ATAR course **Year 11 Physics**

Student Name: ____________________

Practice Exam 1 (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	23	23	60	60	33%
Section two: Problem solving	11	11	90	90	50%
Section three: Comprehension	3	3	30	30	17%
		Totals	**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 **23** 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.

Spare pages are included at the end of this practice examination. They can be used for planning your responses and/or as additional space if required to continue an answer.

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- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question that you are continuing to answer at the top of the page.

Suggested working time: 60 minutes.

Question 1 (2 marks)

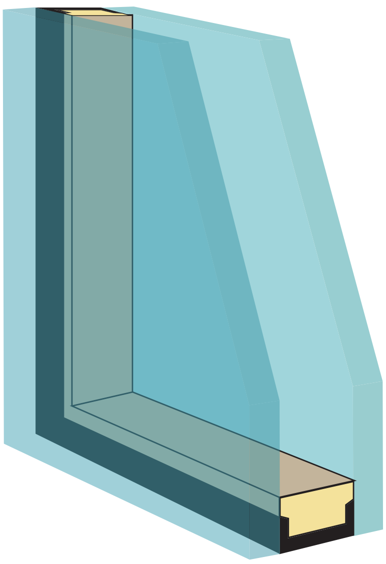
Explain why a 'space blanket' to protect against hypothermia has a shiny silver surface.

Question 2 (2 marks)

When the Space Shuttle was flying space missions it had black ceramic tiles on its front nose. What was the role of these tiles when the Shuttle re-entered the Earth's atmosphere?

Question 3 (2 marks)

Double-glazed windows offer more effective insulation than single glazed windows. Explain how double-glazed windows achieve this.



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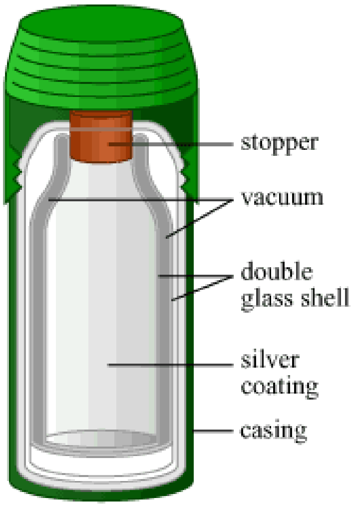
Question 4 (4 marks)

A vacuum flask (as shown below) can be used to keep hot liquids hot. The diagram has four labelled design features of the flask. Explain how each of the four features cut down heat loss.



Question 5 (2 marks)

${}^{58}_{28}Ni$ and ${}^{63}_{28}Ni$ are both isotopes of nickel. Explain the meaning of the term 'isotope' referring to these two atoms as examples.

Question 6 (2 marks)

${}^{63}_{28}Ni$ is a radioisotope of nickel. Explain what the term 'radioisotope' means. Explain why Ni-63 is radioactive and Ni-58 is not radioactive.

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Question 7 (1 mark)

Give a definition of nuclear binding energy.

Question 8 (1 mark)

A controlled chain reaction is required to sustain nuclear fission inside a nuclear reactor. For this to occur, what number of neutrons per fission needs to be released?

Question 9 (2 marks)

Cadmium is often used to control the rate of nuclear fission in a reactor. How does cadmium achieve this?

Question 10 (2 marks)

In the nuclear equation: ${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U \rightarrow {}^{91}_{36}Kr + {}^{142}_{86}Ba + X$ + energy, what would X be?

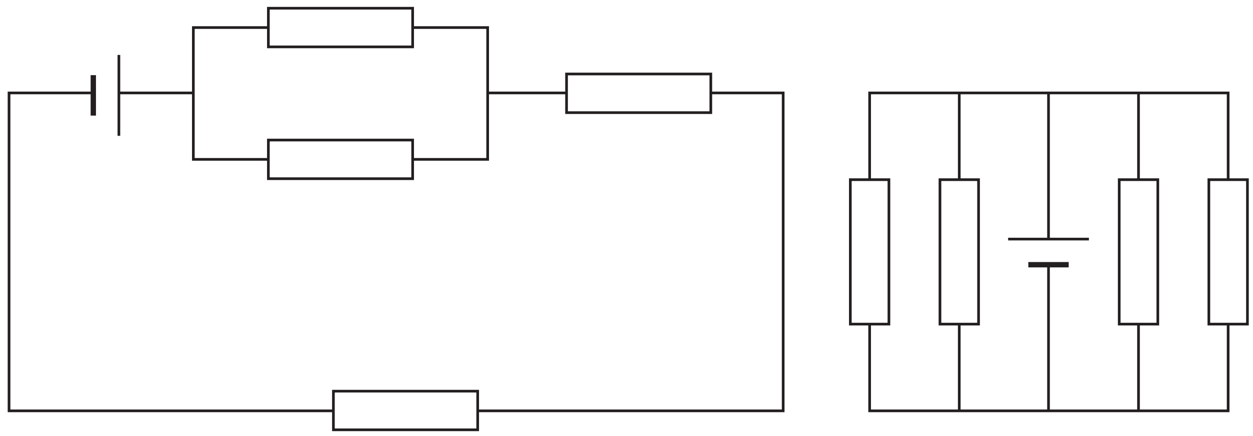
Question 11 (3 marks)

