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National Qualifications SPECIMEN ONLY

Mark

SQ35/N5/02

Physics Section 1— Answer Grid and Section 2

Date — Not applicable

Duration — 2 hours

* S Q 3 5 N 5 0 2 *

Fill in these boxes and read what is printed below.

Full name of centre

Town

Forename(s)

Surname

Number of seat

Date of birth

Day Month Year

Scottish candidate number

Total marks — 110

SECTION 1 — 20 marks

Attempt ALL questions in this section.

Instructions for completion of Section 1 are given on Page two.

SECTION 2 — 90 marks

Attempt ALL questions in this section.

Read all questions carefully before answering.

Use **blue** or **black** ink. Do NOT use gel pens.

Write your answers in the spaces provided. Additional space for answers and rough work is provided at the end of this booklet. If you use this space, write clearly the number of the question you are answering. Any rough work must be written in this booklet. You should score through your rough work when you have written your fair copy.

Before leaving the examination room you must give this booklet to the Invigilator. If you do not, you may lose all the marks for this paper.

SQA ©

SECTION 1 — 20 marks

The questions for Section 1 are contained in the booklet Physics Section 1 — Questions. Read these and record your answers on the grid on Page three opposite.

1. The answer to each question is **either** A, B, C, D or E. Decide what your answer is, then fill in the appropriate bubble (see sample question below).

2. There is **only one correct** answer to each question.

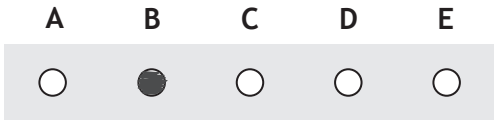
3. Any rough working should be done on the rough working sheet.

Sample Question

The energy unit measured by the electricity meter in your home is the:

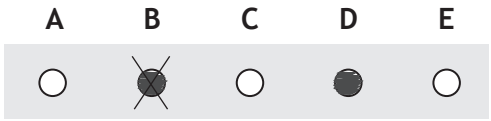
A ampere
B kilowatt-hour
C watt
D coulomb
E volt.

The correct answer is **B**—kilowatt-hour. The answer **B** bubble has been clearly filled in (see below).

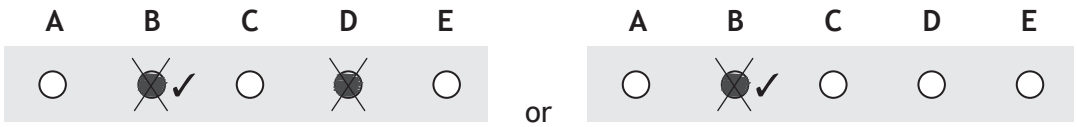


Changing an answer

If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.



If you then decide to change back to an answer you have already scored out, put a tick (✓) to the **right** of the answer you want, as shown below:



or

You must record your answers to Section 1 questions on the answer grid on **Page 3** of your **answer booklet.**

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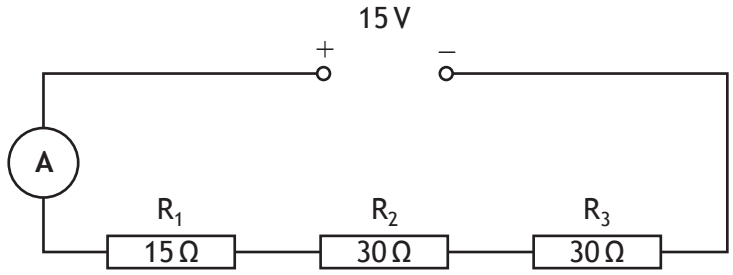
SECTION 2 — 90 marks

Attempt ALL questions

MARKS | DO NOT WRITE IN THIS MARGIN

1. (a) A student sets up the following circuit.



(i) Calculate the current in the circuit. **4**

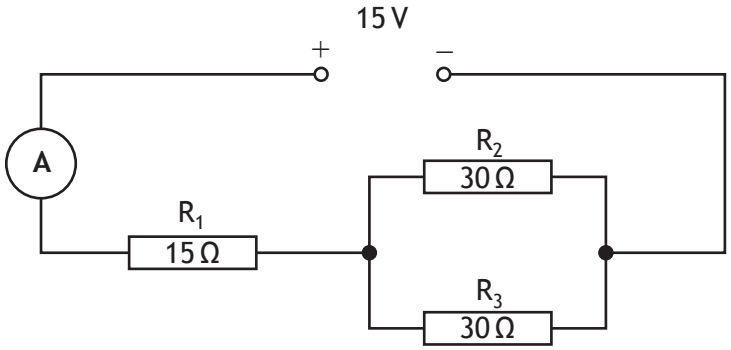
Space for working and answer

(ii) Calculate the potential difference across resistor R_1. **3**

Space for working and answer

1. **(continued)**

(b) The circuit is now rearranged as shown below.



