N5 National Qualifications 2018

X857/75/02

Physics
Section 1 — Questions

TUESDAY, 8 MAY

1:00 PM – 3:30 PM

Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet X857/75/01.

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 X857/75/11.

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.

X8577502

A/HTP

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 is a scalar quantity?

A velocity

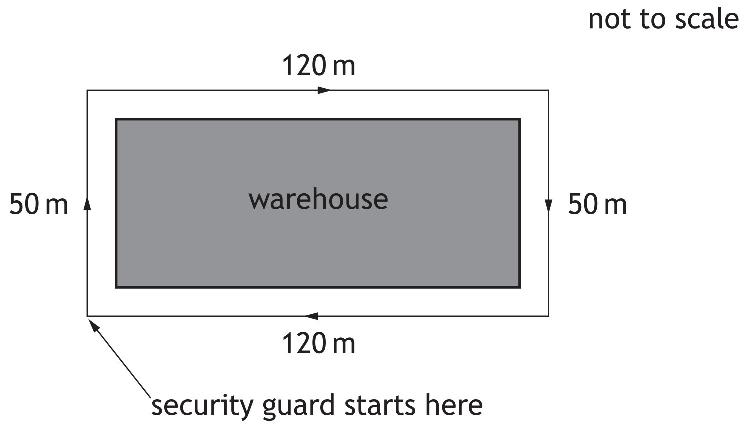
B displacement

C acceleration

D force

E speed

2. A security guard starts at the corner of a warehouse, walks round the warehouse as shown and arrives back at the same corner.



Which row in the table shows the total distance walked by the security guard and the magnitude of the displacement of the security guard from the start to the end of the walk?

	Total distance (m)	*Displacement* (m)
A	0	0
B	0	340
C	170	130
D	340	0
E	340	340

[Turn over

3. A ball is thrown vertically upwards. The ball reaches its maximum height.

Which of the following describes the forces acting on the ball at this instant?

A There is no vertical force acting on the ball.

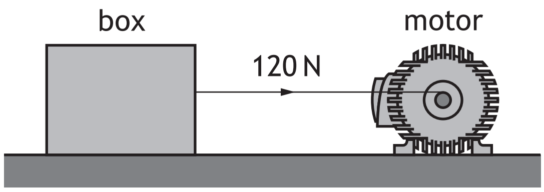
B There is only a horizontal force acting on the ball.

C There is an upward force acting on the ball.

D The forces acting on the ball are balanced.

E There is only a downward force acting on the ball.

4. A motor is used to apply a force of 120 N to a box of mass 30 kg.



The box moves at a constant speed across a horizontal surface.

The box moves a distance of 25 m in a time of 5·0 s.

Which row in the table shows the work done on the box and the minimum output power of the motor?

	Work done (J)	*Minimum output power* (W)
A	600	120
B	600	3000
C	3000	600
D	3000	15 000
E	3600	720

5. A galaxy is a collection of

A stars

B satellites

C moons

D planets

E asteroids.

6. The communications satellite Iridium-124 has a period of 97 minutes and an orbital height of 630 km.

The geostationary satellite Astra-5B has a period of 1440 minutes and an orbital height of 36 000 km.

A satellite with an orbital height of 23 000 km has a period of

A 62 minutes

B 97 minutes

C 835 minutes

D 1440 minutes

E 2250 minutes.

7. Far out in space, the rocket engine of a space probe is switched on for a short time causing it to accelerate.

When the engine is then switched off, the probe will

A slow down until it stops

B follow a curved path

C continue to accelerate

D move at a constant speed

E change direction.

8. A spacecraft lands on a distant planet.

The gravitational field strength on this planet is $14\,N\,kg^{-1}$.

Which row in the table shows how the mass and weight of the spacecraft on this planet compares with the mass and weight of the spacecraft on Earth?

	Mass on planet	*Weight on planet*
A	same as on Earth	greater than on Earth
B	greater than on Earth	greater than on Earth
C	same as on Earth	same as on Earth
D	greater than on Earth	same as on Earth
E	same as on Earth	less than on Earth

[Turn over

9. The distance from the Sun to the star Sirius is 8·6 light years.

This distance is equivalent to

A $2{\cdot}2 \times 10^{14}$ m

B $1{\cdot}4 \times 10^{15}$ m

C $3{\cdot}4 \times 10^{15}$ m

D $8{\cdot}1 \times 10^{16}$ m

E $9{\cdot}5 \times 10^{16}$ m.

