N5 National Qualifications SPECIMEN ONLY

S857/75/02

Physics
Section 1 — Questions

Date — Not applicable

Duration — 2 hours 30 minutes

Instructions for completion of Section 1 are given on *page 02* of your question and answer booklet S857/75/01.

Record your answers on the answer grid on *page 03* of your question and answer booklet.

Reference may be made to the Data Sheet on *page 02* of this booklet and to the Relationships Sheet S857/75/11.

Before leaving the examination room you must give your question and answer booklet to the Invigilator; if you do not, you may lose all the marks for this paper.

S857 7502

DATA SHEET

Speed of light in materials

Material	*Speed* in m s^{-1}
Air	$3 \cdot 0 \times 10^8$
Carbon dioxide	$3 \cdot 0 \times 10^8$
Diamond	$1 \cdot 2 \times 10^8$
Glass	$2 \cdot 0 \times 10^8$
Glycerol	$2 \cdot 1 \times 10^8$
Water	$2 \cdot 3 \times 10^8$

Gravitational field strengths

	Gravitational field strength on the surface in N kg^{-1}
Earth	9·8
Jupiter	23
Mars	3·7
Mercury	3·7
Moon	1·6
Neptune	11
Saturn	9·0
Sun	270
Uranus	8·7
Venus	8·9

Specific latent heat of fusion of materials

Material	*Specific latent heat of fusion* in J kg^{-1}
Alcohol	$0 \cdot 99 \times 10^5$
Aluminium	$3 \cdot 95 \times 10^5$
Carbon Dioxide	$1 \cdot 80 \times 10^5$
Copper	$2 \cdot 05 \times 10^5$
Iron	$2 \cdot 67 \times 10^5$
Lead	$0 \cdot 25 \times 10^5$
Water	$3 \cdot 34 \times 10^5$

Specific latent heat of vaporisation of materials

Material	*Specific latent heat of vaporisation* in J kg^{-1}
Alcohol	$11 \cdot 2 \times 10^5$
Carbon Dioxide	$3 \cdot 77 \times 10^5$
Glycerol	$8 \cdot 30 \times 10^5$
Turpentine	$2 \cdot 90 \times 10^5$
Water	$22 \cdot 6 \times 10^5$

Speed of sound in materials

Material	*Speed* in m s^{-1}
Aluminium	5200
Air	340
Bone	4100
Carbon dioxide	270
Glycerol	1900
Muscle	1600
Steel	5200
Tissue	1500
Water	1500

Specific heat capacity of materials

Material	*Specific heat capacity* in J kg^{-1} °C^{-1}
Alcohol	2350
Aluminium	902
Copper	386
Glass	500
Ice	2100
Iron	480
Lead	128
Oil	2130
Water	4180

Melting and boiling points of materials

Material	*Melting point* in °C	*Boiling point* in °C
Alcohol	−98	65
Aluminium	660	2470
Copper	1077	2567
Glycerol	18	290
Lead	328	1737
Iron	1537	2737

Radiation weighting factors

Type of radiation	*Radiation weighting factor*
alpha	20
beta	1
fast neutrons	10
gamma	1
slow neutrons	3
X-rays	1

SECTION 1

Attempt ALL questions

1. Which of the following contains two scalar quantities?

A Force and mass

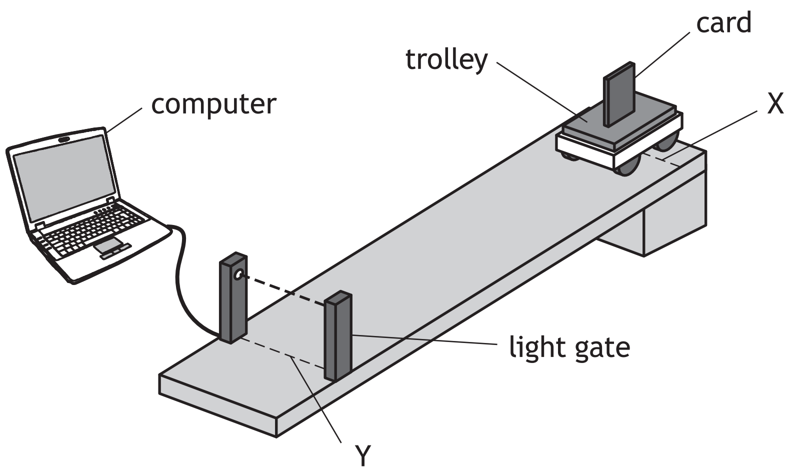
B Weight and mass

C Displacement and speed

D Distance and speed

E Displacement and velocity

2. A student sets up the apparatus as shown.



The trolley is released from X and moves down the ramp.

The following measurements are recorded.

time for card to pass through light gate = 0·080 s

distance from X to Y = 0·50 m

length of card = 0·040 m

The instantaneous speed of the trolley at Y is

A 0·50 m s^{-1}

B 1·6 m s^{-1}

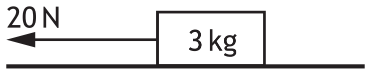
C 2·0 m s^{-1}

D 3·2 m s^{-1}

E 6·3 m s^{-1}.

[Turn over

3. A block of mass 3 kg is pulled across a horizontal bench by a force of 20 N as shown below.



The block accelerates at $4\ m\ s^{-2}$.

The force of friction between the block and the bench is

A 0 N

B 8 N

C 12 N

D 20 N

E 32 N.

4. An aircraft engine exerts a force on the air.

Which of the following completes the 'Newton pair' of forces?

A The force of the air on the aircraft engine.

B The force of friction between the aircraft engine and the air.

C The force of the aircraft engine on the aircraft.

D The force of the Earth on the aircraft engine.

E The force of the aircraft engine on the Earth.

5. A trolley of mass 0·50 kg has a kinetic energy of 0·36 J.

The speed of the trolley is

A $0{\cdot}60\ m\ s^{-1}$

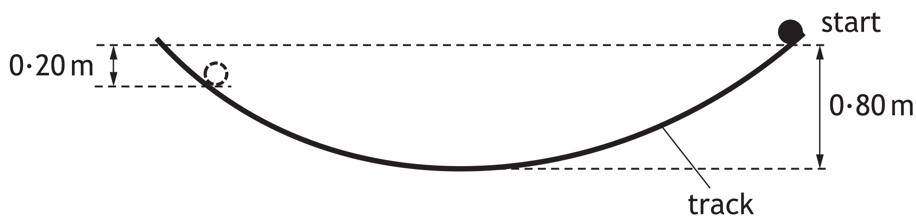
B $0{\cdot}85\ m\ s^{-1}$

C $1{\cdot}2\ m\ s^{-1}$

D $1{\cdot}44\ m\ s^{-1}$

E $1{\cdot}7\ m\ s^{-1}$.

6. A ball is released from rest and allowed to roll down a curved track as shown.



The mass of the ball is 0·50 kg.

The maximum height reached on the opposite side of the track is 0·20 m lower than the height of the starting point.

The amount of energy lost is

A 0·080 J

B 0·10 J

C 0·98 J

D 2·9 J

E 3·9 J.

7. The Mars Curiosity Rover has a mass of 900 kg.

Which row of the table gives the mass and weight of the Rover on Mars?

	Mass (kg)	*Weight* (N)
A	243	243
B	243	900
C	900	900
D	900	3330
E	900	8820

[Turn over

8. A student makes the following statements about the Universe.

I The Big Bang Theory is a theory about the origin of the Universe.

II The Universe is approximately 14 million years old.

III The Universe is expanding.

Which of these statements is/are correct?

A I only

B II only

C I and II only

D I and III only

E I, II and III

9. A conductor carries a current of $4{\cdot}0\,\mu A$ for 250 s.

The total charge passing a point in the conductor is

A $1{\cdot}6 \times 10^{-8}$ C

B $1{\cdot}0 \times 10^{-3}$ C

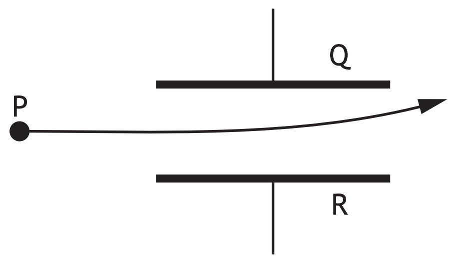
C $6{\cdot}25 \times 10^{1}$ C

D $1{\cdot}0 \times 10^{3}$ C

E $6{\cdot}25 \times 10^{7}$ C.

10. A uniform electric field exists between plates Q and R.

The diagram shows the path taken by a particle as it passes through the field.



Which row in the table identifies the charge on the particle, the charge on plate Q and the charge on plate R?

	Charge on particle	*Charge on plate Q*	*Charge on plate R*
A	negative	positive	negative
B	negative	negative	positive
C	no charge	negative	positive
D	no charge	positive	negative
E	positive	positive	negative

11. 1 volt is equivalent to

A 1 ampere per watt

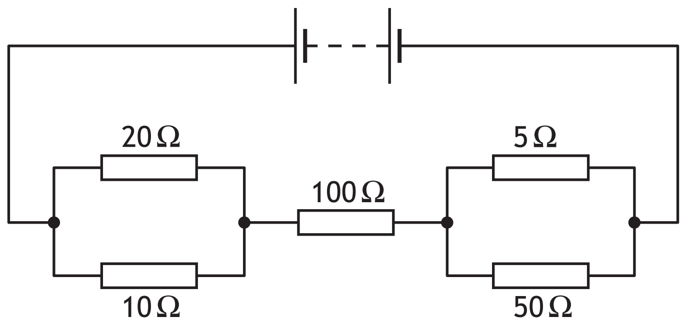
B 1 coulomb per second

C 1 joule per coulomb

D 1 joule per second

E 1 watt per second.

12. In the circuit shown, the current in each resistor is different.



In which resistor is the current smallest?