State how the reading on the ammeter compares to your answer in (a)(i). **5**

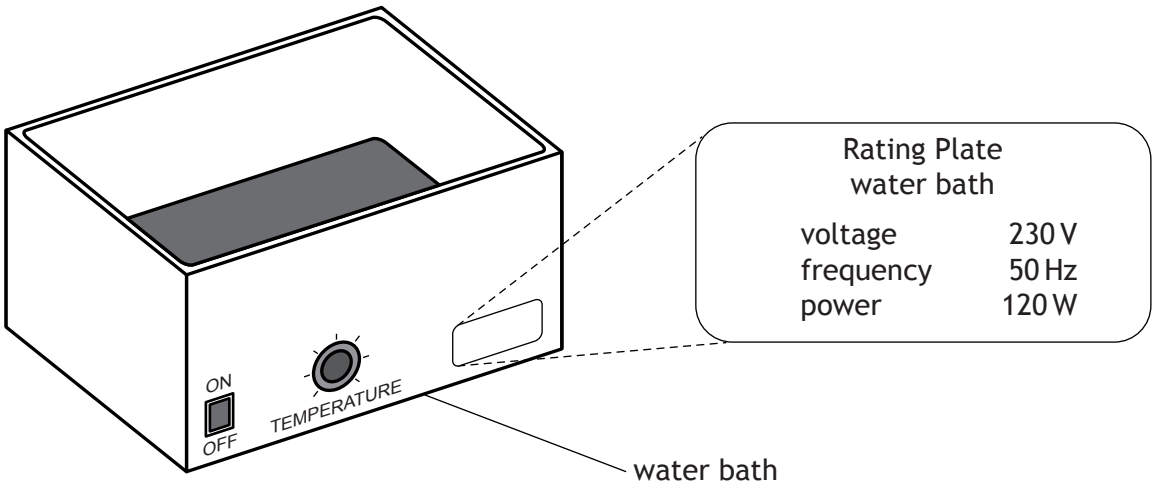
Justify your answer by calculation.

Space for working and answer

Total marks 12

2. A technician sets up a water bath for an experiment to study fermentation at different temperatures.

The rating plate of the water bath is shown.



(a) The water bath contains 3·0 kg of water at an initial temperature of 15 °C.

The specific heat capacity of the water is 4180 J kg^{-1} °C^{-1}.

Calculate the energy required to raise the temperature of the water to 45 °C. **3**

Space for working and answer

(b) Calculate the minimum time required to heat the water to 45 °C. **3**

Space for working and answer

2. (continued)

(c) In practice it requires more time than calculated to heat the water.

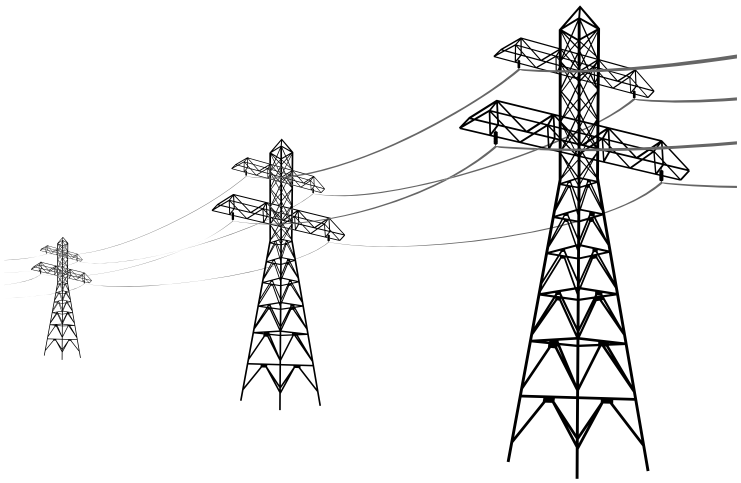
(i) Explain why more time is required. **1**

(ii) Suggest one way of reducing this additional time. **1**

Total marks 8

MARKS DO NOT WRITE IN THIS MARGIN

3. Extreme temperatures have been known to cause some electricity supply pylons to collapse.



Using your knowledge of physics, comment on why this happens. **3**

4. Architects need to know how well different materials insulate buildings. This can be determined using U-values.

The U-value is defined as the rate at which heat energy is transferred through one square metre of building material when the temperature difference is one degree Celsius.