10. Light from a star is split into a line spectrum of different colours.

The line spectrum from the star is shown, along with the line spectra of the elements X, Y and Z.

The elements present in this star are

A X only

B Y only

C X and Y only

D X and Z only

E X, Y and Z.

11. A student makes the following statements about a.c. and d.c. circuits.

I In an a.c. circuit the direction of the current changes regularly.

II In a d.c. circuit negative charges flow in one direction only.

III In an a.c. circuit the size of the current varies with time.

Which of these statements is/are correct?

A I only

B II only

C I and II only

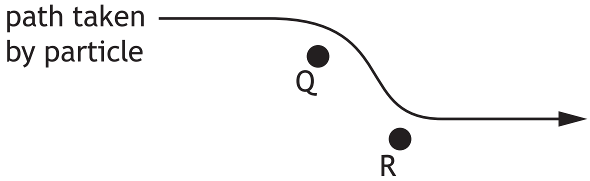
D I and III only

E I, II and III

12. An electric field exists around two point charges Q and R.

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

The motion of the particle is as shown.

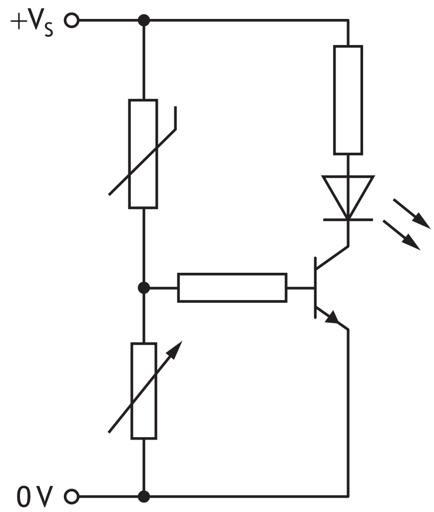


Which row in the table identifies the charge on the particle, the charge on Q and the charge on R?

	Charge on particle	*Charge on Q*	*Charge on R*
A	positive	negative	negative
B	negative	negative	negative
C	negative	positive	positive
D	positive	negative	positive
E	positive	positive	negative

[Turn over

13. A transistor switching circuit is set up as shown.



The variable resistor is adjusted until the LED switches off.

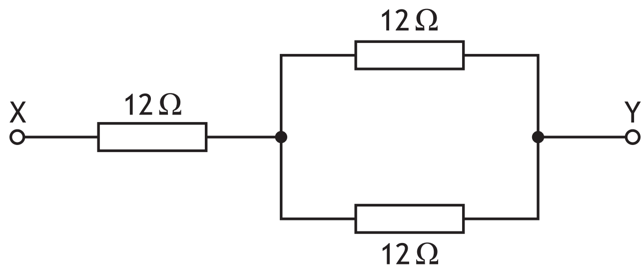
The temperature of the thermistor is now increased.

The resistance of the thermistor decreases as the temperature increases.

Which row in the table describes the effect of this change on the voltage across the thermistor, the voltage across the variable resistor, and whether the LED stays off or switches on?

	Voltage across the thermistor	*Voltage across the variable resistor*	*LED*
A	decreases	increases	switches on
B	decreases	decreases	switches on
C	decreases	decreases	stays off
D	increases	decreases	stays off
E	increases	increases	switches on

14. Three resistors are connected as shown.



The resistance between X and Y is

A 4 Ω

B 6 Ω

C 18 Ω

D 24 Ω

E 36 Ω.

15. The filament of a lamp has a resistance of 4·0 Ω.

The lamp is connected to a 12 V supply.