A 5 Ω

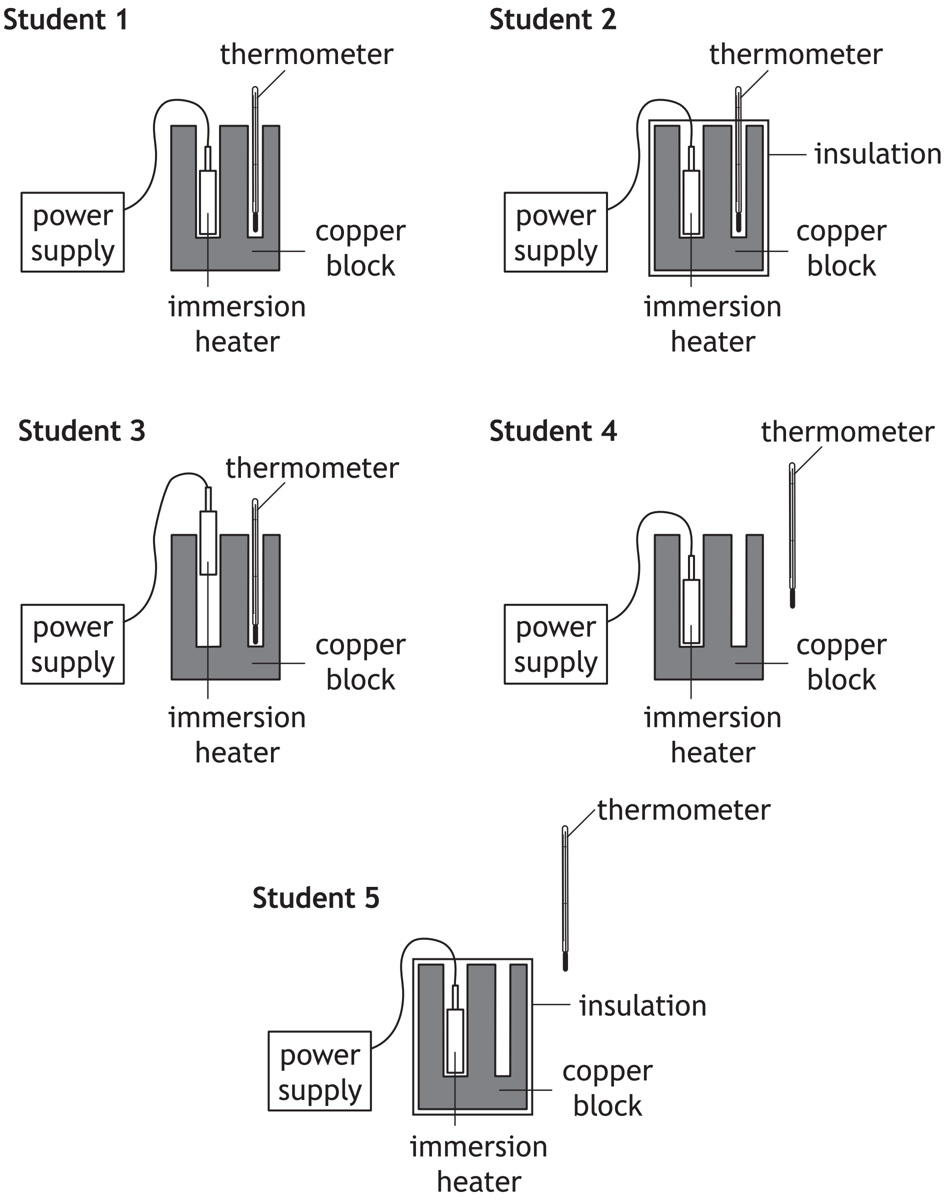
B 10 Ω

C 20 Ω

D 50 Ω

E 100 Ω

13. Five students each carry out an experiment to determine the specific heat capacity of copper. The setup used by each student is shown.



The student with the setup that would allow the most accurate value for the specific heat capacity of copper to be determined is

A student 1

B student 2

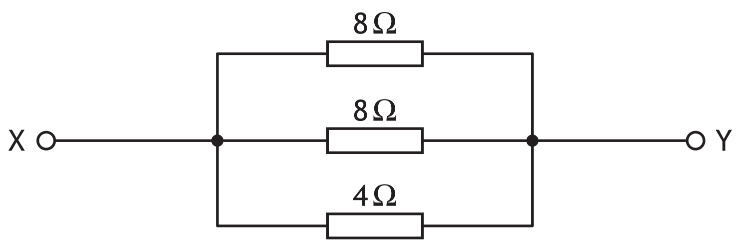
C student 3

D student 4

E student 5.

[Turn over

14. Three resistors are connected as shown.



The resistance between X and Y is

A 0·08 Ω

B 0·5 Ω

C 2 Ω

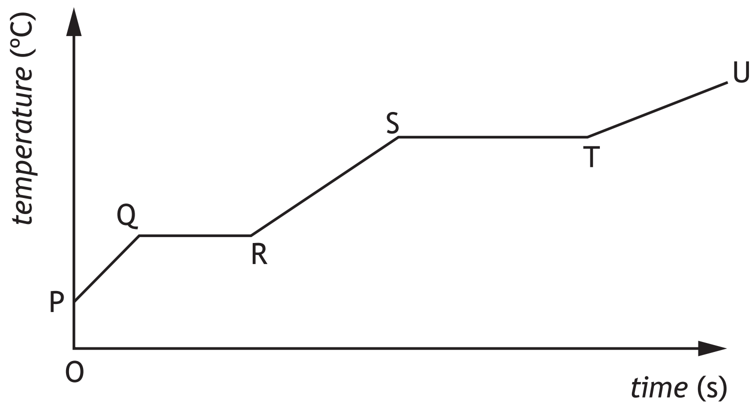
D 13 Ω

E 20 Ω.

15. A heater is immersed in a substance.

The heater is then switched on.

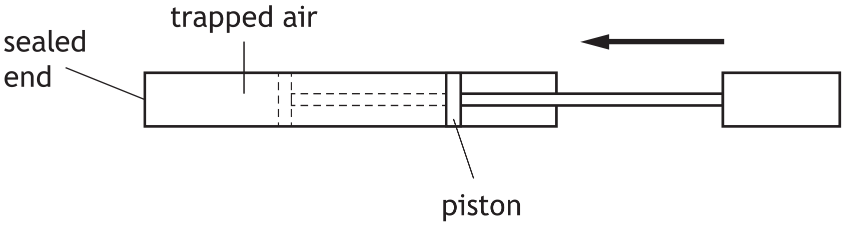
The graph shows the temperature of the substance over a period of time.



Which row in the table identifies the sections of the graph when the substance is changing state?

	Solid to liquid	*Liquid to gas*
A	QR	TU
B	QR	ST
C	PQ	RS
D	PQ	TU
E	ST	QR

16. A bicycle pump is sealed at one end and the piston pushed until the pressure of the trapped air is $4{\cdot}00 \times 10^5$ Pa.



The area of the piston compressing the air is $5{\cdot}00 \times 10^{-4}\,m^2$.

The force that the trapped air exerts on the piston is

A $1{\cdot}25 \times 10^{-9}$ N

B $8{\cdot}00 \times 10^{-1}$ N

C $2{\cdot}00 \times 10^{2}$ N

D $8{\cdot}00 \times 10^{8}$ N

E $2{\cdot}00 \times 10^{10}$ N.

17. A liquid is heated from 17 °C to 50 °C. The temperature rise in kelvin is

A 33 K

B 67 K

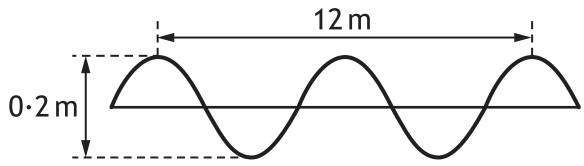
C 306 K

D 340 K

E 579 K.

[Turn over

18. The following diagram shows a wave.



Which row in the table gives the wavelength and amplitude of the wave?

	Wavelength (m)	*Amplitude* (m)
A	4	0·2
B	6	0·1
C	6	0·2
D	12	0·1
E	12	0·2

19. A wave machine in a swimming pool generates 15 waves per minute.

The wavelength of these waves is 2·0 m.

The frequency of the waves is

A 0·25 Hz

B 0·50 Hz

C 4·0 Hz

D 15 Hz

E 30 Hz.

[Turn over

20. The diagram shows members of the electromagnetic spectrum in order of increasing wavelength.

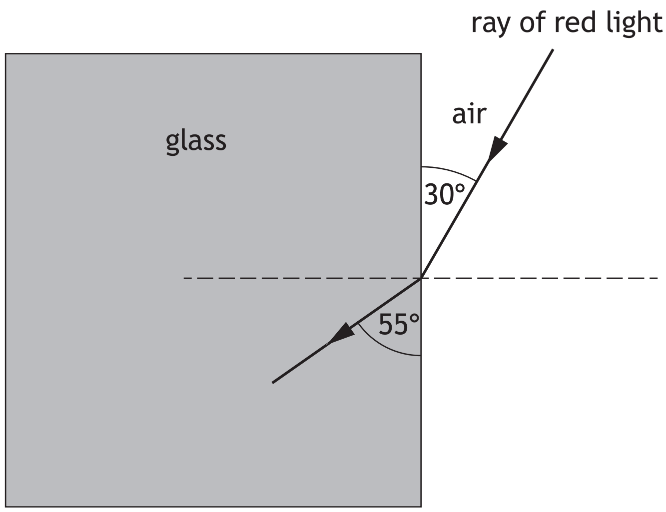
Gamma rays	P	Ultraviolet radiation	Q	Infrared radiation	R	TV and radio waves

increasing wavelength →

Which row in the table identifies the radiations represented by the letters P, Q and R?

	P	*Q*	*R*
A	X-rays	visible light	microwaves
B	X-rays	microwaves	visible light
C	microwaves	visible light	X-rays
D	visible light	microwaves	X-rays
E	visible light	X-rays	microwaves

21. A ray of red light is incident on a glass block as shown.



Which row in the table shows the values of the angle of incidence and angle of refraction?

	Angle of incidence	*Angle of refraction*
A	35°	60°
B	30°	55°
C	30°	35°
D	60°	55°
E	60°	35°

22. Which of the following describes the term ionisation?

A An atom losing an orbiting electron.

B An atom losing a proton.

C A nucleus emitting an alpha particle.

D A nucleus emitting a neutron.

E A nucleus emitting a gamma ray.

23. A student writes the following statements about the activity of a radioactive source.

I The activity decreases with time.

II The activity is measured in becquerels.

III The activity is the number of decays per second.

Which of these statements is/are correct?

A I only

B II only

C I and II only

D II and III only

E I, II and III

24. A worker in a nuclear power station is exposed to 3·00 mGy of gamma radiation and 0·500 mGy of fast neutrons.

The total equivalent dose received by the worker is

A 3·50 mSv

B 8·00 mSv

C 30·5 mSv

D 35·0 mSv

E 38·5 mSv.

[Turn over

25. In a nuclear reactor a chain reaction releases energy from nuclei.

Which of the following statements describes the beginning of a chain reaction?

A An electron splits a nucleus releasing more electrons.

B An electron splits a nucleus releasing protons.

C A proton splits a nucleus releasing more protons.

D A neutron splits a nucleus releasing electrons.

E A neutron splits a nucleus releasing more neutrons.