The rate of heat transfer through a material can be determined using:

rate of heat transfer = *U-value* × *area* × *difference in temperature*

The tables below give information for two houses.

House P

House P	*U-value* ($W\,m^{-2}\,°C^{-1}$)	*Total area* (m^2)
Uninsulated roof	2·0	150
Cavity walls	1·9	300
Single glazed windows	5·6	50

House Q

House Q	*U-value* ($W\,m^{-2}\,°C^{-1}$)	*Total area* (m^2)
Insulated roof	0·5	150
Filled cavity walls	0·6	500
Double glazed windows	2·8	80

4. (continued)

(a) Complete the sentence below by circling the correct answer. **1**

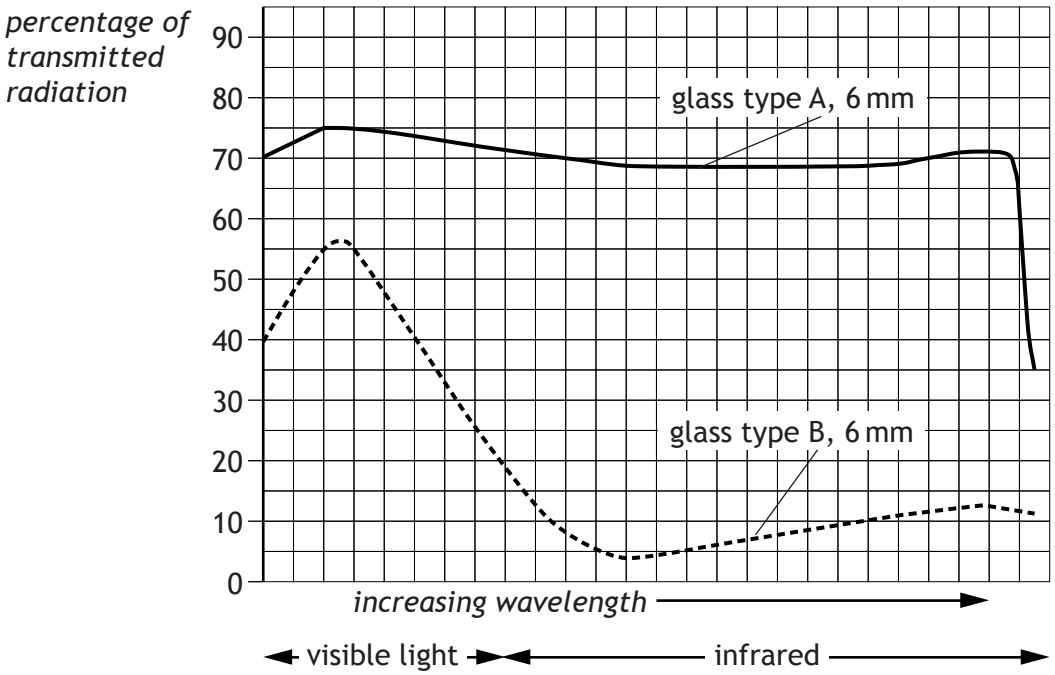
The {higher / lower} the U-value, the better the material is as a heat insulator.

(b) Show by calculation that house P has the highest rate of heat transfer through the **walls** when the outside temperature is 2 °C and the inside temperature in both houses is 18 °C. **4**

Space for working and answer

4. (continued)

(c) Glass transmits infrared radiation and visible light. The percentage transmitted depends on the type and thickness of the glass. The data from tests on two different types of glass is displayed in the graph below.