${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{236}_{92}U \rightarrow {}^{148}_{57}La + {}^{85}_{35}Br + 3{}^{1}_{0}n$ + energy

If the mass defect as a result of this nuclear equation is 2.12×10^{-28} kg. How much energy would be released in MeV? (3 marks)

Question 12 (3 marks)

A student constructs two circuits, as shown below. She wants them to have the same effective resistance. The resistors are all identical.



Has she achieved her aim? Use calculations to prove your answer.

Question 13 (6 marks)

Outline how you would construct a circuit consisting of a mini-electric kettle whose heating element has an effective power consumption of 10 watts **and** how you would investigate the efficiency of your kettle. You are permitted to use your choice of only the following common laboratory items:

50 mL beaker, a given length of nichrome wire which you are not allowed to cut, a DC power supply set to 12 volts, one variable resistor, two voltmeters, one ammeter, plug-plug electrical leads, alligator clips, 30 mL of water, 0–110°C thermometer, stopwatch.

Useful data: 1 mL of water requires approximately 4.18 joules of energy per 1°C rise in its temperature.

Question 14 (4 marks)

Distinguish between the electrical resistance of ammeters and voltmeters, and give reasons for those differences.

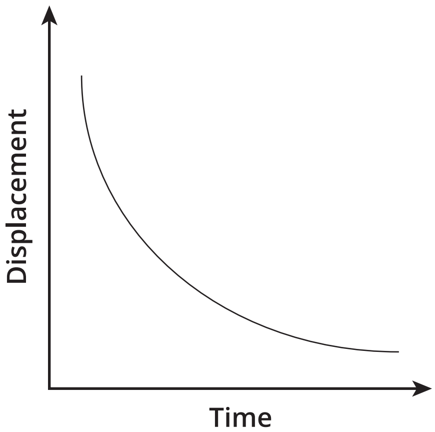
Question 15 (2 marks)

The diagram shows a stationary gymnast hanging from a set of rings.

Describe the reaction force to the action of the force due to gravity on the gymnast?

Question 16 (4 marks)

Interpret the following displacement versus time graph. Sketch the shapes of its matching velocity versus time graph and acceleration versus time graph.



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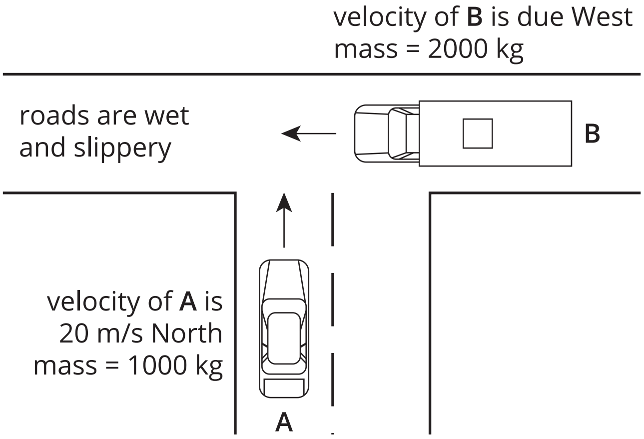
Question 17 (4 marks)

Two vehicles are approaching each other at a T-intersection. The vehicles subsequently collide, as a result of both vehicles continuing to travel straight ahead.



After the impact the car becomes jammed under the truck and the two vehicles skid off as one mass with a velocity of 9.43 ms^{-1} North 45° West.

The driver of the truck claims that he was travelling at 5 ms^{-1} also, just before the collision. Analyse the situation and extrapolate from the given information in order to deduce whether or not the driver of the truck is lying or at least wrong.

