ATAR course Year 11 Physics

Student Name: _____

Practice Exam 2 (Unit 1 & 2)

Time allowed

Reading time before commencing work: ten minutes

Working time: three hours

Section	Number of questions	Number of questions to be answered	Suggested working time (minutes)	Number of marks	Percentage of exam
Section one: Short answers	14	14	60	60	33%
Section two: Problem solving	10	10	85	84	47%
Section three: Comprehension	3	3	35	36	20%
Totals	**27**	**27**	**180**	**180**	**100%**

Notes to students

- Write your name in the space above.
- A Formulae and data booklet has been provided.
- The following items are approved for use in the examinations:

  Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters.

  Special items: non-programmable calculators approved for use in the examinations, drawing templates, drawing compass and a protractor.
- You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.

Disclaimer

This is a practice examination. It represents Pearson Australia's view only of what would be useful preparation material for the externally assessed examination.

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Section one: Short answer 33% (60 marks)

This section has 14 questions. Answer **all** questions. Write your answer in the spaces provided.

When calculating numerical answers, show your working or reasoning clearly. Give final answers to **three** significant figures and include appropriate units where applicable.

When estimating numerical answers, show your working or reasoning clearly. Give final answers to **two** significant figures and include appropriate units where applicable.

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Suggested working time: 60 minutes

Question 1 (2 marks)

What is wrong with this statement? How could you rewrite it so it is correct?

"Close the door, you are letting the cold in!"

Question 2 (4 marks)

Consider a bucket of water and a swimming pool both at the same temperature. Fill in the following table with the same, less or more:

	Average kinetic energy	Internal energy
bucket		
pool		

Question 3 (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, Q1, from the water as its temperature falls from 25°C to 0°C. (1 mark)

b Calculate the heat transfer, Q2, from the water as it changes from 0° water to 0° ice. (2 marks)

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

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)

Question 4 (4 marks)

As a results of your studies of heat and temperature this year, 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	Scientist 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.	

Question 5 (3 marks)

Your teacher gives you three unlabelled radioactive sources and a Geiger counter. One emits α particles, one emits β particles and the last one emits γ radiation. You have been asked to design an experiment, based on the penetrating power of these different types of radiation that may be used to verify the types of radiation emitted by the source. The experiment described should allow you to determine whether the radiation is alpha (α), beta (β) or gamma (γ) radiation.

Your answer should include

- any additional materials you would use
- the measurements you would makes
- how the measurements would be used to reach a final decision about the emitted radiation.

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Question 6 (4 marks)

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

Question 7 **(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)

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)

Question 8 **(4 marks)**

Plutonium-239 is a fissile material. A particular 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)

Number of neutrons = _____

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

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

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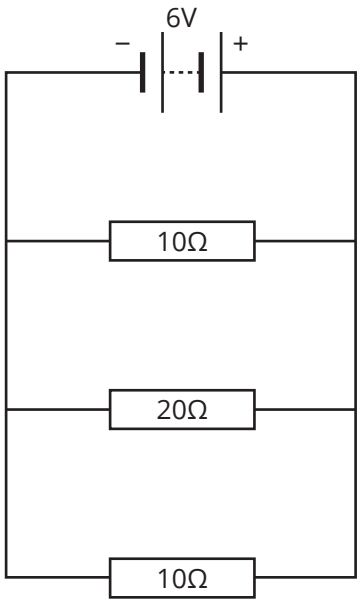
Question 9 **(7 marks)**

Three resistors are connected in parallel as shown below:



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

Answer: _____

b State Ohm's Law. (1 mark)

_____

c What is current in amperes through the 30 Ω? (2 marks)

_____

_____

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

_____

_____

_____

Question 10 (3 marks)

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

_____

_____

_____

_____

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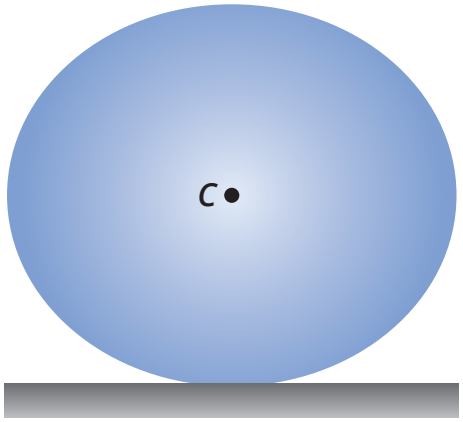
Question 11 (2 marks)