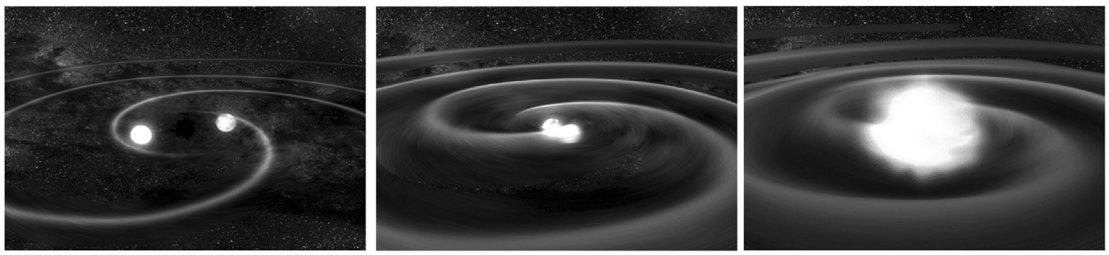


A glass conservatory is being built on house Q. The homeowner wants the inside of the conservatory to remain as cool as possible throughout the summer.

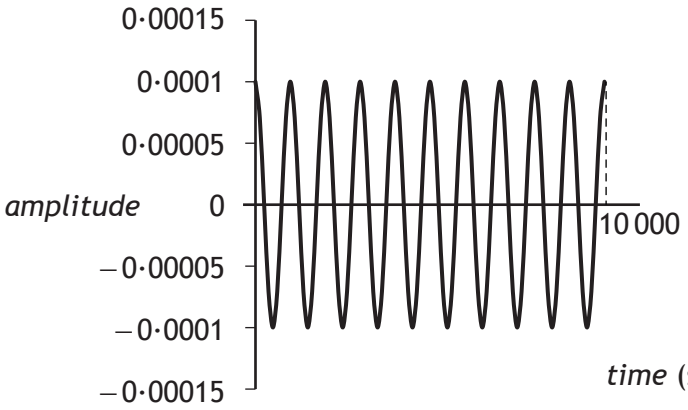
Using information from the graph, explain which type of glass should be used. **2**

Total marks 7

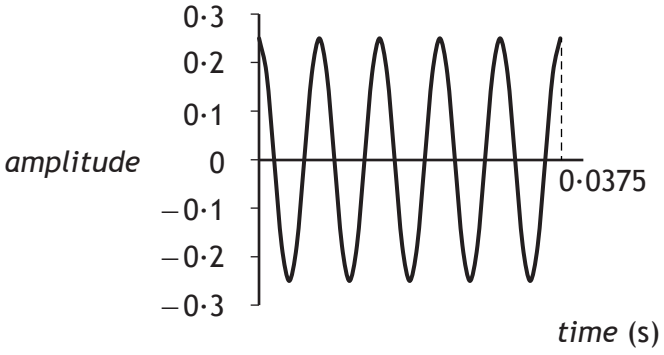
5. A pair of neutron stars which orbit one another will over time move closer together and eventually join.



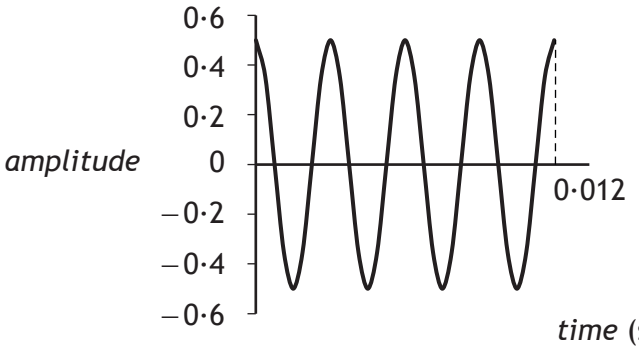
Astronomers believe that as the neutron stars move closer, they emit energy in the form of gravitational waves. It is predicted that gravitational wave detectors will produce the graphs shown.



One million years before stars join together



One second before stars join together



0·1 seconds before stars join together

5. (continued)

(a) Use the graphs to complete the following table. The first row has already been completed. **4**

Time before the stars join	*Period of gravitational waves* (s)	*Frequency of gravitational waves* (Hz)
1 million years	1000	0·001
1 second		
0·1 second		

Space for working

(b) State what happens to the frequency of the gravitational waves as the neutron stars move closer together. **1**

(c) The orbital speed, in metres per second, of the rotating neutron stars is given by the equation:

$$v = \frac{2\pi}{T}R$$

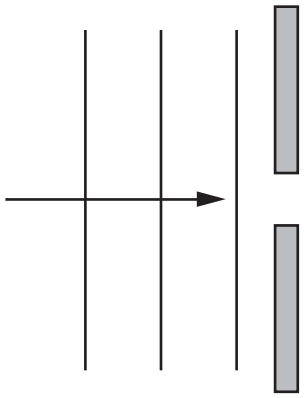
where T is the orbital period in seconds and R is half the distance between the stars in metres.