[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2 OF YOUR QUESTION AND ANSWER BOOKLET]

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Mark

S857/75/01

Physics
Section 1 — Answer Grid
And Section 2

Date — Not applicable

Duration — 2 hours 30 minutes

S857750 1

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 — 135

SECTION 1 — 25 marks

Attempt ALL questions.

Instructions for completion of Section 1 are given on *page 02*.

SECTION 2 — 110 marks

Attempt ALL questions.

Reference may be made to the Data Sheet on *page 02* of the question paper S857/75/02 and to the Relationships Sheet S857/75/11.

Write your answers clearly in the spaces provided in this booklet. Additional space for answers and rough work is provided at the end of this booklet. If you use this space you must clearly identify the question number you are attempting. Any rough work must be written in this booklet. Score through your rough work when you have written your final copy.

Use **blue** or **black** ink.

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.

The questions for Section 1 are contained in the question paper S857/75/02.

Read these and record your answers on the answer grid on *page 03* opposite.

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

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 work must be written in the additional space for answers and rough work at the end of this booklet.

Sample Question

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

A ampere

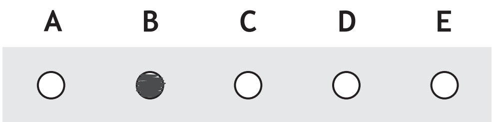
B kilowatt-hour

C watt

D coulomb

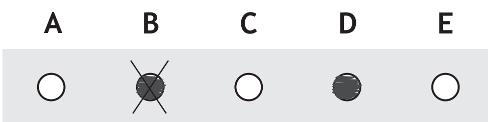
E volt.

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

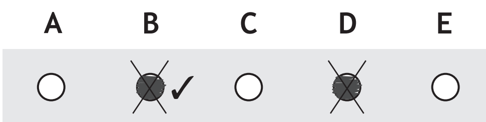


Changing an answer

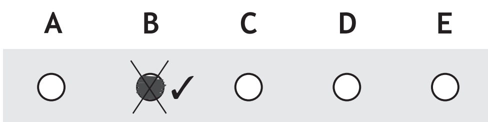
If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.



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



OBJ25AE1

	A	B	C	D	E
1	○	○	○	○	○
2	○	○	○	○	○
3	○	○	○	○	○
4	○	○	○	○	○
5	○	○	○	○	○
6	○	○	○	○	○
7	○	○	○	○	○
8	○	○	○	○	○
9	○	○	○	○	○
10	○	○	○	○	○
11	○	○	○	○	○
12	○	○	○	○	○
13	○	○	○	○	○
14	○	○	○	○	○
15	○	○	○	○	○
16	○	○	○	○	○
17	○	○	○	○	○
18	○	○	○	○	○
19	○	○	○	○	○
20	○	○	○	○	○
21	○	○	○	○	○
22	○	○	○	○	○
23	○	○	○	○	○
24	○	○	○	○	○
25	○	○	○	○	○

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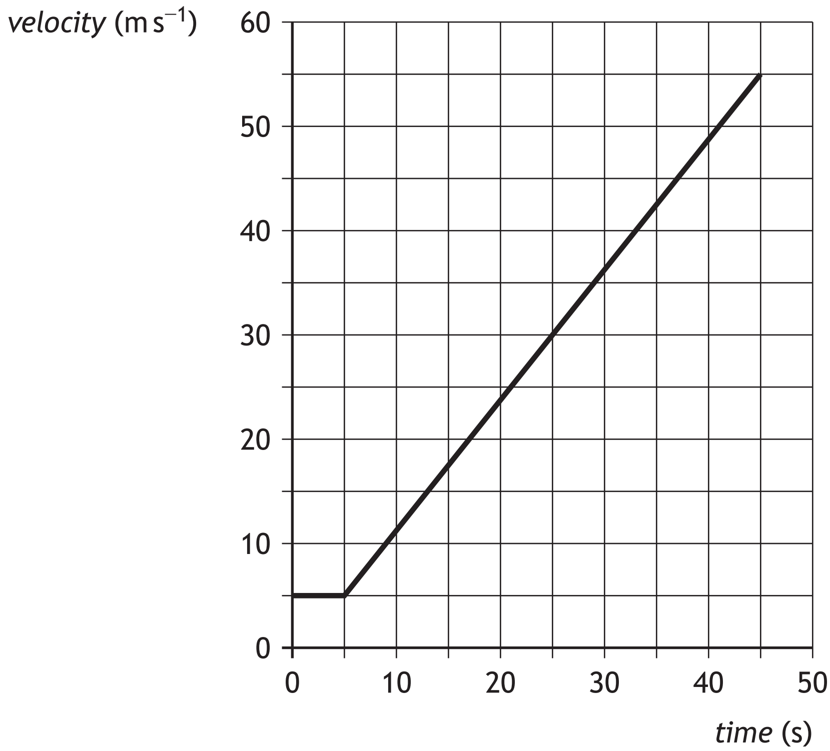
SECTION 2 — 110 marks

Attempt ALL questions

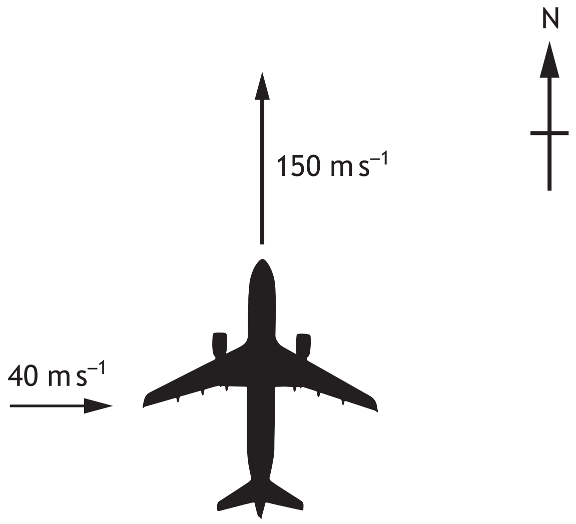
1. An aircraft is making a journey between two airports. A graph of the aircraft's velocity during take-off is shown.



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

Space for working and answer

(b) 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:

(i) the magnitude of the resultant velocity of the aircraft; **2**

Space for working and answer

(ii) the direction of the resultant velocity of the aircraft. **2**

Space for working and answer

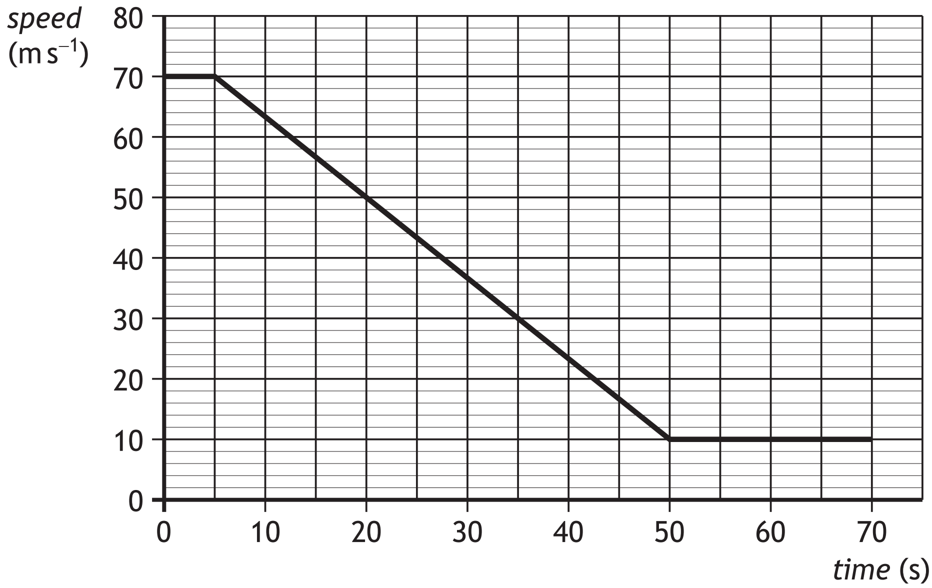
1. **(continued)** **MARKS** DO NOT WRITE IN THIS MARGIN

(c) The aircraft arrives at the destination airport.

There are three runways, X, Y and Z, available for the aircraft to land on. The length of each runway is given in the table.

Runway	*Length* (m)
X	3776
Y	3048
Z	2743

(i) The speed-time graph below shows the speed of the aircraft during landing on the runway, from the moment the wheels touch down.



Determine which runways the aircraft could have used to land safely.

Justify your answer by calculation. **4**

Space for working and answer

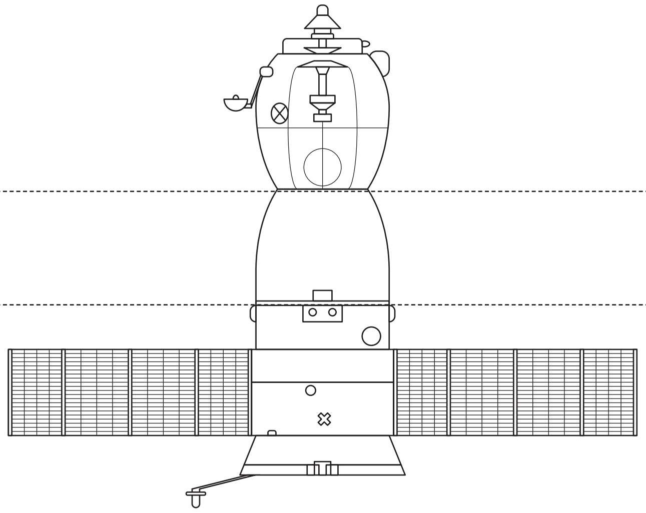
MARKS DO NOT WRITE IN THIS MARGIN

(ii) This airport has runways of different lengths to accommodate different sizes of aircraft.

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

2. The Soyuz Spacecraft is used to transport astronauts from the International Space Station (ISS) to Earth.

The spacecraft contains three parts.

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

(a) When the spacecraft leaves the ISS, the three parts are launched together. The 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

2. **(continued)** **MARKS** DO NOT WRITE IN THIS MARGIN

(b) During the 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.