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

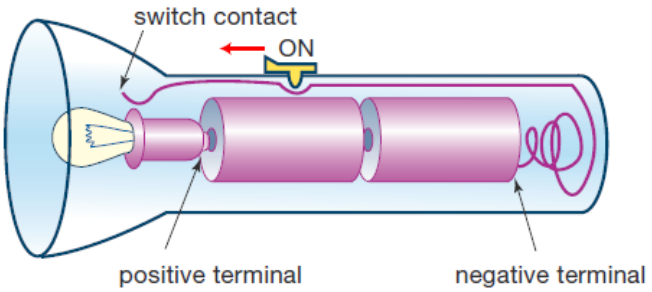
Question 12 (3 marks)

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



Question 13 (2 marks)

A typical torch uses two 150 V batteries in series and is rated 0.900 W. Calculate the resistance.



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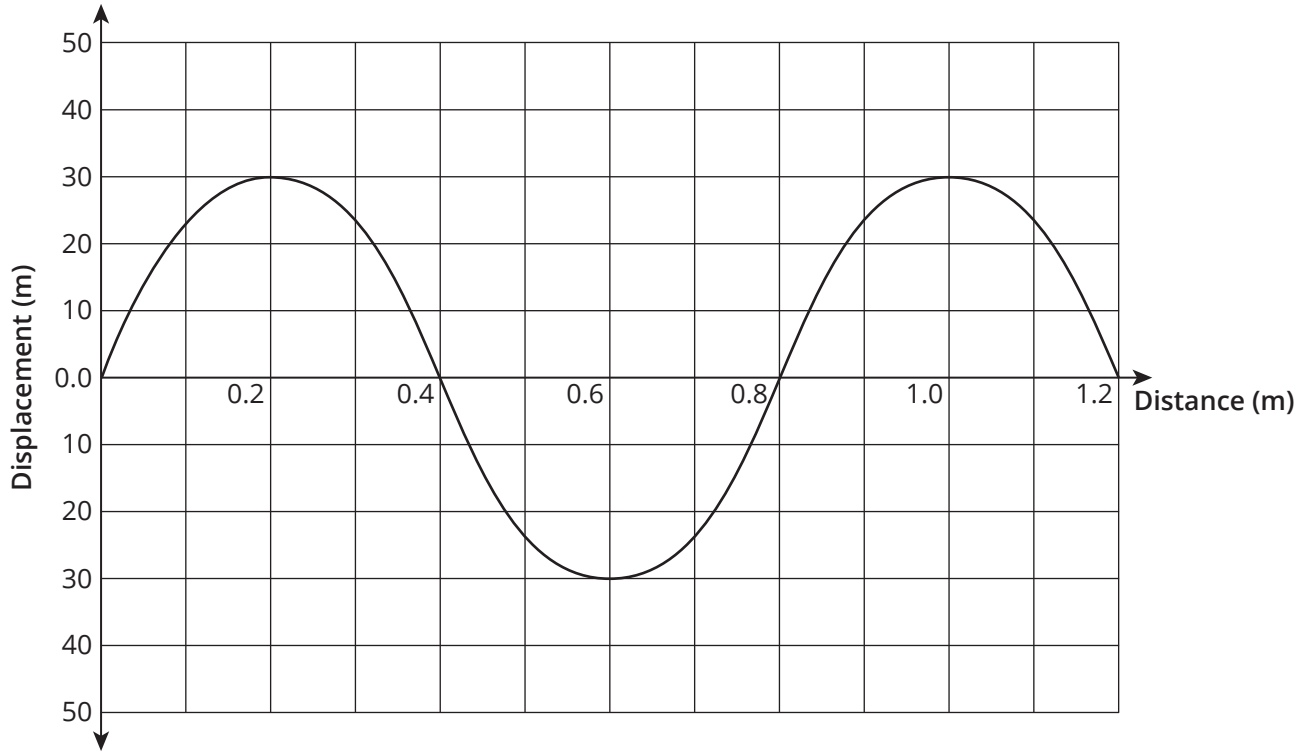
Question 14 **(8 marks)**

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



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

b What is the wavelength? (1 mark)

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

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

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Section two: **Problem solving** **47% (84 marks)**

This section has 10 questions. Answer **all** questions. Write your answers in the spaces provided.