The power developed by the lamp is

A 3 W

B 36 W

C 48 W

D 96 W

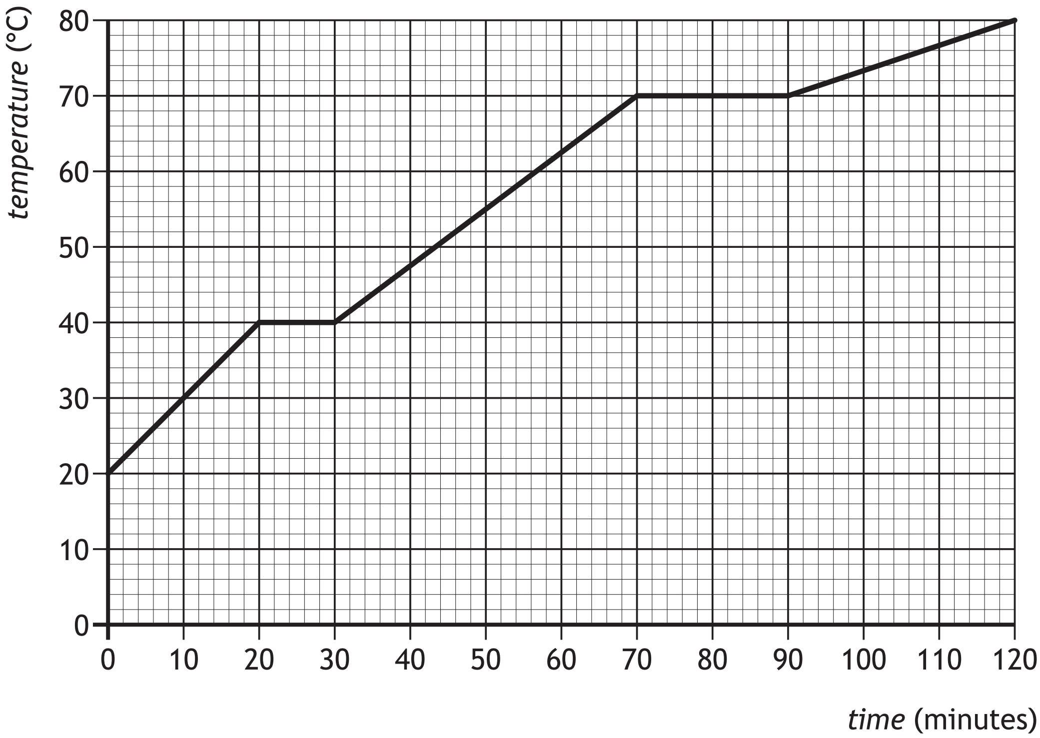
E 576 W.

[Turn over

16. A block of wax is initially in the solid state.

The block of wax is then heated.

The graph shows how the temperature of the wax changes with time.



The melting point of the wax is

A 0 °C

B 20 °C

C 40 °C

D 70 °C

E 80 °C.

17. The pressure of the air outside an aircraft is $0{\cdot}40 \times 10^5$ Pa.

The air pressure inside the aircraft cabin is $1{\cdot}0 \times 10^5$ Pa.

The area of an external cabin door is $2{\cdot}0\,m^2$.

The outward force on the door due to the pressure difference is

A $0{\cdot}30 \times 10^5$ N

B $0{\cdot}70 \times 10^5$ N

C $1{\cdot}2 \times 10^5$ N

D $2{\cdot}0 \times 10^5$ N

E $2{\cdot}8 \times 10^5$ N.

18. A solid at a temperature of −20 °C is heated until it becomes a liquid at 70 °C.

The temperature change in kelvin is

A 50 K

B 90 K

C 343 K

D 363 K

E 596 K.

19. A sealed bicycle pump contains $4 \cdot 0 \times 10^{-5}$ m^3 of air at a pressure of $1 \cdot 2 \times 10^5$ Pa.

The piston of the pump is pushed in until the volume of air in the pump is reduced to $0 \cdot 80 \times 10^{-5}$ m^3.

During this time the temperature of the air in the pump remains constant.

The pressure of the air in the pump is now

A $2 \cdot 4 \times 10^4$ Pa

B $1 \cdot 2 \times 10^5$ Pa

C $1 \cdot 5 \times 10^5$ Pa

D $4 \cdot 4 \times 10^5$ Pa

E $6 \cdot 0 \times 10^5$ Pa.

20. A student makes the following statements about diffraction.

I Diffraction occurs when waves pass from one medium into another.

II Waves with a longer wavelength diffract more than waves with a shorter wavelength.

III Microwaves diffract more than radio waves.

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

[Turn over

21. The diagram shows part of the electromagnetic spectrum arranged in order of increasing wavelength.

increasing wavelength →

gamma rays	R	ultraviolet	visible light

Which row in the table identifies radiation R and describes its frequency?