Question 18 (3 marks)

A 1000 kg vehicle is accelerated from rest to a speed of 17.8 ms^{-1} over 9.4 s. Determine the size of the net force acting on the vehicle during this time.

Question 19 (3 marks)

A 1600 kg vehicle travelling at 14.5 ms^{-1} is allowed to slow to a halt over a distance of 350 m. Determine the combined total of the frictional force and the air resistance that slows the vehicle down.

Question 20 (1 mark)

Mechanical waves can be either ... ?

Question 21 (2 marks)

Why does light refract?

Question 22 (2 marks)

What type of interference will we get if two identical waves arrive at a point, 180 degrees out of phase? Explain your answer.

Question 23 (3 marks)

A light bulb when viewed from a distance of 5.0 m has an intensity of 0.32 Wm^{-2}. Calculate what distance the light bulb would need to be away to have an intensity of 0.50 Wm^{-2}.

Section two: **Problem solving** 50% (90 marks)

This section has 11 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.

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Suggested working time: 90 minutes.

Question 24 **(12 marks)**

James Bond likes to drink cocktails. On a warm afternoon (26°C), 007 is mixing cocktails whilst the ice is melting (0°C) in a bowl. Note: the specific heat capacity of the cocktails is 2.7×10^3 Jkg^{-1}°C^{-1}.

a A colleague of 007, 006 likes his cocktails served at 0°C. What is the minimum mass ice cube he should select to cool his 60 gram cocktail from 26°C to 0°C? (2 marks)

b 007 prefers his 60 gram cocktail served at 10°C and shaken not stirred! What mass ice cube will he need to cool his drink from 26°C to this temperature? (3 marks)

c A colleague 008 decides he wants a cup of tea. He uses a 2000 W mains operated kettle filled with 1.20 kg of water at room temperature (26°C). How long will he have to wait for the water to reach boiling point (100°C)? (2 marks)

d In reality, it takes a little longer than this to boil the kettle. Give one good reason why it would take longer. (1 mark)

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e After several minutes it is noticed that there are drops of liquid water on the outside surfaces of the cold cocktail glasses. Explain why this effect occurs and describe what thermal effect this will have on the remaining contents of the glass.

Explanation: (2 marks)

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Description: (2 marks)

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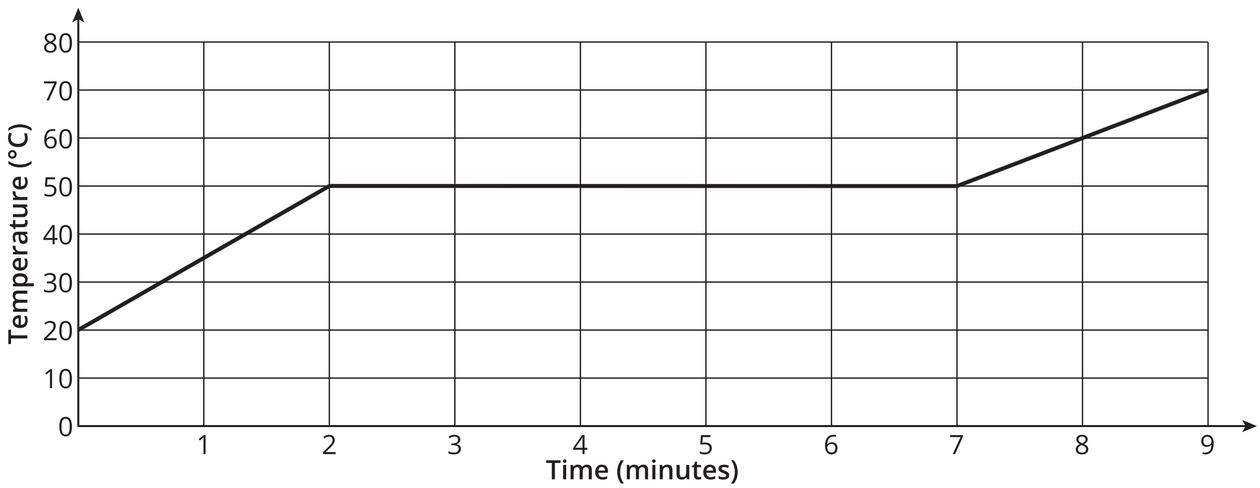
Question 25 **(5 marks)**

The graph below shows the temperature–time relationship for the heating of 0.25 kg of soft wax by an electrical heater supplying 50 J of heat energy per second.