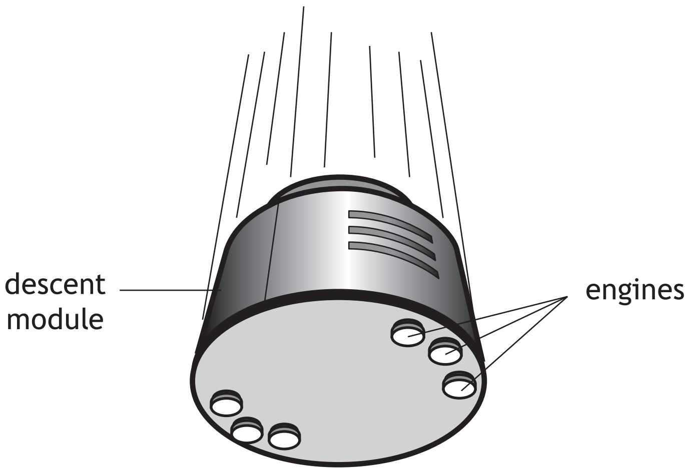
Explain why these Modules burn up on re-entry into the atmosphere. **2**

(c) (i) After the Descent Module has re-entered the atmosphere, its speed is dramatically reduced. Four parachutes are used to slow the Module's rate of descent.

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

MARKS | DO NOT WRITE IN THIS MARGIN

(ii) Just before touchdown, small engines fire on the bottom of the Module, slowing it down further. The work done by the engines is $8{\cdot}0 \times 10^4$ J over a distance of $5{\cdot}0$ m.



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

Space for working and answer

2. **(continued)** **MARKS**

DO NOT WRITE IN THIS MARGIN

(d) The ISS orbits with an altitude of between $3{\cdot}30 \times 10^5$ m and $4{\cdot}35 \times 10^5$ m above the surface of the Earth.

(i) The orbital period T, in seconds, of the ISS can be calculated using the relationship

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

where v is the orbital speed in metres per second and R is the orbital radius in metres.

The orbital radius R is the sum of the radius of the Earth and the altitude above the surface of the Earth.

The radius of the Earth is $6{\cdot}4 \times 10^6$ m.

The orbital speed of the ISS can be taken to be $7{\cdot}7 \times 10^3 \text{ m s}^{-1}$.

Calculate the orbital period of the ISS when it is orbiting at an altitude of $3{\cdot}30 \times 10^5$ m. **3**

Space for working and answer

(ii) State whether the orbital period of the ISS in its highest orbit will be less than, the same as, or greater than the orbital period calculated in part (d) (i). **1**

(iii) Explain, in terms of its horizontal velocity and weight, how the ISS remains in orbit around the Earth. **2**

3. Read the passage below about the Dragonfish nebula, an interstellar cloud of dust and gases and star-forming region in space. 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**

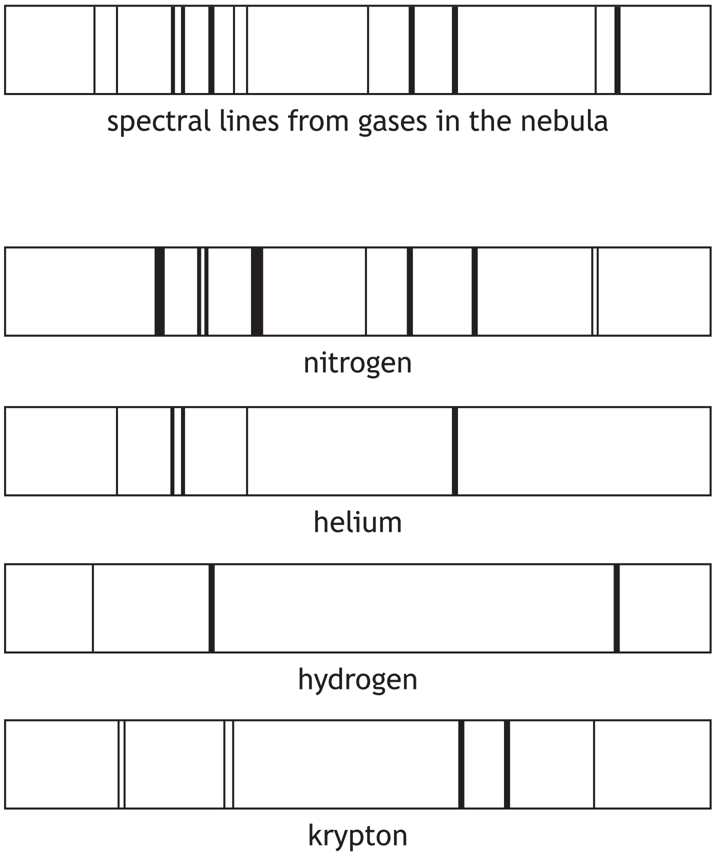
(b) Show that the Dragonfish nebula is approximately $2{\cdot}8 \times 10^{20}$ m away from Earth. **3**

Space for working and answer

3. (continued) **MARKS** DO NOT WRITE IN THIS MARGIN

(c) State how the frequency of microwave radiation compares to the frequency of infrared radiation. **1**

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

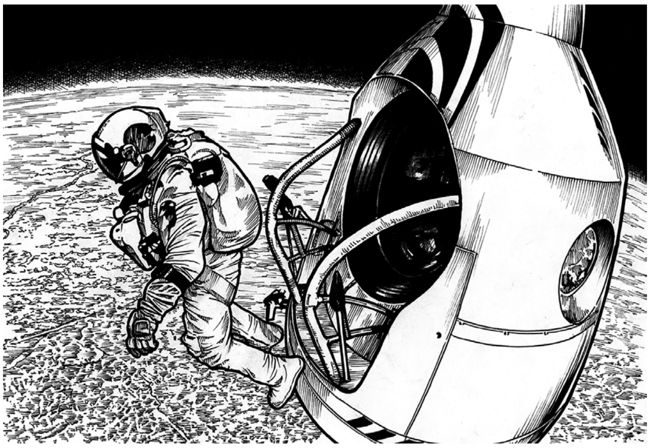


Identify which of these elements are present in the nebula. **2**

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

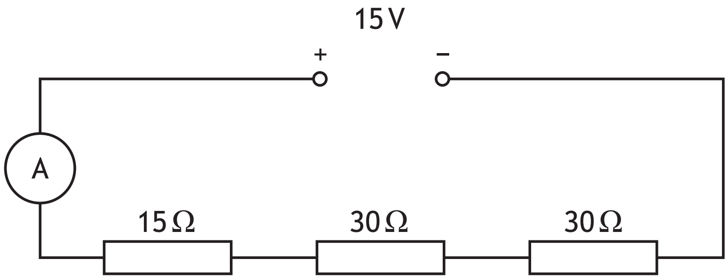
He became the first person to jump from this height.

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**

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



(i) Determine the total resistance in the circuit. **1**

(ii) Calculate the current in the circuit. **3**

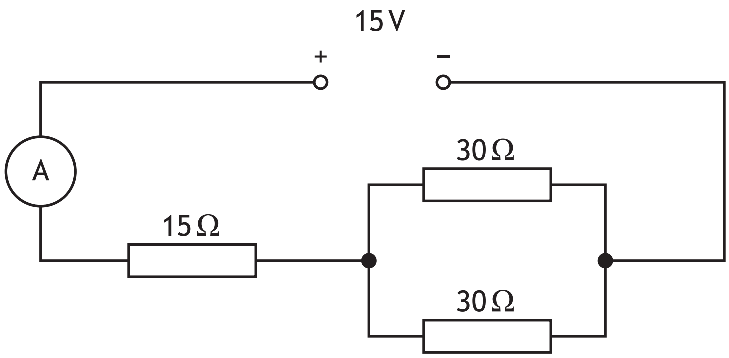
Space for working and answer

(iii) Calculate the power dissipated in the 15 Ω resistor. **3**

Space for working and answer

5. (continued) **MARKS** DO NOT WRITE IN THIS MARGIN

(b) The circuit is now rearranged as shown.



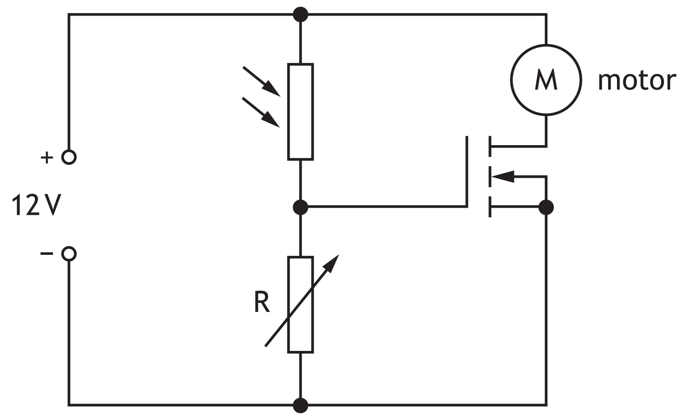
State how the power dissipated in the 15 Ω resistor compares to your answer in (a) (iii).

You must justify your answer. **3**

S857750117

6. An office has an automatic window blind that closes when the light level outside gets too high.

The electronic circuit that operates the motor to close the blind is shown.



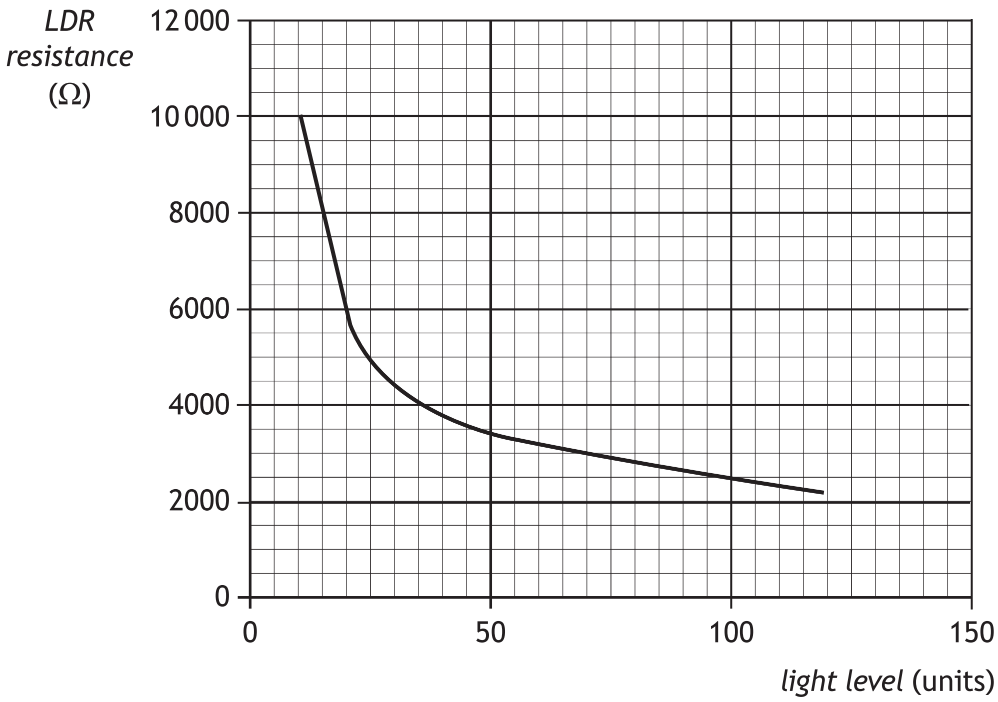
(a) The MOSFET switches on when the voltage across variable resistor R reaches 2·4 V.