Calculate the orbital speed of the neutron stars when they are 340 000 km apart and the orbital period is 1150 s. **2**

Space for working and answer

Total marks 7

6. A water wave is diffracted when it passes through a gap in a barrier. The wavelength of the wave is 10 mm. The gap is less than 10 mm.



(a) Complete the diagram above to show the pattern of the wave to the right of the barrier. **2**

(b) The diagram below represents the electromagnetic spectrum.

Radio & TV waves	A	Infrared radiation	Visible light	Ultraviolet light	X-rays	Gamma radiation

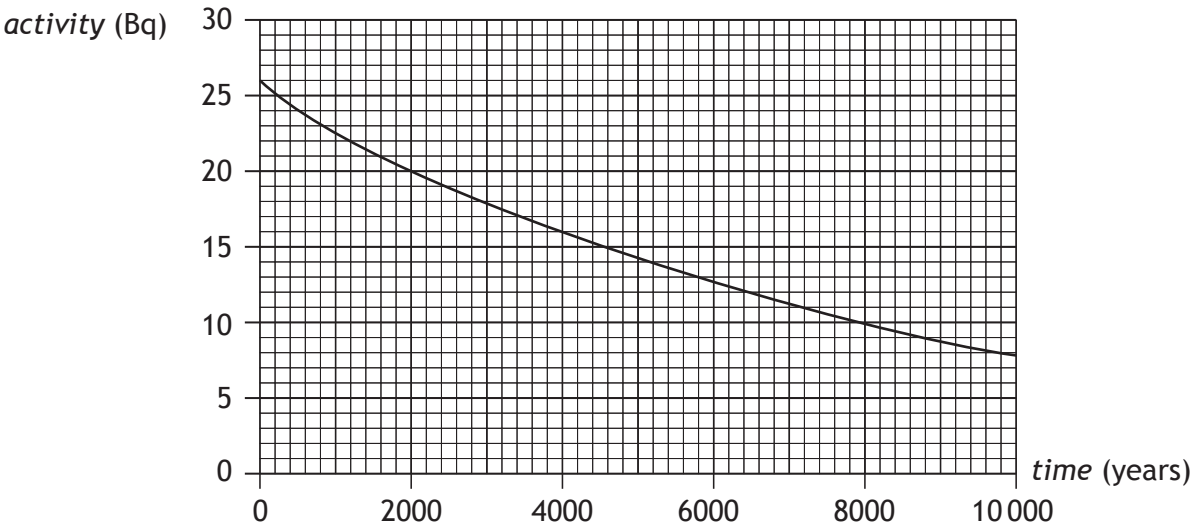
(i) Identify radiation A. **1**

(ii) Apart from diffraction, state one property that all electromagnetic waves have in common. **1**

Total marks **4**

7. Trees continually absorb carbon-14 when they are alive. When a tree dies the carbon-14 contained in its wood is not replaced. Carbon-14 is radioactive and decays by beta emission.

(a) Following the tree's death, the activity of the carbon-14 within a **25 mg** sample of its wood changes as shown.



(i) Use the graph to determine the half-life of carbon-14. **2**

(ii) Calculate the time taken for the activity of this sample of carbon-14 to fall to 6·5 Bq. **3**

Space for working and answer

7. (a) (continued)

(iii) During an archaeological dig, a 125 mg sample of the same type of wood was obtained. The activity of this sample was 40 Bq.

Estimate the age of this sample. **3**

Space for working and answer

(b) Explain why this method could not be used to estimate the age of a tree that died 100 years ago. **1**

Total marks 9

MARKS DO NOT WRITE IN THIS MARGIN

8. A technician uses a radioactive source to investigate the effect of gamma rays on biological tissue.

(a) State what is meant by the term *gamma rays*. **1**

(b) The wavelength of a gamma ray is $6{\cdot}0 \times 10^{-13}$ m.

Calculate the frequency of the gamma ray. **3**

Space for working and answer

(c) In one experiment, a biological tissue sample of mass 0·10 kg receives an absorbed dose of 50 μGy.