a Determine the wax's melting temperature. (1 mark)

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b Find the latent heat of fusion (Lf) of the wax. (2 marks)

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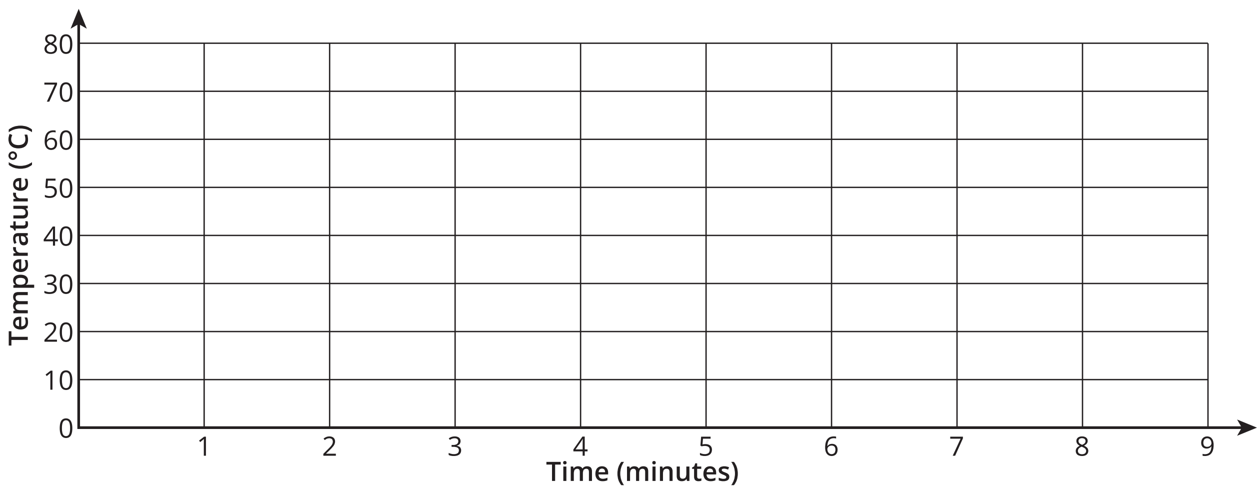
c On the copy of the axes below, sketch the expected temperature–time relationship if the heater delivered energy to heat the solid wax from the same starting temperature but at double the rate, i.e. at 100 joules per second instead of at 50 joules per second. (2 marks)



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Question 26 **(6 marks)**

a Complete the nuclear decay equation for Ni-63 when it emits a β-particle by placing the appropriate numbers and symbols in the boxes below: (4 marks)

$$ {}^{\square}_{\square}\square \;\rightarrow\; {}^{\square}_{\square}\square \;+\; {}^{\square}_{\square}\beta \;+\; \text{energy} $$

b Explain where the emitted β-particle has come from. (2 marks)

Question 27 **(8 marks)**

Polonium-215 atoms decay into atoms of lead-211 by emitting an α-particle.

The average kinetic energy of the emitted α-particle is 7.39 MeV.

Polonium-215 has a half-life of 1.78×10^{-3} seconds.

$1.00 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$

a What is the average kinetic energy of an emitted α-particle in joules? (2 marks)

As an α-particle travels through air it will ionise about 100 000 atoms for every centimetre travelled. Each time an α-particle ionises an atom, the α-particle will lose about 34 eV of its kinetic energy.

b Approximately how much energy would an α-particle lose as it passes through 1.0 cm of air? (2 marks)

c Calculate the approximate distance that an α-particle with a kinetic energy of 7.39 MeV will travel in air before it loses all of its energy. Give your answer to the nearest millimetre. (2 marks)

d What percentage of the original sample of polonium-215 would be left after 4.13×10^{-3} seconds? (2 marks)

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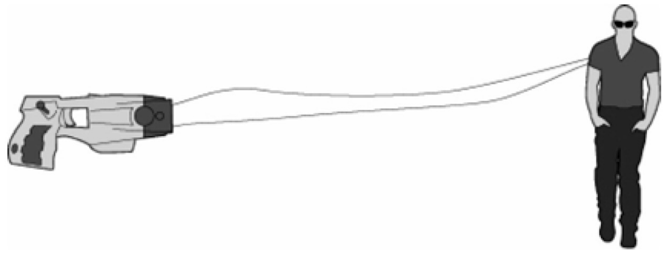
Question 28 **(7 marks)**

The diagram below shows the X-26 Taser that is sometimes used by police. A taser is a device designed to subdue a person by making them part of an electric circuit and then sending pulses of electrical current into their body.