When calculating numerical answers, show your working or reasoning clearly. Give final answers to **three** significant figures and include appropriate units where applicable.

When estimating numerical answers, show your working or reasoning clearly. Give final answers to **two** significant figures and include appropriate units where applicable.

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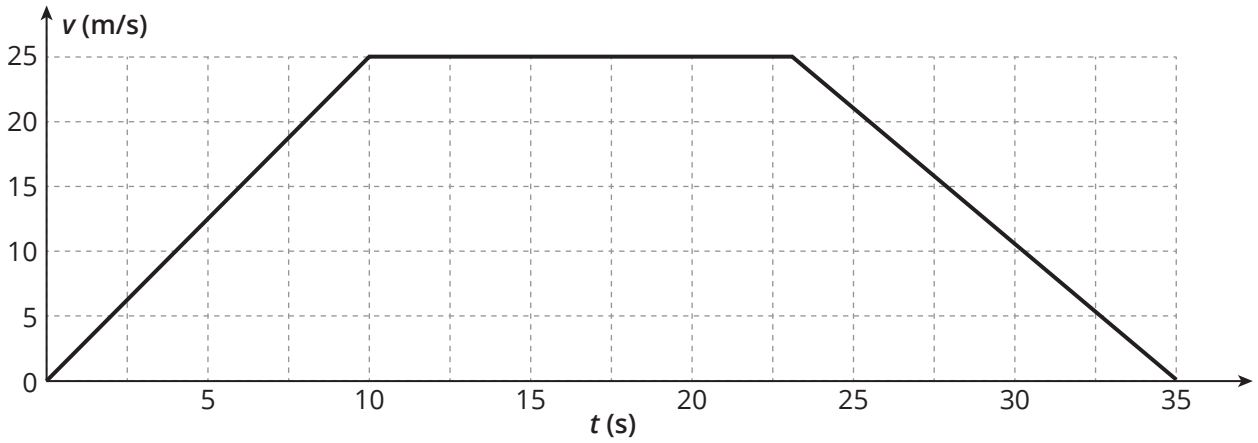
Suggested working time: 85 minutes

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 an appropriate unit with your answer. (3 marks)