Calculate the energy absorbed by the tissue. **3**

Space for working and answer

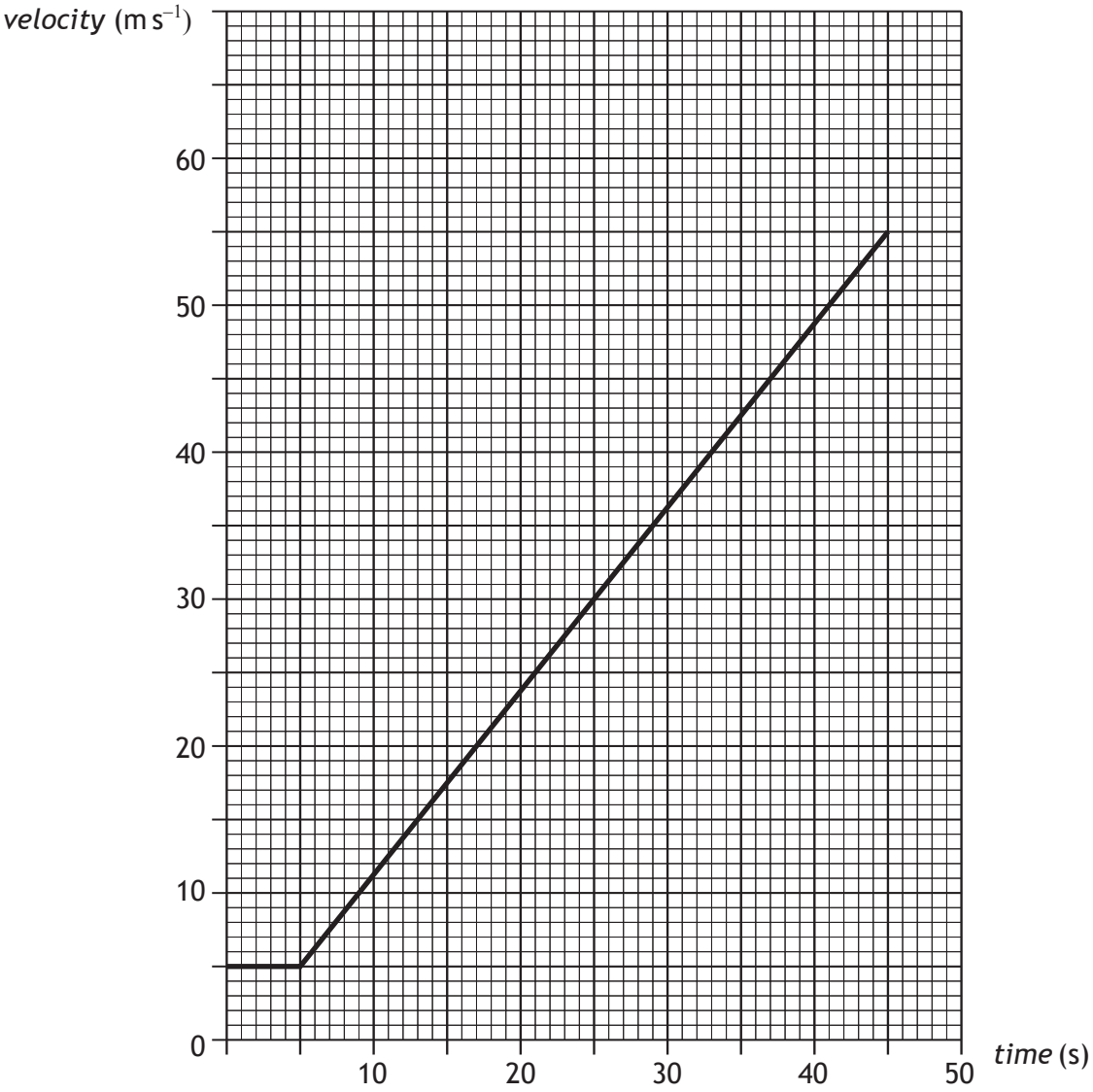
8. (continued)

(d) The radioactive source must be stored in a lead-lined container.

Explain why a lead-lined container should be used. **1**

Total marks 8

9. An aircraft is making a journey between two airports. A graph of the aircraft's velocity during take-off is shown below.