When operating:

- the X-26 Taser sends 10 pulses of electric current each second.
- each pulse of current lasts for 1.00×10^{-4} seconds.
- during each pulse 1.90×10^{-3} A of current flows.
- during each pulse the potential difference across the circuit at the points of contact is 350 V.

a How much charge passes through the offender's body during a single pulse from the Taser X-26? (2 marks)

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b How many electrons would flow through the wires of the X-26 Taser during a single pulse? (2 marks)

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c How much electrical energy is delivered in 2.00 seconds? (3 marks)

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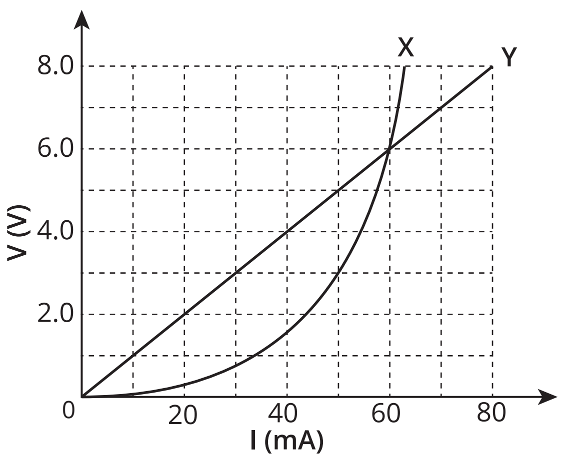
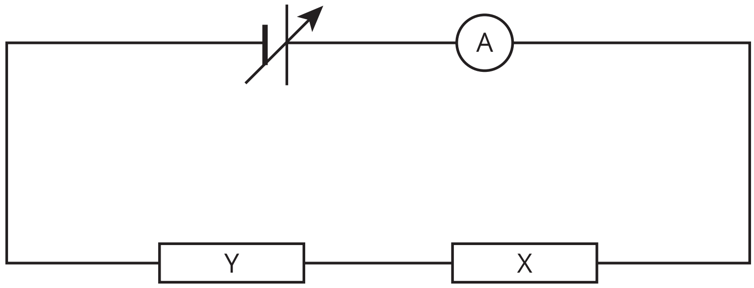
Question 29 **(10 marks)**

As part of their studies in electricity, Paul and Natasha investigated the behaviour of two different types of conductors, X and Y. The graph below shows the voltage and current characteristics for each of the two conductors.



The students then set up the circuit shown below. The internal resistance of the variable power supply can be ignored. The variable power supply was set so that the current flowing in the ammeter was 50 mA.

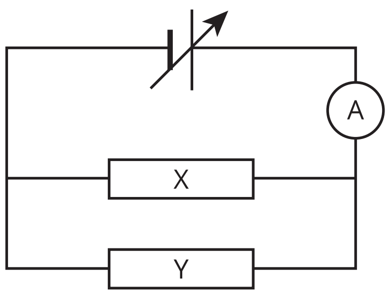


a Use the graph to determine what emf was supplied to the circuit. (2 marks)

b Determine the resistance of conductor X when 50 mA of current is flowing through it. (2 marks)

c Is conductor X an example of an ohmic, or a non-ohmic conductor? Explain your answer and support it with appropriate reasoning. (2 marks)

The students then set up the circuit shown below. The variable power supply was set at 6.0 V.



d What current now flows through the ammeter? (2 marks)

e What power is dissipated in conductor X? (2 marks)

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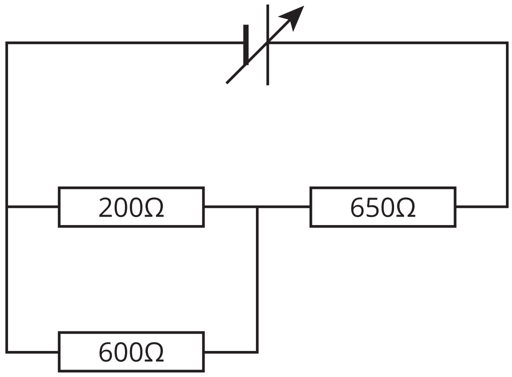
Question 30 **(7 marks)**

This question refers to the following circuit.



a Show, by calculation, that the total resistance of the circuit is 800 Ω. (3 marks)

b Calculate the current that flows through the 600 Ω resistor? (4 marks)