	Radiation R	*Frequency of radiation R*
A	X-rays	higher frequency than visible light
B	microwaves	lower frequency than visible light
C	X-rays	lower frequency than visible light
D	infrared	lower frequency than visible light
E	microwaves	higher frequency than visible light

22. The energy of a water wave can be calculated using

$$E = \frac{\rho g A^2}{2}$$

where: E is the energy of the wave in J

ρ is the density of the water in kg m^{-3}

g is the gravitational field strength in N kg^{-1}

A is the amplitude of the wave in m.

A wave out at sea has an amplitude of 3·5 m.

The density of the sea water is $1{\cdot}02 \times 10^3$ kg m^{-3}.

The energy of the wave is

A $6{\cdot}2 \times 10^3$ J

B $1{\cdot}7 \times 10^4$ J

C $6{\cdot}1 \times 10^4$ J

D $1{\cdot}2 \times 10^5$ J

E $6{\cdot}1 \times 10^8$ J.

23. A sample of tissue receives an equivalent dose rate of $0{\cdot}40\,\text{mSv}\,\text{h}^{-1}$ from a source of alpha radiation.

The equivalent dose received by the sample in 30 minutes is

A 0·20 mSv

B 0·80 mSv

C 4·0 mSv

D 12 mSv

E 720 mSv.

24. A radioactive source has an initial activity of 200 kBq. After 12 days the activity of the source is 25 kBq.

The half-life of the source is

A 3 days

B 4 days

C 8 days

D 36 days

E 48 days.

25. In the following passage some words have been replaced by the letters *X*, *Y* and *Z*.

During a nuclear ...X... reaction two nuclei of smaller mass number combine to produce a nucleus of larger mass number. These reactions take place at very ...Y... temperatures and are important because they can release ...Z...

Which row in the table shows the missing words?

	X	*Y*	*Z*
A	fusion	low	electrons
B	fusion	high	energy
C	fission	high	protons
D	fission	low	energy
E	fusion	high	electrons

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

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National Qualifications 2018

Mark

X857/75/01

Physics
Section 1 — Answer Grid and Section 2

TUESDAY, 8 MAY

1:00 PM – 3:30 PM

X8577501

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 X857/75/02 and to the Relationships Sheet X857/75/11.

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 X857/75/02.

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

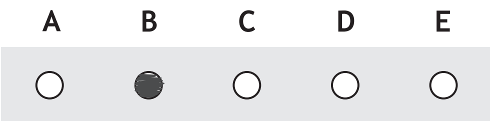
B kilowatt-hour

C watt

D coulomb

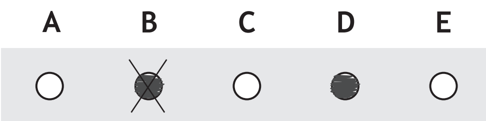
E volt.

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

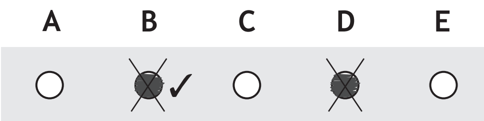


Changing an answer

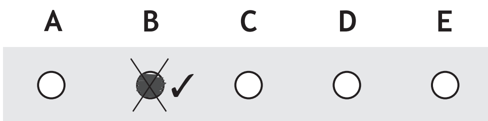
If you decide to change your answer, cancel your first answer by putting a cross through it (see below) and fill in the answer you want. The answer below has been changed to **D**.



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



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You must record your answers to Section 1 questions on the answer grid on **Page 03** of your **answer booklet.**

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X857750104

[Turn over for SECTION 2

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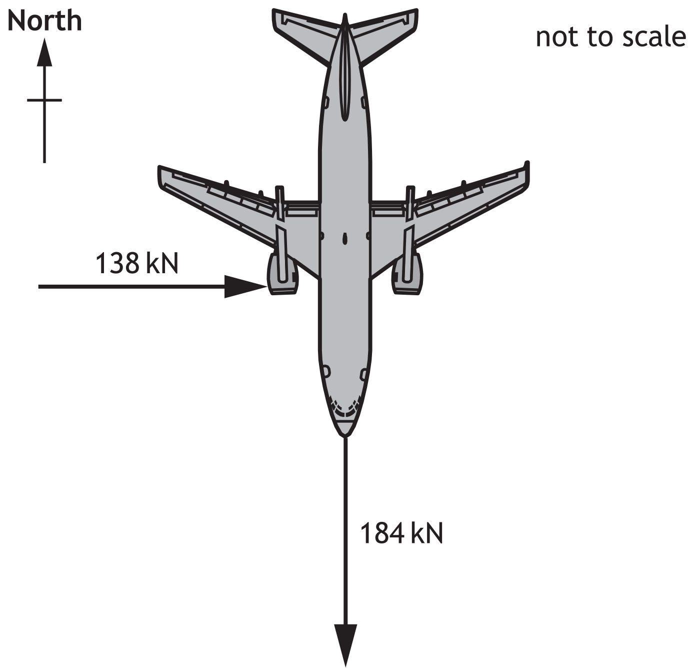
SECTION 2 — 110 marks