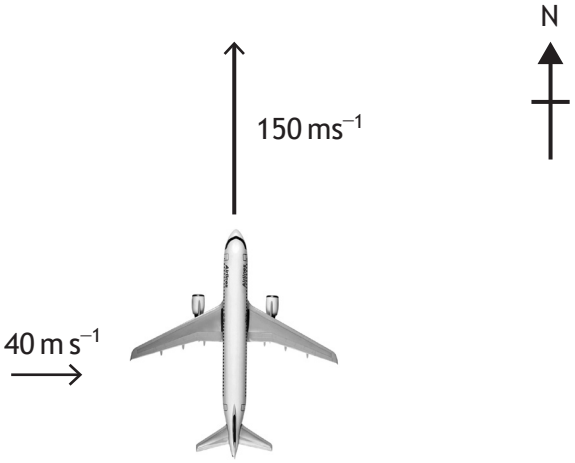
(a) Calculate the acceleration during take-off. **3**

Space for working and answer

9. (continued)

(b) (i) During flight, the aircraft is travelling at a velocity of 150 m s^{-1} due north and then encounters a crosswind of 40 m s^{-1} due east.

By scale diagram, or otherwise, determine the resultant velocity of the aircraft. **4**



Space for working and answer

9. (b) (continued)

(ii) Describe what action the pilot could take to ensure that the aircraft remains travelling north at 150 m s^{-1}. **2**

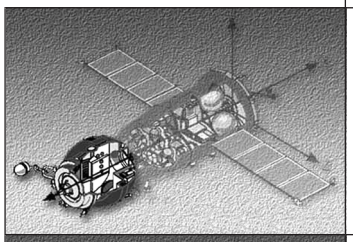
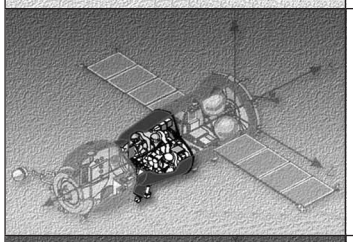
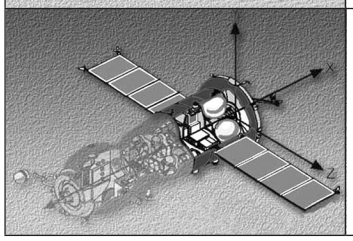
(c) The aircraft arrives at the destination airport.

This airport has three runways of different lengths to accommodate different sizes of aircraft.

Explain why larger aircraft require a much longer runway to land safely. **2**

Total marks 11

10. The Soyuz Spacecraft is used to transport astronauts to the International Space Station (ISS). The spacecraft contains three parts that are launched together.

	Part	*Mass* (kg)
	Orbital Module	1300
	Descent Module (including astronauts)	2950
	Instrumentation/ Propulsion Module	2900

(a) When the spacecraft leaves the ISS, its propulsion module produces a force of 1430 N.

Calculate the acceleration of the spacecraft as it leaves the ISS. **4**

Space for working and answer

10. (continued)

(b) On the return flight, the Orbital Module and the Instrumentation/ Propulsion Module are jettisoned. Instead of returning to Earth, they burn up in the atmosphere at a very high temperature.

Explain why these Modules burn up on re-entry into the atmosphere. **2**

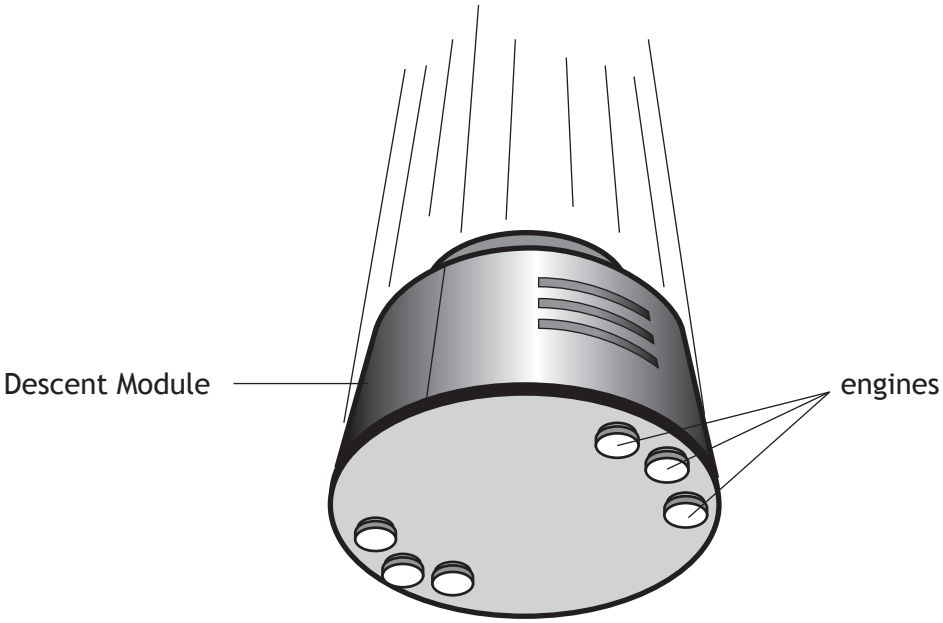
(c) After the Descent Module has re-entered the atmosphere, its speed is dramatically reduced.

