a gamma emitter. This makes it a very useful tool for locating and treating cancers.

a Write the decay equation for molybedum-99 decaying to technetium-99m. (2 marks)

$${}^{99}_{42}\text{Mo} \rightarrow {}^{99m}_{43}\text{Tc} + {}^{0}_{-1}\beta + \nu$$

b Write the decay for technetium-99m decaying to technetium-99. (2 marks)

$${}^{99m}_{43}\text{Tc} \rightarrow {}^{99}_{43}\text{Tc} + {}^{0}_{0}\gamma$$

Q25 continued

c State an advantage of choosing radioactive isotopes with a short half-life for medical purposes. (2 marks)

If a radioactive isotope has too long a half-life, the patient and others around them would be subjected to a continuing radiation dose.

d Why must a much higher amount of molydenum-99 leave the manufacturing point at Lucas Heights in NSW than is needed by the hospitals? (2 marks)

Molydenum-99 will decay in transport so less will arrive at the hospital than left Lucas Heights.

e When using technetium-99m for diagnostic purposes information is monitored and collected by special radiation cameras outside the patient. Explain why technetium-99m is suitable for this purpose. (2 marks)

Gamma rays can pass through body, whereas alpha and beta particles will mostly be stopped by the body. Therefore gamma radiation can be detected by cameras outside the body.

f A patient is administered 500 MBq of technetium-99m. Determine the activity of this isotope in the patient after 24 hours. (3 marks)

$$\text{activity} = \frac{500}{2^4} = 31.3 \text{ MBq}$$

Q26

(10 marks)

A popular misconception among motorists is that cars would be much safer if they were sturdier and more rigid. Drivers often complain that cars seem to collapse too easily during collisions, and it would be better if cars were structurally stronger—more like an army tank. In fact, cars are specifically designed to crumple to some extent. This makes them safer and actually reduces the seriousness of injuries suffered in car accidents.

Army tanks are designed to be extremely sturdy and rigid vehicles. They are able to withstand the effects of collisions without suffering serious structural damage. If a tank travelling at 50 km h^{-1} crashed into a solid obstacle, the tank would be relatively undamaged. However, its occupants would most likely be killed. This is because the tank has no 'give' in its structure and so the tank and its occupants would stop in an extremely short time interval. The occupants would lose all of their momentum in an instant, which means all the forces acting on them would be extremely large. The occupants would sustain serious injuries even if they were wearing seat belts.

Cars today have strong rigid passenger compartments; however, they are also designed with non-rigid sections such as bonnets and boots that crumple if the cars are struck from the front or the rear. The chassis contains members that have grooves or beads cast into them. In a collision, these beads act as weak points in the members, causing them to crumple in a concertina shape.

This concertina effect allows the front or rear of the car to crumple, extending the time interval over which the car and its occupants come to a stop. Because the occupants' momentum is lost more gradually, the maximum forces that act on the occupants are smaller and so the chances of injury are reduced.

a With respect to the relationship $\Delta p = F\Delta t$ explain how crumple zones reduce the force on an occupant of a car in a collision. (2 marks)

Crumple zones increase the time over which the vehicle comes to a stop, therefore decreasing the force for the same change in momentum.

Q26 continued

If an 80 kg crash test dummy was travelling at 50 km h^{-1} in an army tank that crashed, it would come to rest in 0.01 s, while the same crash test dummy would come to rest in 0.1 s if it was travelling in a car with a crumple zone that crashed.

b Covert 50 km h^{-1} into m s^{-1}. (1 mark)

13.9 m s^{-1}

c In which situation did the crash test dummy experience the greater change in momentum? Use calculations to support your answer. (3 marks)

Neither—in both situations the crash test dummy has the same change in momentum.

$\Delta p = mv - mu = 80 \times 0 - 80 \times 13.889$

d In which situation did the crash test dummy experience a greater stopping force? Use calculations to support your answer. (4 marks)

Tank: $\Delta p = Ft$ $\quad -1.11 \times 10^4$ kg m s^{-1} $= F \times 0.01$

$F = -1.11 \times 10^6$ N

Car: $\Delta p = Ft$ $\quad -1.11 \times 10^4$ kg m s^{-1} $= F \times 0.1$

$F = -1.11 \times 10^5$ N

The crash test dummy in the tank has the greatest stopping force.

Q27

Question 27 **(13 marks)**

The flute is a typical example of a pipe open at both ends where an air column can be made to vibrate. Blowing over the hole of a flute produces vibrations that correspond to a range of frequencies that create sound waves in the tube. The natural vibrations of the air in the flute are due to resonance. When a note is played on a flute, vibrations, or waves, travel back and forth and standing waves are produced. Several harmonically related standing waves are possible. The first pattern has the longest wavelength and is called the first harmonic or the fundamental frequency. Other harmonics are possible, including the second, third, fourth and so on. Different harmonics can be emphasised depending on how the flute is blown. Placing fingers over the holes in the flute, in differing combinations, changes the effective length of the tube.

A particular flute has an effective length of 30 cm. Take the speed of sound to be 340 m s^{-1}.

a Calculate the fundamental frequency of the flute. (2 marks)

$$f = \frac{v}{2L} = \frac{340}{0.6} = 567 \text{ Hz}$$

b Calculate the frequency of the next three possible harmonics for this flute. (3 marks)

1130 Hz, 1700 Hz and 2270 Hz

Q27 continued

c Explain how standing waves are produced. (3 marks)

Standing waves are the result of superposition of two waves of equal amplitude and frequency, travelling in opposite directions along the column of the flute.

d At the open ends of the flute, will there be pressure antinodes or pressure nodes? Explain how these are formed at the open end of the pipe. (3 marks)

Pressure node: at an open end of pipes, sound waves are reflected. At an open end, a compression or rarefaction is reflected with a phase change of $\frac{\lambda}{2}$, resulting in destructive interference and, hence, a pressure node is created.

e The length of the flute cannot be changed. Name two different ways in which different sounds can be produced by the flautist. (2 marks)

Placement of fingers over holes; how the flute is blown