Question 31 **(11 marks)**

Sally was driving her car at a constant speed of 54 kmh^{-1} along a straight stretch of road. The total mass of the car and driver is 1600 kg.

a Use an appropriate calculation to show that Sally's car was moving at a constant speed of 15 ms^{-1}. (1 mark)

Sally saw a traffic light in front of her change from green to red. It took her 1.2 seconds to see the light change and make the decision to apply her brakes in order to stop the car.

b From the moment she sees the traffic light turn red, what distance did the car travel before Sally applied the brakes? (2 marks)

c Once Sally applied the brakes it took the car 4.4 seconds to come to a stop. Assuming the deceleration is constant, what was the magnitude of the car's deceleration? (2 marks)

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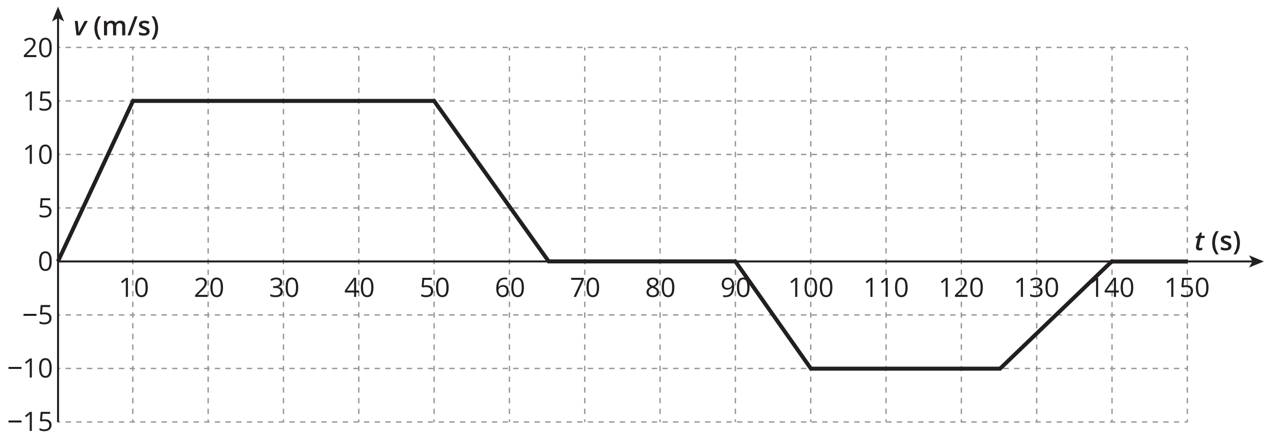
d If Sally's car came to a stop next to the traffic light, how far from it had she been when she first saw it change from green to red? (3 marks)

e How much work was done by the car's brakes in bringing the car to a stop? (3 marks)

Question 32 **(13 marks)**

The graph below shows part of a journey taken by a student on a bus. The bus and its passengers have a combined mass of 32 000 kg.



a What was the magnitude of the bus's acceleration at t = 60 seconds? (2 marks)

b What was the size of the net force acting on the bus at t = 110 seconds? Explain your answer. (2 marks)

c If the driving force provided by the bus's motors during the first 10 seconds of the journey was a constant 61.3 kN, what average resistive force acted against the bus during this time? (4 marks)

d What was the bus's average speed for the 150-second journey as shown by the graph? (5 marks)

Question 33 (4 marks)

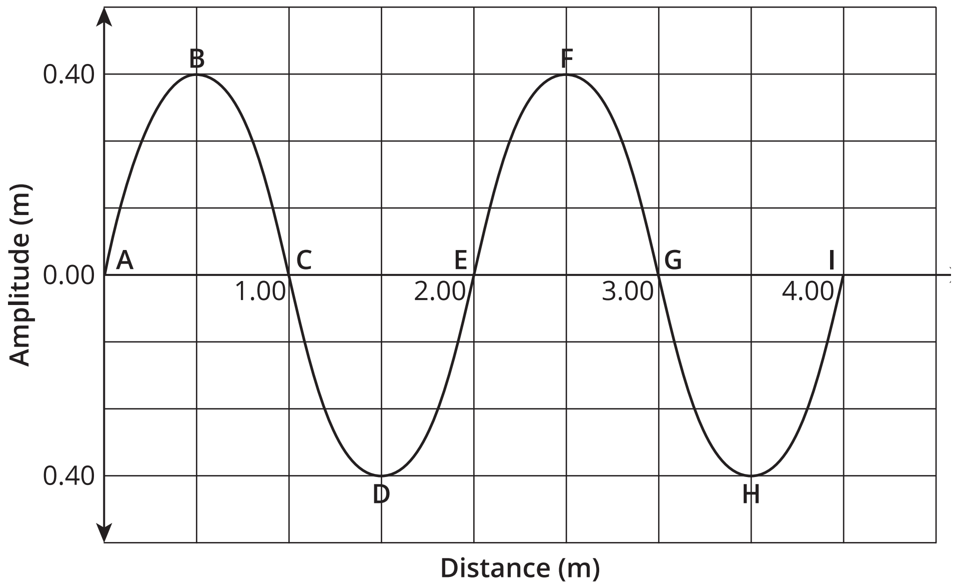
Blu-ray DVD players use a laser that emits a coherent beam of blue light that has a wavelength of 405 nm (405×10^{-9} m).