(i) Explain how this circuit works to close the blind. **3**

(ii) What is the purpose of the variable resistor R? **1**

6. **(continued)** **MARKS** DO NOT WRITE IN THIS MARGIN

(b) The graph shows how the resistance of the LDR varies with light level.



(i) Determine the resistance of the LDR when the light level is 70 units. **1**

(ii) The variable resistor R is set at a resistance of 600 Ω.

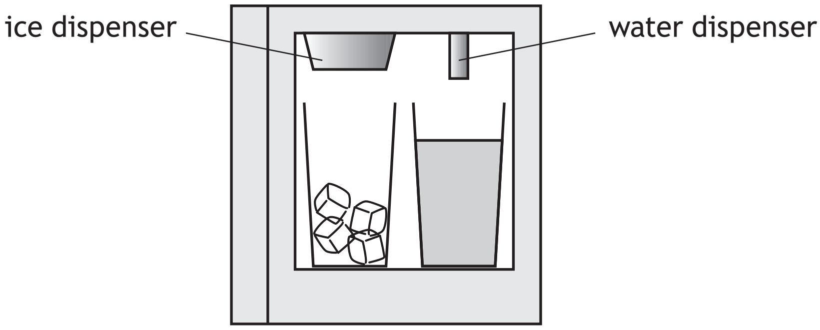
Calculate the voltage across R when the light level is 70 units. **3**

Space for working and answer

(iii) State whether or not the blinds will close when the light level is 70 units.

Justify your answer. **2**

7. A fridge/freezer has water and ice dispensers as shown.



(a) Water of mass 0·100 kg flows into the freezer at 15·0 °C and is cooled to 0 °C.

Show that $6{\cdot}27 \times 10^3$ J of energy is removed when the water cools. **2**

Space for working and answer

(b) Calculate the energy released when 0·100 kg of water at 0 °C changes to 0·100 kg of ice at 0 °C. **3**

Space for working and answer

7. (continued) MARKS DO NOT WRITE IN THIS MARGIN

(c) The fridge/freezer system removes heat energy at a rate of 115 J s^{-1}.

(i) Calculate the minimum time taken to produce 0·100 kg of ice from 0·100 kg of water at 15·0 °C. **4**

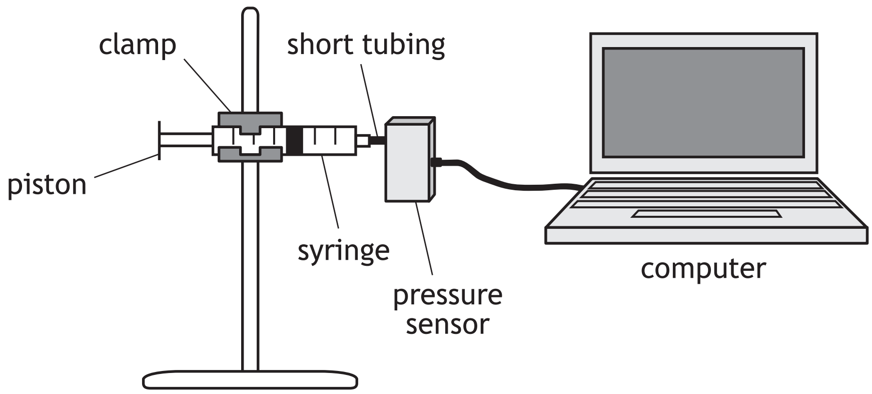
Space for working and answer

(ii) Explain why the actual time taken to make the ice will be longer than the time calculated in part (c) (i). **2**

S857750121

[Turn over

8. A student carries out an experiment to investigate the relationship between the pressure and volume of a fixed mass of gas using the apparatus shown.



The pressure p of the gas is recorded using a pressure sensor connected to a computer. The volume V of the gas in the syringe is also recorded. The student pushes the piston to alter the volume and a series of readings is taken.

The temperature of the gas is constant during the experiment.

The results are shown.

p (kPa)	100	125	152	185	200
V (cm^3)	50	40	33	27	25
$1/V$ (cm^{-3})	0·020	0·025	0·030	0·037	0·040

(a) (i) Using the square-ruled paper on *page 23*, draw a graph of p against $1/V$.

You must start the scale on each axis from 0. **3**

(Additional square-ruled paper, if required, can be found on *page 32*.)

(ii) Explain how the graph confirms that pressure is directly proportional to 1/volume. **1**

8. (a) (continued)

8. (continued)

(b) Calculate the pressure of the gas in the syringe when its volume is $8{\cdot}0\,cm^3$. **3**

Space for working and answer

(c) Using the kinetic model, explain the increase in the pressure of the gas in the syringe as its volume decreases. **2**

(d) (i) When carrying out the experiment, the student clamped the syringe rather than holding it in their hand.

Explain why this is better experimental practice. **2**

(ii) A second student suggests that replacing the short tubing between the syringe and the pressure sensor with one of longer length would improve the experiment.

Explain why this student's suggestion is incorrect. **2**

9. A mountain climber carries a small, portable device which receives radio signals from satellites to determine the climber's position.

The device can also be used to send the climber's position to the emergency services in the event of an accident.

emergency alert button

(a) One satellite sends a radio signal that is received by the device 0·0047 s after transmission.

(i) State the speed of the radio signal. **1**

(ii) Calculate the distance between this satellite and the climber. **3**

Space for working and answer

(b) The device sends a radio signal via satellite to the emergency services.

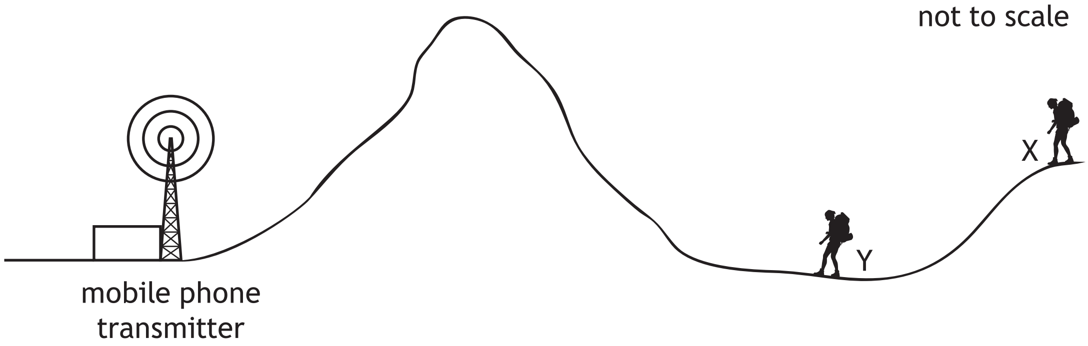
The frequency of the signal is 1620 MHz.

Calculate the wavelength of this signal. **3**

Space for working and answer

9. (continued) MARKS DO NOT WRITE IN THIS MARGIN

(c)



The climber also carries a mobile phone. The climber notices that the phone receives a signal at X but not at Y.

Explain why the phone receives a signal at X but not at Y. **2**

S857750126

MARKS DO NOT WRITE IN THIS MARGIN

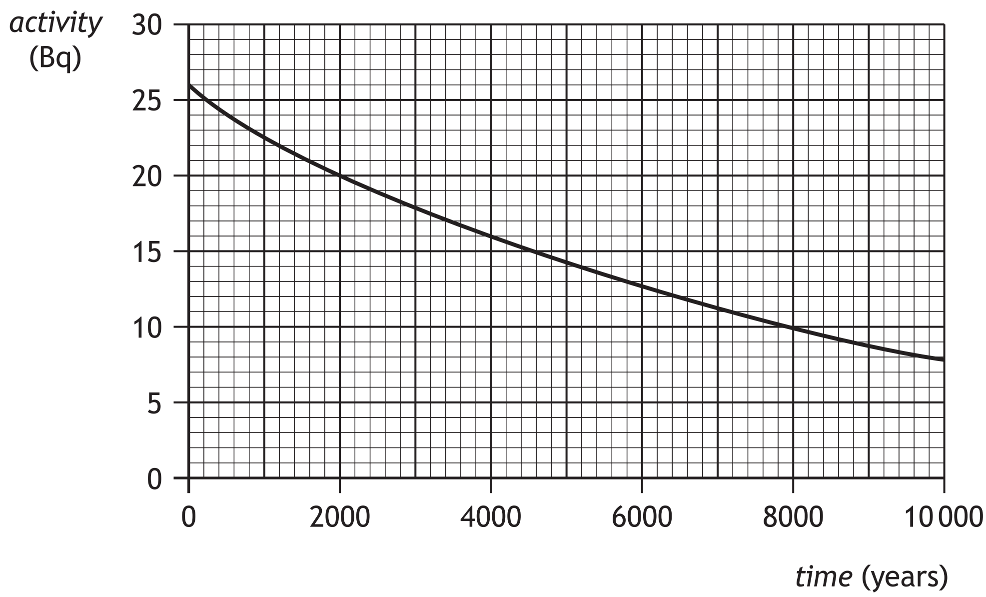
10. A physics textbook contains the following statement.

'Electromagnetic waves can be sent out like ripples on a pond.'