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

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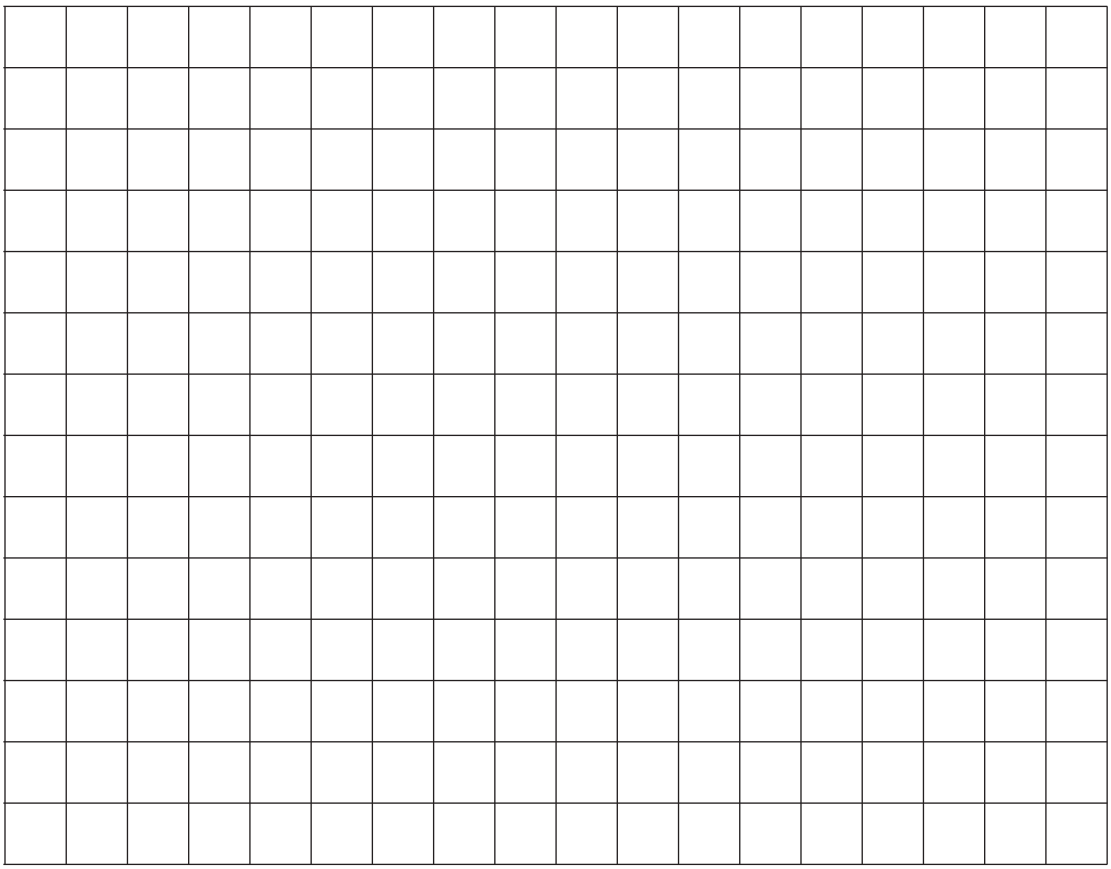
c What is the net force acting on the car at time t = 30 s? (3 marks)

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

Question 16 **(5 marks)**

A hungry lion begins to accelerate as a zebra runs by at its top speed of 20 ms^{-1}. The lion reaches its top speed of 30 ms^{-1} after accelerating constantly for 5 seconds. The lion maintains this speed until it catches the zebra. Use the grid or otherwise calculate:



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)

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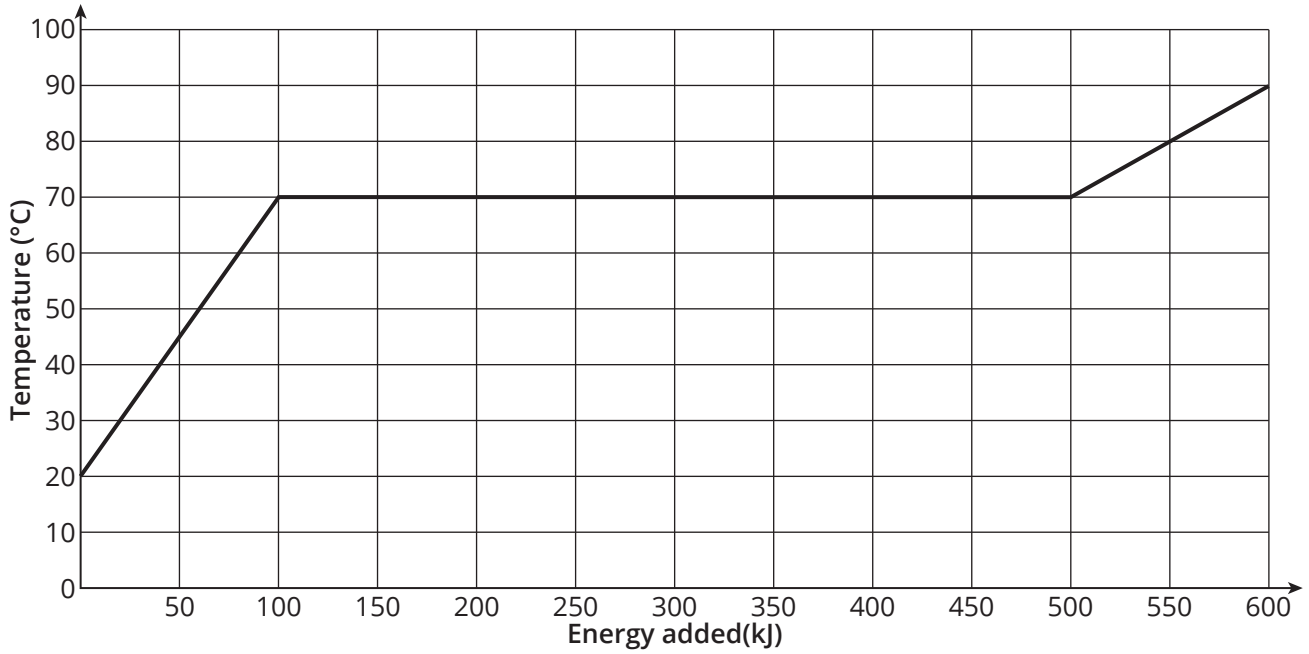
Question 17 **(9 marks)**