a Calculate the frequency of the blue laser light if the speed of light is 3×10^{8} ms^{-1}. (2 marks)

b Calculate the period of the blue laser light. (2 marks)

Question 34 (7 marks)

The following diagram shows a wave 1.0 s after it has been produced.



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

b How many wavelengths are there in the diagram? (1 mark)

c What is the wavelength of the wave? (1 mark)

d What is the frequency of the wave? (1 mark)

e Calculate the speed of the wave. Show your formula and working. (2 marks)

f Calculate the period of the wave. (1 mark)

Section three: **Comprehension** 17% (30 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.

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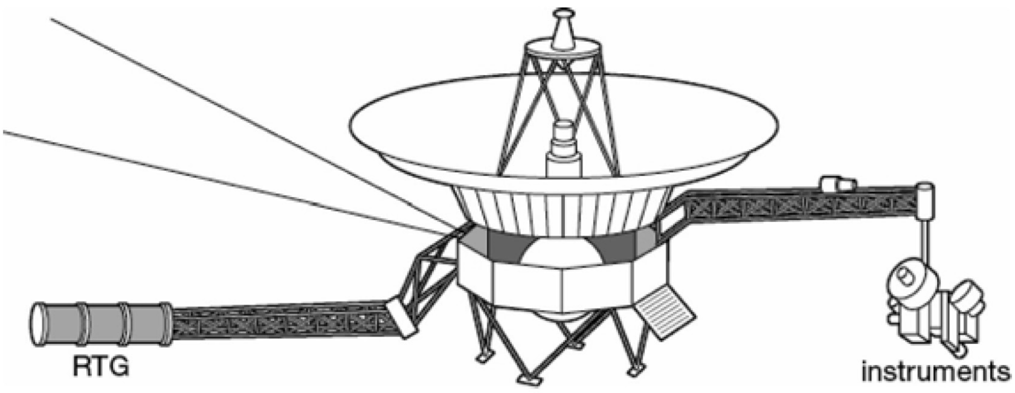
Suggested working time: 30 minutes.

Question 35 **(8 marks)**

On 20 August 1977 the unmanned space probe *Voyager 2* (see below), was launched. Since its launch it has visited all four of the outer planets – Jupiter in 1979, Saturn in 1981, Uranus in 1986 and Neptune in 1989. Currently, it is about 13.4 billion kilometres from the Sun and heading out of the solar system.



To operate its electronic instruments and be able to send radio signals back to Earth, *Voyager 2* was equipped with a radioisotope thermoelectric generator (RTG). RTGs use the heat generated from radioactive decay to produce electricity.

The radioisotope chosen for *Voyager 2*'s RTG needed to:

- be strongly ionising in order to release enough energy to generate the power needed by the probe's electronic instruments and radio.
- be easily shielded so that any emitted radiation would not damage the probes sensitive electronic instruments.
- have a working lifetime of 35 years. To achieve this, its activity cannot drop below 40% of its initial activity in that time.

The following table is a list of five possible radioisotopes that could be used for *Voyager 2*'s RTG and the daughter radioisotopes resulting from their initial decay.