Using your knowledge of physics, comment on the similarities and/or differences between electromagnetic waves and the ripples on a pond. **3**

11. 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. **1**

(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

11. (a) (continued)

MARKS | DO NOT WRITE IN THIS MARGIN

(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**

MARKS | DO NOT WRITE IN THIS MARGIN

12. A worker in the radiation industry 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) 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

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

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

MARKS DO NOT WRITE IN THIS MARGIN

12. (continued)

(d) State the annual effective dose limit for the radiation worker. **1**

[END OF SPECIMEN QUESTION PAPER]

* S 8 5 7 7 5 0 1 3 2 *

MARKS DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORKING

S857750133

MARKS DO NOT WRITE IN THIS MARGIN

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORKING

Acknowledgement of Copyright

Section 1 Question 7	sandystifler/shuttertock.com
Section 2 Question 3	Article is adapted from 'Dragonfish nebula conceals giant star cluster' by David Shiga, taken from the *New Scientist Magazine*, 26 January 2011. https://www.newscientist.com/blogs/shortsharpscience/2011/01/dragonfish-nebula-conceals-gia.html. © New Scientist.
Section 2 Question 9 (c)	Backpacker silhouettes: vadimmmus/shutterstock.com

S857750134

N5 National Qualifications SPECIMEN ONLY

S857/75/11

Physics
Relationships Sheet

Date — Not applicable

Duration — 2 hours 30 minutes

S857751 1

$$d = vt$$

$$d = \bar{v}t$$

$$s = vt$$

$$s = \bar{v}t$$

$$a = \frac{v - u}{t}$$

$$F = ma$$

$$W = mg$$

$$E_w = Fd$$

$$E_p = mgh$$

$$E_k = \frac{1}{2}mv^2$$

$$Q = It$$

$$V = IR$$

$$V_2 = \left(\frac{R_2}{R_1 + R_2}\right)V_S$$

$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$

$$R_T = R_1 + R_2 + ...$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + ...$$

$$P = \frac{E}{t}$$

$$P = IV$$

$$P = I^2R$$

$$P = \frac{V^2}{R}$$

$$E_h = cm\Delta T$$

$$E_h = ml$$

$$p = \frac{F}{A}$$

$$p_1V_1 = p_2V_2$$

$$\frac{p_1}{T_1} = \frac{p_2}{T_2}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{pV}{T} = \text{constant}$$

$$f = \frac{N}{t}$$

$$v = f\lambda$$

$$T = \frac{1}{f}$$

$$A = \frac{N}{t}$$

$$D = \frac{E}{m}$$

$$H = Dw_r$$

$$\dot{H} = \frac{H}{t}$$

Additional Relationships

Circle

circumference $= 2\pi r$

area $= \pi r^2$

Sphere

area $= 4\pi r^2$

volume $= \frac{4}{3}\pi r^3$

Trigonometry

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\sin^2\theta + \cos^2\theta = 1$$

Electron Arrangements of Elements

Key

Atomic number
Symbol
Electron arrangement
Name

Transition Elements

Group 1 (1)	Group 2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	Group 3 (13)	Group 4 (14)	Group 5 (15)	Group 6 (16)	Group 7 (17)	Group 0 (18)
1 **H** 1 Hydrogen																	2 **He** 2 Helium
3 **Li** 2,1 Lithium	4 **Be** 2,2 Beryllium											5 **B** 2,3 Boron	6 **C** 2,4 Carbon	7 **N** 2,5 Nitrogen	8 **O** 2,6 Oxygen	9 **F** 2,7 Fluorine	10 **Ne** 2,8 Neon
11 **Na** 2,8,1 Sodium	12 **Mg** 2,8,2 Magnesium											13 **Al** 2,8,3 Aluminium	14 **Si** 2,8,4 Silicon	15 **P** 2,8,5 Phosphorus	16 **S** 2,8,6 Sulfur	17 **Cl** 2,8,7 Chlorine	18 **Ar** 2,8,8 Argon
19 **K** 2,8,8,1 Potassium	20 **Ca** 2,8,8,2 Calcium	21 **Sc** 2,8,9,2 Scandium	22 **Ti** 2,8,10,2 Titanium	23 **V** 2,8,11,2 Vanadium	24 **Cr** 2,8,13,1 Chromium	25 **Mn** 2,8,13,2 Manganese	26 **Fe** 2,8,14,2 Iron	27 **Co** 2,8,15,2 Cobalt	28 **Ni** 2,8,16,2 Nickel	29 **Cu** 2,8,18,1 Copper	30 **Zn** 2,8,18,2 Zinc	31 **Ga** 2,8,18,3 Gallium	32 **Ge** 2,8,18,4 Germanium	33 **As** 2,8,18,5 Arsenic	34 **Se** 2,8,18,6 Selenium	35 **Br** 2,8,18,7 Bromine	36 **Kr** 2,8,18,8 Krypton
37 **Rb** 2,8,18,8,1 Rubidium	38 **Sr** 2,8,18,8,2 Strontium	39 **Y** 2,8,18,9,2 Yttrium	40 **Zr** 2,8,18,10,2 Zirconium	41 **Nb** 2,8,18,12,1 Niobium	42 **Mo** 2,8,18,13,1 Molybdenum	43 **Tc** 2,8,18,13,2 Technetium	44 **Ru** 2,8,18,15,1 Ruthenium	45 **Rh** 2,8,18,16,1 Rhodium	46 **Pd** 2,8,18,18,0 Palladium	47 **Ag** 2,8,18,18,1 Silver	48 **Cd** 2,8,18,18,2 Cadmium	49 **In** 2,8,18,18,3 Indium	50 **Sn** 2,8,18,18,4 Tin	51 **Sb** 2,8,18,18,5 Antimony	52 **Te** 2,8,18,18,6 Tellurium	53 **I** 2,8,18,18,7 Iodine	54 **Xe** 2,8,18,18,8 Xenon
55 **Cs** 2,8,18,18,8,1 Caesium	56 **Ba** 2,8,18,18,8,2 Barium	57 **La** 2,8,18,18,9,2 Lanthanum	72 **Hf** 2,8,18,32,10,2 Hafnium	73 **Ta** 2,8,18,32,11,2 Tantalum	74 **W** 2,8,18,32,12,2 Tungsten	75 **Re** 2,8,18,32,13,2 Rhenium	76 **Os** 2,8,18,32,14,2 Osmium	77 **Ir** 2,8,18,32,15,2 Iridium	78 **Pt** 2,8,18,32,17,1 Platinum	79 **Au** 2,8,18,32,18,1 Gold	80 **Hg** 2,8,18,32,18,2 Mercury	81 **Tl** 2,8,18,32,18,3 Thallium	82 **Pb** 2,8,18,32,18,4 Lead	83 **Bi** 2,8,18,32,18,5 Bismuth	84 **Po** 2,8,18,32,18,6 Polonium	85 **At** 2,8,18,32,18,7 Astatine	86 **Rn** 2,8,18,32,18,8 Radon
87 **Fr** 2,8,18,32,18,8,1 Francium	88 **Ra** 2,8,18,32,18,8,2 Radium	89 **Ac** 2,8,18,32,18,9,2 Actinium	104 **Rf** 2,8,18,32,32,10,2 Rutherfordium	105 **Db** 2,8,18,32,32,11,2 Dubnium	106 **Sg** 2,8,18,32,32,12,2 Seaborgium	107 **Bh** 2,8,18,32,32,13,2 Bohrium	108 **Hs** 2,8,18,32,32,14,2 Hassium	109 **Mt** 2,8,18,32,32,15,2 Meitnerium	110 **Ds** 2,8,18,32,32,17,1 Darmstadtium	111 **Rg** 2,8,18,32,32,18,1 Roentgenium	112 **Cn** 2,8,18,32,32,18,2 Copernicium						

Lanthanides	57 **La** 2,8,18,18,9,2 Lanthanum	58 **Ce** 2,8,18,20,8,2 Cerium	59 **Pr** 2,8,18,21,8,2 Praseodymium	60 **Nd** 2,8,18,22,8,2 Neodymium	61 **Pm** 2,8,18,23,8,2 Promethium	62 **Sm** 2,8,18,24,8,2 Samarium	63 **Eu** 2,8,18,25,8,2 Europium	64 **Gd** 2,8,18,25,9,2 Gadolinium	65 **Tb** 2,8,18,27,8,2 Terbium	66 **Dy** 2,8,18,28,8,2 Dysprosium	67 **Ho** 2,8,18,29,8,2 Holmium	68 **Er** 2,8,18,30,8,2 Erbium	69 **Tm** 2,8,18,31,8,2 Thulium	70 **Yb** 2,8,18,32,8,2 Ytterbium	71 **Lu** 2,8,18,32,9,2 Lutetium
Actinides	89 **Ac** 2,8,18,32,18,9,2 Actinium	90 **Th** 2,8,18,32,18,10,2 Thorium	91 **Pa** 2,8,18,32,20,9,2 Protactinium	92 **U** 2,8,18,32,21,9,2 Uranium	93 **Np** 2,8,18,32,22,9,2 Neptunium	94 **Pu** 2,8,18,32,24,8,2 Plutonium	95 **Am** 2,8,18,32,25,8,2 Americium	96 **Cm** 2,8,18,32,25,9,2 Curium	97 **Bk** 2,8,18,32,27,8,2 Berkelium	98 **Cf** 2,8,18,32,28,8,2 Californium	99 **Es** 2,8,18,32,29,8,2 Einsteinium	100 **Fm** 2,8,18,32,30,8,2 Fermium	101 **Md** 2,8,18,32,31,8,2 Mendelevium	102 **No** 2,8,18,32,32,8,2 Nobelium	103 **Lr** 2,8,18,32,32,9,2 Lawrencium

N5

National
Qualifications
SPECIMEN ONLY

S857/75/01 **Physics**

Marking Instructions

These marking instructions have been provided to show how SQA would mark this specimen question paper.

General marking principles for National 5 Physics

This information is provided to help you understand the general principles you must apply when marking candidate responses to questions in this paper. These principles must be read in conjunction with the detailed marking instructions, which identify the key features required in candidate responses.

(a) Marks for each candidate response must <u>always</u> be assigned in line with these general marking principles and the detailed marking instructions for this assessment.

(b) Marking should always be positive. This means that, for each candidate response, marks are accumulated for the demonstration of relevant skills, knowledge and understanding: they are not deducted from a maximum on the basis of errors or omissions.

(c) If a specific candidate response does not seem to be covered by either the principles or detailed marking instructions, and you are uncertain how to assess it, you must seek guidance from your team leader.

(d) There are **no half marks** awarded.

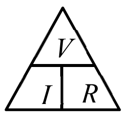
(e) Where a wrong answer to part of a question is carried forward and the wrong answer is then used correctly in the following part, give the candidate credit for the subsequent part or 'follow-on'.

(f) Award marks for non-standard symbols where the symbols are defined and the relationship is correct, or where the substitution shows that the relationship used is correct. This must be clear and unambiguous.

(g) Award full marks for a correct final answer (including units if required) on its own, unless a numerical question specifically requires evidence of working to be shown, eg in a 'show' question.

(h) Give credit where a diagram or sketch conveys correctly the response required by the question. It will usually require clear and correct labels (or the use of standard symbols).

(i) Marks are allocated for knowledge of relevant formulae alone. Do not award a mark when a candidate writes down several formulae and does not select the correct one to continue with, for example by substituting values.

(j) Do not award marks if a 'magic triangle', eg 

, is the only statement in a candidate's response. To gain the mark, the correct relationship must be stated eg $V = IR$ or $R = \frac{V}{I}$, etc.