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 State the temperature at which the substance melts. (1 mark)

Answer: _____

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

Answer: _____

_____

_____

_____

c The specific latent heat of fusion of the material is: (2 marks)

Answer: _____

_____

_____

_____

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

_____

_____

_____

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Question 18 **(9 marks)**

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

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

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

The 1986 Chernobyl nuclear accident contaminated a vast area with $^{93}_{38}Sr$. 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)

d Another radioisotope of strontium, strontium-89, which 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)

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

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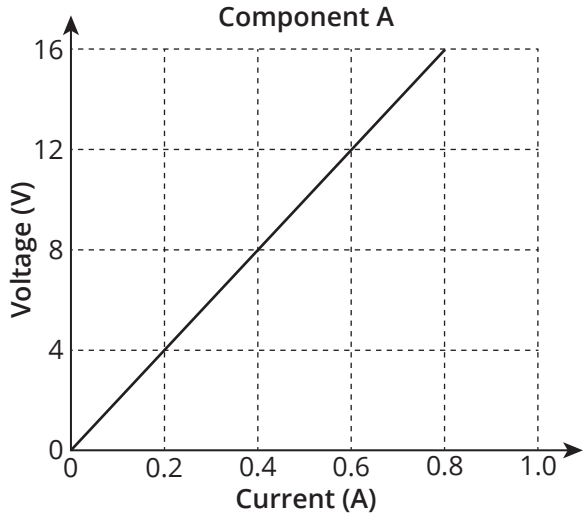
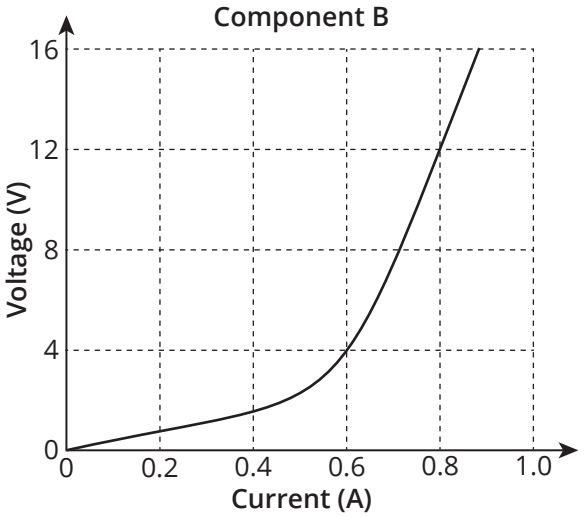
Question 19 **(7 marks)**

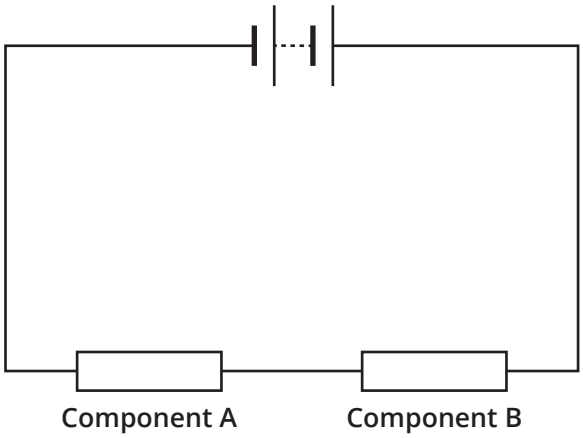
The two figures below show current-voltage characteristics for two circuit components:





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

Answer: _____



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

b Determine the current in component A. Include a unit in your answer. (3 marks)

Answer: _____

_____

_____

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

Answer: _____

_____

_____

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Question 20 (3 marks)

A student needs a resistor of 35 Ω for an electronics circuit. However, the only available resistors have a value of 10 Ω. She has 10 of these resistors.

In the space below, sketch how she could connect **some** or **all** of these resistors to create a total resistance of 35 Ω.

Question 21 **(7 marks)**

A 150 g ice puck collides head on with a smaller 100 g ice puck, initially stationary, on a smooth, frictionless surface. The initial speed of the 150 g puck is 2 ms^{-1}. After the collision the 150 g ice puck moves off at 0.5 ms^{-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)

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

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Question 22 **(10 marks)**

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

a Draw the circuit. (3 marks)

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

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

d Calculate the power dispersed in the 2 Ω resistor. (2 marks)

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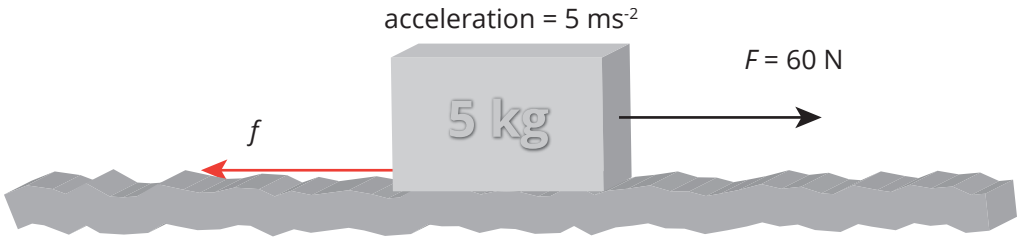
Question 23 **(14 marks)**

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



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

b What is the magnitude of the force of friction, f? Include a unit. (3 marks)

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

d What is the work done by the applied force on the mass? Include a unit. (3 marks)

e How much energy has been dissipated as heat during this time? Include a unit. (3 marks)

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Question 24 **(8 marks)**

Students study resonance in air columns, using a narrow tube of length 40 cm that is closed at one end and open at the other. They use an audio signal generator and loudspeaker to generate a range of sound frequencies as shown below:

The students 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 ms^{-1}.

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

b What will be the next resonant frequency identified? (2 marks)

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

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Section three: **Comprehension** **20% (36 marks)**

This section has 3 questions. Answer **all** questions. Write your answers in the spaces provided.

When calculating numerical answers, show your working or reasoning clearly. Give final answers to three significant figures and include appropriate units where applicable.

When estimating numerical answers, show your working or reasoning clearly. Give final answers to a maximum of two significant figures and include appropriate units where applicable.

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Suggested working time: 35 minutes

Question 25 **(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, as is transported quickly and efficiently to the smaller generators near the hospital. molydenum-99 decays by beta emissions to form a relatively stable (or metastable) isotope of technetium, technetium-99m. The half-life of technetium-99m is approximately six hours while molydenum-99 has a half-life of approximately 67 hours.

Technetium-99m is then 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 diagnostic tool for locating and treating cancers.

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

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

c Name an advantage of using radioactive isotopes for medical purposes with short half-life. (2 marks)

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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)

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

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

Question 26 **(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 kmh^{-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. Occupants sustain serious injuries even if they are wearing seat belts.

Motor 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 peak 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 in a collision. (2 marks)

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

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

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

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

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 it 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 ms^{-1}.

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

b State the next three possible harmonics for this flute. (3 marks)

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

d At the open ends of the flute will be pressure antinodes or pressure nodes. Explain how your choice is formed at the open end of the pipe. (3 marks)

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)

End of Questions

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Additional working space

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