Parent radioisotope	$^{108}_{47}\text{Ag}$	$^{63}_{28}\text{Ni}$	$^{137}_{55}\text{Cs}$	$^{238}_{94}\text{Pu}$	$^{250}_{98}\text{Cf}$
Type of radiation emitted	γ	β	β, γ	α	α
Energy released per decay (eV)	720 k	70 k	510 k	5.59 M	6.13 M
Half-life (years)	418	100	30.2	88	13.1
Daughter radioisotope	$^{108}_{47}\text{Ag}$	$^{63}_{29}\text{Cu}$	$^{137}_{56}\text{Ba}$	$^{234}_{92}\text{U}$	$^{246}_{96}\text{Cm}$
Type of radiation emitted	none	none	γ	α	α
Energy released per decay (eV)	-	-	660 k	4.86 M	5.48 M
Half-life	-	-	2.6 min	2.46×10^5 years	4.70×10^3 years

With respect to each of the three criteria provided above the table, suggest reasons that support any of the five radioisotopes as being the most suitable for *Voyager 2*'s RTG and why any other radioisotopes are unsuitable. Where necessary you should support your answer with appropriate calculations. Hence, decide which of the five parent radioisotopes you think would have been the most appropriate choice for use in *Voyager 2*'s RTG?

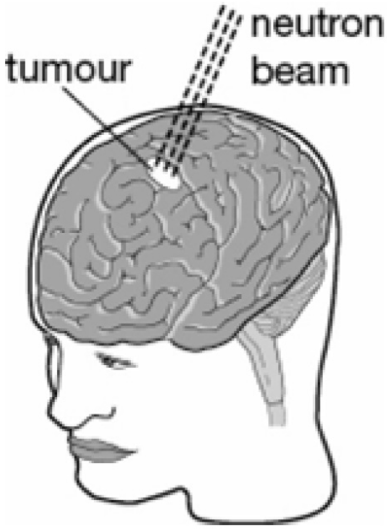
a Ionising ability: (2 marks)

b Shielding: (2 marks)

c Working lifetime: (3 marks)

d Answer: (1 mark)

Question 36 **(11 marks)**



Boron Neutron Capture Therapy (BNCT) is a specialised form of radiotherapy that provides a way of destroying the cancer cells in a tumour without injuring adjacent normal cells. The process involves injecting the patient with the non-radioactive isotope boron-10. The cancer cells in the tumour take up the boron-10 and the patient's tumour is then irradiated with a beam of slow-moving neutrons as shown in the diagram. The slow-moving neutrons are strongly absorbed by the boron-10 atoms, which will then decay by emitting α-particles with an average kinetic energy of 1.47 MeV. The daughter isotope created typically has 0.84 MeV of kinetic energy.

a Complete the nuclear equation for the absorption of a neutron by boron-10 and its subsequent alpha decay by placing the appropriate numbers and symbols in the empty boxes below. (5 marks)

$${}^{10}_{5}\mathrm{B} + {}^{\square}_{\square}\square \rightarrow {}^{\square}_{\square}\square \rightarrow {}^{\square}_{\square}\square + {}^{4}_{2}\alpha + {}^{0}_{0}\square$$

A cancer patient with a brain tumour with an estimated mass of 70.0 g was treated using BNCT. During one particular session the patient's tumour cells received 0.50 J of radioactive energy.

b Calculate the absorbed dose received by the tumour in grays. (2 marks)

c What would be the dose equivalent in sieverts received by the tumour if it absorbed 0.50 J of radioactive energy from the alpha particles? (2 marks)

d What effect would the emitted α-particles and the daughter nuclei have on the tumour's cells? (2 marks)

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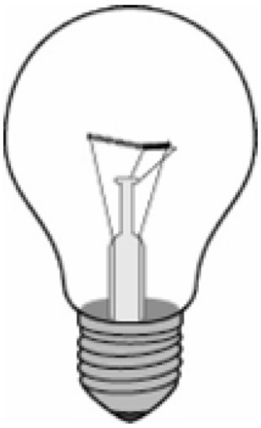
Question 37 **(11 marks)**

A student wanted to investigate the differences in energy usage and running costs between two different types of light globes that emit the same amount of light. The results of her investigation are shown below.

	
Globe 1 – Incandescent light globe V = 240 volts P = 100 watts Average globe life = 1000 hours Purchase cost = $1.20	Globe 2 – Compact fluorescent light (CFL) globe V = 240 volts P = 20 watts Average globe life = 10 000 hours Purchase cost = $5.60

a How much energy would each globe use in 1.0 hour? (3 marks)

b If electrical energy costs $0.208 for every kWh of energy used, determine, using appropriate calculations, which of the two globes is the most economical to run. Remember to include the purchase cost of each globe in your calculations. (8 marks)

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Additional working space

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