(k) In rounding to an expected number of significant figures, award the mark for correct answers which have up to two figures more or one figure less than the number in the data with the fewest significant figures.

(Note: the use of a recurrence dot, eg $0 \cdot \dot{6}$, would imply an infinite number of significant figures and would therefore not be acceptable.)

(l) The incorrect spelling of technical terms should usually be ignored and candidates should be awarded the relevant mark, provided that answers can be interpreted and understood without any doubt as to the meaning.

Where there is ambiguity, do not award the mark. Two specific examples of this would be when the candidate uses a term:

- that might be interpreted as *reflection*, *refraction* or *diffraction*, eg 'defraction'
- that might be interpreted as either *fission* or *fusion*, eg 'fussion'

The spelling of these words is similar, but the words have totally different meanings. If the spelling (or handwriting) in an answer makes it difficult for you to interpret a candidate's intention, then do not award the mark.

(m) Marks are awarded only for a valid response to the question asked. For example, in response to questions that ask candidates to:

- **identify**, **name**, **give**, or **state**, they need only name or present in brief form.
- **describe**, they must provide a statement or structure of characteristics and/or features.
- **explain**, they must relate cause and effect and/or make relationships between things clear.
- **determine** or **calculate**, they must determine a number from given facts, figures or information.
- **estimate**, they must determine an approximate value for something.
- **justify**, they must give reasons to support their suggestions or conclusions, eg this might be by identifying an appropriate relationship and the effect of changing variables.
- **show that**, they must use physics (and mathematics) to prove something, eg a given value. All steps, including the stated answer, must be shown
- **predict**, they must suggest what may happen based on available information.
- **suggest**, they must apply their knowledge and understanding of physics to a new situation. A number of responses are acceptable: marks will be awarded for any suggestions that are supported by knowledge and understanding of physics.
- **use your knowledge of physics or aspect of physics to comment on**, they must apply their skills, knowledge and understanding to respond appropriately to the problem/situation presented, for example by making a statement of principle(s) involved and/or a relationship or equation, and applying these to respond to the problem/situation. They will gain credit for the breadth and/or depth of their conceptual understanding.

Common issues with candidate responses

When marking National 5 Physics, there are some common issues which arise when considering candidates' answers.

There is often a range of acceptable responses which would sensibly answer a particular question. However, it is often difficult to anticipate all correct or partially correct responses to questions.

The detailed marking instructions contain ideal answers, and examples of other acceptable answers which offer guidance for interpreting candidates' responses. They may also contain advice on answers which are **not** acceptable, or only attract partial marks.

Units

Do not penalise incorrect spelling of a unit in a **non-numerical** answer which requires a unit to be stated, as long as the unit can be clearly identified, eg

Q State the unit for the activity of a radioactive source.
A *Becquerels.* The answer *beckerels* is acceptable.

Do not penalise use of upper/lower case for **non-numerical** answers when the abbreviated version is given, eg DB, sV, hZ, bq.

However, for **numerical answers**, take care to ensure the unit has the correct prefix, eg for an answer t = 0·005 seconds, t = 5 ms is acceptable but t = 5 Ms is not.

Where a candidate makes multiple unit errors or conversion errors/omissions in any part of a question, penalise once only. For example, when calculating speed from distance and time, and the answer is required to be in m s^{-1}.

If d = 4 km and t = 2 minutes

$$v = \frac{d}{t} \qquad (1)$$

$$v = \frac{400}{2} \qquad (1)$$

$$v = 200 \qquad (0)$$

Although the candidate has made three unit errors, (not correctly converted distance or time and has omitted the final unit), do not award the final mark only.

Some common units often attract wrong abbreviations in answers to numerical questions. When the abbreviation can be confused with a different unit then apply a unit penalty, eg sec or secs as an abbreviation for seconds is **not** acceptable.

Common units and abbreviations	
Acceptable unit and abbreviation	*unacceptable version*
second, s	sec, secs
ampere, amp, amps, A, a	
metres per second, m/s, m s^{-1}	mps, m/s^{-1}
metres per second per second, m/s^2, m s^{-2}	m/s/s, mpsps, m/s^{-2}

Standard form
Where a candidate fails to express an answer in standard form correctly, treat it as an arithmetic error and do not award the final mark. For example:

For an answer t = 400 000 s, then t = 4×10^5 s would be correct but t = 4^5 s would be treated as an arithmetic error.

Incorrect answer carried forward
Do not apply a further penalty where a candidate carries forward an incorrect answer to part of a question, and uses that incorrect answer correctly:

- within that part of the question, eg from (a)(i) to (a)(ii)
- or to the next part of the question, eg from (a) to (b).

Similarly, if a candidate has selected the wrong value in a question which requires a data value, then award full marks in the subsequent answer for a correct response that uses **either** the candidate's wrong value **or** the correct data value. For example:

(a) State the speed of microwaves in air.
Candidate's answer: *240 m s⁻¹*. This answer would attract zero marks.

(b) Calculate the distance travelled by these microwaves in 0·34 seconds.
The candidate may use **either** the value given in part (a) **or** the correct value for the speed, and could gain full marks if correctly completed.

Where an incorrect answer may be carried forward, this is indicated in the additional guidance column of the detailed marking instructions by the comment 'or consistent with part ...'.

Standard three marker
The examples below set out how to apportion marks to answers requiring calculations. These are the 'standard three marker' type of questions.

Award full marks for a correct answer to a numerical question, even if the steps are not shown explicitly, **unless** it specifically requires evidence of working to be shown.

For some questions requiring numerical calculations, there may be alternative methods (eg alternative relationships) which would lead to a correct answer.

Sometimes, a question requires a calculation which does not fit into the 'standard three marker' type of response. In these cases, the detailed marking instructions will contain guidance for marking the question.

When marking partially correct answers, apportion individual marks as shown below.

Example of a 'standard three marker' question
The current in a resistor is 1·5 amperes when the potential difference across it is 7·5 volts.
Calculate the resistance of the resistor. (3 marks)

	Candidate answer	Mark and comment
1.	$V = IR$	1 mark: relationship
	$7{\cdot}5 = 1{\cdot}5 \times R$	1 mark: substitution
	$R = 5{\cdot}0\ \Omega$	1 mark: correct answer
2.	$5{\cdot}0\ \Omega$	3 marks: correct answer
3.	5·0	2 marks: unit missing

4. 4·0 Ω — 0 marks: no evidence, wrong answer

5. __ Ω — 0 marks: no working or final answer

6. $R = \frac{V}{I} = \frac{7 \cdot 5}{1 \cdot 5} = 4 \cdot 0\ \Omega$ — 2 marks: arithmetic error

7. $R = \frac{V}{I} = 4 \cdot 0\ \Omega$ — 1 mark: relationship only

8. $R = \frac{V}{I} = \_\_\ \Omega$ — 1 mark: relationship only

9. $R = \frac{V}{I} = \frac{7 \cdot 5}{1 \cdot 5} = \_\_\ \Omega$ — 2 marks: relationship and substitution, no final answer

10. $R = \frac{V}{I} = \frac{7 \cdot 5}{1 \cdot 5} = 4 \cdot 0$ — 2 marks: relationship and substitution, wrong answer

11. $R = \frac{V}{I} = \frac{1 \cdot 5}{7 \cdot 5} = 5 \cdot 0\ \Omega$ — 1 mark: relationship but wrong substitution

12. $R = \frac{V}{I} = \frac{75}{1 \cdot 5} = 5 \cdot 0\ \Omega$ — 1 mark: relationship but wrong substitution

13. $R = \frac{I}{V} = \frac{7 \cdot 5}{1 \cdot 5} = 5 \cdot 0\ \Omega$ — 0 marks: wrong relationship

14. $V = IR$ — 2 marks: relationship and substitution, arithmetic error
$7 \cdot 5 = 1 \cdot 5 \times R$
$R = 0 \cdot 2\ \Omega$

15. $V = IR$
$R = \frac{I}{V} = \frac{1 \cdot 5}{7 \cdot 5} = 0 \cdot 2\ \Omega$ — 1 mark: relationship only, wrong rearrangement of symbols

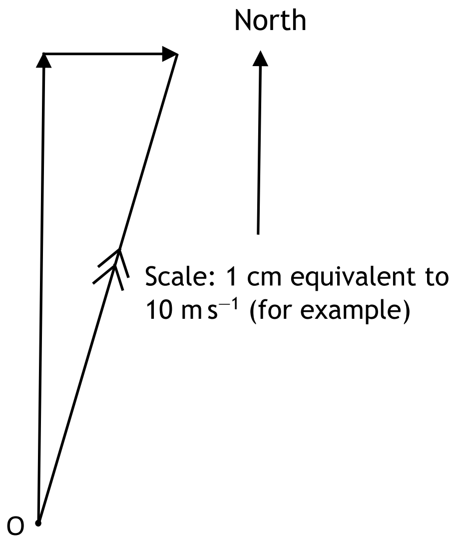
Marking instructions for each question

Section 1

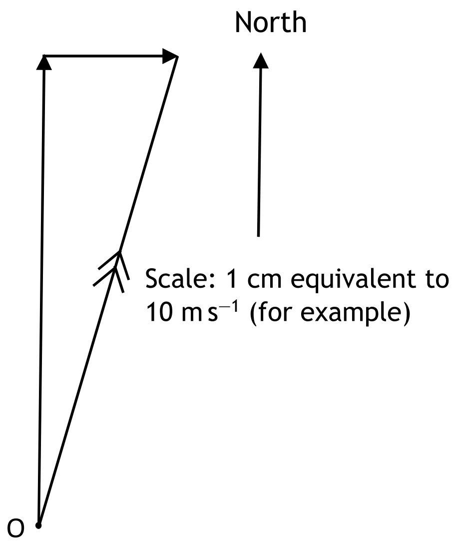
Question	Answer	Max mark
1.	D	1
2.	A	1
3.	B	1
4.	A	1
5.	C	1
6.	C	1
7.	D	1
8.	D	1
9.	B	1
10.	A	1
11.	C	1
12.	D	1
13.	B	1
14.	C	1
15.	B	1
16.	C	1
17.	A	1
18.	B	1
19.	A	1
20.	A	1
21.	E	1
22.	A	1
23.	E	1
24.	B	1
25.	E	1

Section 2

Question			Expected response	Max mark	Additional guidance
1.	(a)		$a = \dfrac{v-u}{t}$ 1 $a = \dfrac{55-5}{40}$ 1 $a = 1 \cdot 25\ \text{m s}^{-2}$ 1	**3**	Accept 1·3, 1·250, 1·2500 Accept $a =$ gradient and substitution of data points from appropriate line
	(b)	(i)	Scale diagram v=155±3 m s^{-1}	**2**	Pythagoras $v = \sqrt{150^2 + 40^2}$ 1 $v = 155\ \text{m s}^{-1}$ 1 Accept 150, 155·2, 155·24