(i) Four parachutes are used to slow the Module's rate of descent from $230\,m\,s^{-1}$ to $80\,m\,s^{-1}$.

Explain, in terms of forces, how the parachutes reduce the speed of the Module. **2**

10. (c) (continued)

(ii) Just before touchdown, small engines fire on the bottom of the Module, slowing it down further. The work done by the engines is 80 kJ over a distance of 5 m.



Calculate the force produced by the engines. **3**

Space for working and answer

Total marks 11

MARKS | DO NOT WRITE IN THIS MARGIN

11. Read the passage below and answer the questions that follow.

Dragonfish nebula conceals giant cluster of young stars

The Dragonfish nebula may contain the Milky Way's most massive cluster of young stars. Scientists from the University of Toronto found the first hint of the cluster in 2010 in the form of a big cloud of ionised gas 30 000 light years from Earth. They detected the gas from its microwave emissions, suspecting that radiation from massive stars nearby had ionised the gas.

Now the scientists have identified a cluster of 400 massive stars in the heart of the gas cloud using images from an infrared telescope. The cluster probably contains more stars which are too small and dim to detect.

The surrounding cloud of ionised gas is producing more microwaves than the clouds around other star clusters in our galaxy. This suggests that the Dragonfish nebula contains the brightest and most massive young cluster discovered so far, with a total mass of around 100 000 times the mass of the Sun.

(a) Name the galaxy mentioned in the passage. **1**

(b) Show that the Dragonfish nebula is approximately $2{\cdot}84 \times 10^{20}$ m away from Earth. **3**

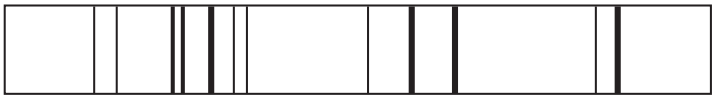
Space for working and answer

11. (continued)

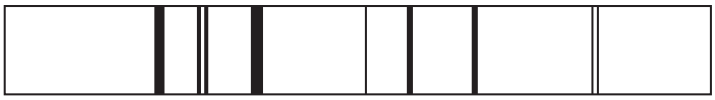
(c) Complete the sentence by circling the correct words.

Compared to infrared radiation, microwaves have a {longer / shorter} wavelength which means they have a {higher / lower} frequency. **1**

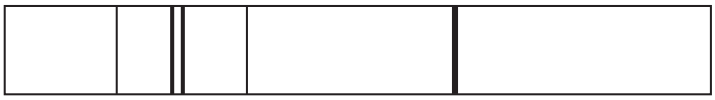
(d) A line spectrum from a nebula is shown below.



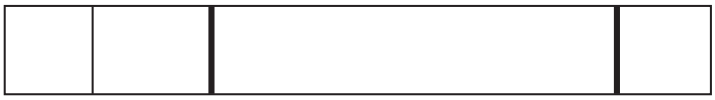
spectral lines from gases in the nebula



nitrogen



helium



hydrogen

krypton

Identify the elements present in the nebula. **2**

Total marks 7

MARKS DO NOT WRITE IN THIS MARGIN

12. In October 2012, a skydiver jumped from a balloon at a height of 39 km above the surface of the Earth.

He became the first person to jump from this height.

He also became the first human to fall at speeds higher than the speed of sound in air.

Using your knowledge of physics, comment on the challenges faced by the skydiver when making this jump. **3**

Space for answer

[END OF SPECIMEN QUESTION PAPER]

MARKS | DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ROUGH WORKING AND ANSWERS

MARKS

DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ROUGH WORKING AND ANSWERS