Question			Expected response	Max mark	Additional guidance
		(ii)	Scale diagram θ=15±2°	**2**	Trigonometry $\tan\theta = \dfrac{40}{150}$ 1 $\theta = 15°$ 1 Accept 10, 14·9, 14·93 Bearing 015 15° E of N



Question			Expected response	Max mark	Additional guidance
1.	(c)	(i)	$s =$ area under $v - t$ graph 1 $s = (10\times70) + (60\times5) + \frac{1}{2}(60\times45)$ 1 $s = 2350$ (m) 1 Runways X,Y and Z could have been used 1	4	
		(ii)	Aircraft has increased mass 1 so has reduced deceleration 1 OR Aircraft has increased kinetic energy 1 $E_w = Fd$ (so if F is constant d is greater) 1	2	

Question			Expected response		Max mark	Additional guidance
2.	(a)		$m = 1300 + 2950 + 2900$	1	4	
			$F = ma$	1		
			$1430 = (1300 + 2950 + 2900) \times a$	1		
			$a = 0 \cdot 2\ \text{m s}^{-2}$	1		
	(b)		Force of friction is created on the surface of the modules	1	2	
			causes heat to be produced	1		
	(c)	(i)	Upward force is increased (by parachutes)	1	2	
			producing an unbalanced force upwards	1		
		(ii)	$E_w = Fd$	1	3	Accept 20 000, 16 000·0, 16 000·00
			$80\,000 = F \times 5$	1		
			$F = 16\,000\ \text{N}$	1		
	(d)	(i)	$T = \dfrac{2\pi R}{v}$		3	1 mark for substitution of radius plus altitude Accept 5000, 5490, 5492
			$T = \dfrac{2 \times \pi \times (6 \cdot 4 \times 10^6 + 3 \cdot 30 \times 10^5)}{7 \cdot 7 \times 10^3}$	1,1		
			$T = 5500\ \text{s}$	1		
		(ii)	(Orbital period will be) greater		1	
		(iii)	The horizontal velocity of the ISS is large enough to ensure that it does not get closer to the Earth's surface (or equivalent statement)	1	2	
			The weight of the ISS is large enough to ensure that it does not move further away from the Earth's surface (or equivalent statement)	1		

Question			Expected response	Max mark	Additional guidance
3.	(a)		Milky Way	**1**	
	(b)		$d = vt$ 1 $d = 30000 \times 3 \times 10^8 \times (365 \cdot 25 \times 24 \times 60 \times 60)$ 1,1 $d = 2 \cdot 8 \times 10^{20}$ m	**3**	**'Show' question** Accept 365, 365·24 If final answer not stated max 2 marks.
	(c)		(Microwave radiation has a) smaller (frequency than infra-red radiation)	**1**	
	(d)		Hydrogen 1 Helium 1	**2**	

Question			Expected response	Max mark	Additional guidance
4.			Demonstrates no understanding 0 marks Demonstrates limited understanding 1 mark Demonstrates reasonable understanding 2 marks Demonstrates good understanding 3 marks This is an open-ended question. **1 mark:** The candidate has demonstrated a limited understanding of the physics involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the physics within the problem is understood. **2 marks**: The candidate has demonstrated a reasonable understanding of the physics involved. The candidate makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **3 marks:** Award the maximum available mark to a candidate who has demonstrated a good understanding of the physics involved. The candidate shows a good comprehension of the physics of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an 'excellent' answer or a 'complete' one.	**3**	Open-ended question: a variety of physics arguments can be used to answer this question. Marks are awarded on the basis of whether the answer overall demonstrates 'no', 'limited', 'reasonable' or 'good' understanding.

Question			Expected response		Max mark	Additional guidance
5.	(a)	(i)	$R_T = 75\ \Omega$		**1**	
		(ii)	$V = IR$	1	**3**	Or consistent with (a)(i)
			$15 = I \times 75$	1		Accept 0·2, 0·200, 0·2000
			$I = 0 \cdot 20$ A	1		
		(iii)	$P = I^2 R$	1	**3**	Or consistent with (a)(ii)
			$P = 0 \cdot 20^2 \times 15$	1		Accept 0·6, 0·600, 0·6000
			$P = 0 \cdot 60$ W	1		
	(b)		(The power dissipated is) greater (than that in (a)(iii))	1	**3**	**'Must justify' question**
			The total resistance of the circuit is now less	1		
			The current in the circuit is now greater	1		

Question			Expected response	Max mark	Additional guidance
6.	(a)	(i)	Light level increases, LDR resistance decreases 1 LDR resistance decreases, voltage across R increases 1 Voltage across R increases, MOSFET switches the motor on 1	**3**	
		(ii)	The variable resistor controls the light level at which the motor operates the blind	**1**	
	(b)	(i)	3000±250 Ω	**1**	
		(ii)	$V_2 = \left(\frac{R_2}{R_1 + R_2}\right)V_s$ 1 $V_2 = \left(\frac{600}{600 + 3000}\right) \times 12$ 1 $V_2 = 2 \cdot 0\ \text{V}$ 1	**3**	Or consistent with (b)(i) Accept 2, 2·00, 2·000
		(iii)	The blinds will not close 1 The voltage across R is insufficient to switch the MOSFET on 1	**2**	

Question			Expected response	Max mark	Additional guidance
7.	(a)		$E_h = cm\Delta T$ 1 $E_h = 4180 \times 0{\cdot}100 \times (15{\cdot}0 - 0)$ 1 $E_h = 6270$ J	**2**	**'Show' question**
	(b)		$E_h = ml$ 1 $E_h = 0{\cdot}100 \times 3{\cdot}34 \times 10^5$ 1 $E_h = 3{\cdot}34 \times 10^4$ J 1	**3**	Accept 3·3, 3·340, 3·3400
	(c)	(i)	$E_h = 6270 + 3{\cdot}34 \times 10^4$ (J) 1 $P = \frac{E_h}{t}$ 1 $115 = \frac{(6270 + 3{\cdot}34 \times 10^4)}{t}$ 1 $t = 345$ s 1	**4**	Or consistent with (b) Accept 340, 345·0, 345·00
		(ii)	Heat will be taken in from the surroundings 1 so the system will have additional heat to remove 1	**2**	

Question			Expected response		Max mark	Additional guidance
8.	(a)	(i)	Axes labelled with units	1	3	
			Axes scaled linearly	1		
			Data points accurately plotted with line of best fit	1		
		(ii)	The line of best fit is a straight line which passes through the origin		1	
	(b)		$p_1V_1 = p_2V_2$	1	3	Accept 600, 625, 625·0 Accept any given data points or points selected from graph
			$125 \times 40 = p_2 \times 8 \cdot 0$	1		
			$p_2 = 630\ \text{kPa}$	1		
	(c)		As volume decreases, the particles of gas will strike the piston of the syringe more often	1	2	
			Since $P = \dfrac{F}{A}$, this results in an increased pressure	1		
	(d)	(i)	Using a clamp will prevent heat from the student's hand increasing the temperature of the gas in the syringe	1	2	Or equivalent statements
			If the temperature of the gas in the syringe is not constant, the experiment would not be valid	1		
		(ii)	The suggestion is incorrect because the volume of air in the tubing is not being read from the scale on the syringe	1	2	Or equivalent statements
			A longer length of tubing would increase the (systematic) uncertainty in the experiment	1		

Question			Expected response	Max mark	Additional guidance
9.	(a)	(i)	$3 \cdot 00 \times 10^8 \text{ m s}^{-1}$	**1**	Accept 3, 3·0
		(ii)	$d = vt$ 1 $d = 3 \cdot 00 \times 10^8 \times 0 \cdot 0047$ 1 $d = 1 \cdot 4 \times 10^6$ m 1	**3**	Or consistent with (a)(i) Accept 1, 1·41, 1·410
	(b)		$v = f\lambda$ 1 $3 \cdot 00 \times 10^8 = 1620 \times 10^6 \times \lambda$ 1 $\lambda = 0 \cdot 185$ m 1	**3**	Or consistent with (a)(i) Accept 0·19, 0·1852, 0·18519
	(c)		The waves from the transmitter will diffract over the hill to reach X 1 but will not diffract enough to reach Y 1	**2**	

Question			Expected response	Max mark	Additional guidance
10.			Demonstrates no understanding 0 marks Demonstrates limited understanding 1 mark Demonstrates reasonable understanding 2 marks Demonstrates good understanding 3 marks This is an open-ended question. **1 mark:** The candidate has demonstrated a limited understanding of the physics involved. The candidate has made some statement(s) which is/are relevant to the situation, showing that at least a little of the physics within the problem is understood. **2 marks**: The candidate has demonstrated a reasonable understanding of the physics involved. The candidate makes some statement(s) which is/are relevant to the situation, showing that the problem is understood. **3 marks:** Award the maximum available mark to a candidate who has demonstrated a good understanding of the physics involved. The candidate shows a good comprehension of the physics of the situation and has provided a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. This does not mean the answer has to be what might be termed an 'excellent' answer or a 'complete' one.	**3**	Open-ended question: a variety of physics arguments can be used to answer this question. Marks are awarded on the basis of whether the answer overall demonstrates 'no', 'limited', 'reasonable' or 'good' understanding.

Question			Expected response	Max mark	Additional guidance
11.	(a)	(i)	5800±100 years	**1**	
		(ii)	$26 \rightarrow 13 \rightarrow 6\cdot5$ Number of half-lives $= 2$ 1 $t = 2 \times 5800$ 1 $t = 10\,600$ years 1	**3**	Or consistent with (a)(i)
		(iii)	$\frac{125}{25} = 5$ 1 Activity per 25 g $= \frac{40}{5} = 8$ (Bq) 1 From graph, age = 9700±100 years 1	**3**	
	(b)		The activity (of a sample from the tree) would not have reduced significantly/ measurably in 100 years	**1**	

Question			Expected response	Max mark	Additional guidance
12.	(a)		High frequency (or short wavelength) electromagnetic radiation	**1**	
	(b)		$D = \frac{E}{m}$ 1 $50 \times 10^{-6} = \frac{E}{0 \cdot 10}$ 1 $E = 5 \cdot 0 \times 10^{-6}$ J 1	**3**	Accept 5, 5·00, 5·000
	(c)		Lead can absorb (some of) the gamma rays	**1**	
	(d)		20 mSv	**1**	

[END OF SPECIMEN MARKING INSTRUCTIONS]