Attempt ALL questions

1. A passenger aircraft is flying horizontally.

(a) At one point during the flight the aircraft engines produce an unbalanced force of 184 kN due south (180).

At this point the aircraft also experiences a crosswind. The force of the crosswind on the aircraft is 138 kN due east (090).



1. (a) (continued)

MARKS DO NOT WRITE IN THIS MARGIN

(i) By scale diagram, or otherwise, determine:

(A) the magnitude of the resultant force acting on the aircraft; **2**

Space for working and answer

(B) the direction of the resultant force acting on the aircraft. **2**

Space for working and answer

[Turn over

* X 8 5 7 7 5 0 1 0 7 *

1. (a) (continued)

MARKS | DO NOT WRITE IN THIS MARGIN

(ii) The mass of the aircraft is $6{\cdot}8 \times 10^4$ kg.

Calculate the magnitude of the acceleration of the aircraft at this point. **3**

Space for working and answer

(b) During the flight the aircraft uses fuel.

Explain why the pressure exerted by the tyres of the aircraft on the runway after the flight is less than the pressure exerted by the tyres on the runway before the flight. **2**

[Turn over for next question

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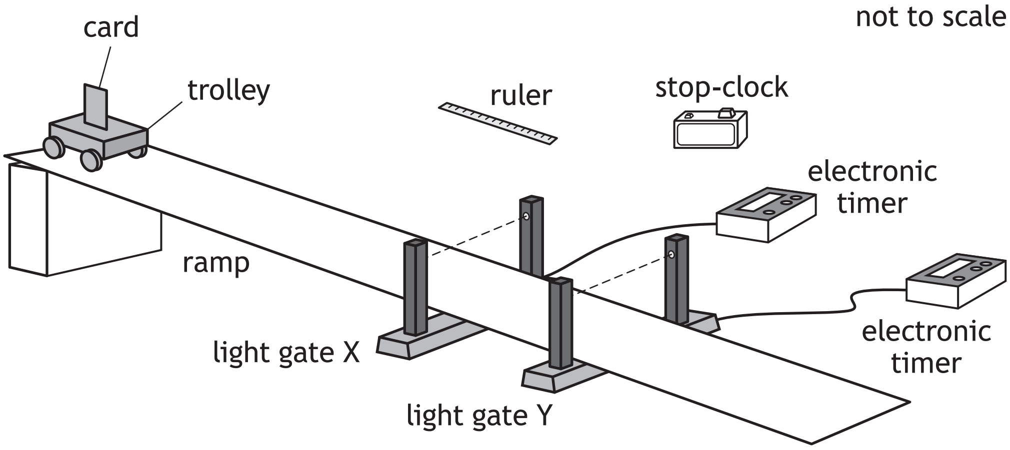
MARKS | DO NOT WRITE IN THIS MARGIN

2. Two students are investigating the acceleration of a trolley down a ramp.

(a) The first student uses the apparatus shown to determine the acceleration of the trolley.



Some of the measurements made by the student are shown.

Time for the card to pass through light gate Y	0·098 s
Distance between light gate X and light gate Y	0·22 m
Length of the card	0·045 m
Time for trolley to pass between light gate X and light gate Y	0·56 s

The student determines the instantaneous speed of the trolley at light gate X to be $0{\cdot}32\,\mathrm{m\,s^{-1}}$.

(i) State the **additional** measurement made by the student to determine the instantaneous speed of the trolley at light gate X. 1

2. (a) (continued)

MARKS | DO NOT WRITE IN THIS MARGIN

(ii) Show that the instantaneous speed of the trolley at light gate Y is $0{\cdot}46\ \mathrm{m\,s^{-1}}$. **2**

Space for working and answer

(iii) Determine the acceleration of the trolley down the ramp. **3**

Space for working and answer

[Turn over

* X 8 5 7 7 5 0 1 1 1 *

2. **(continued)**

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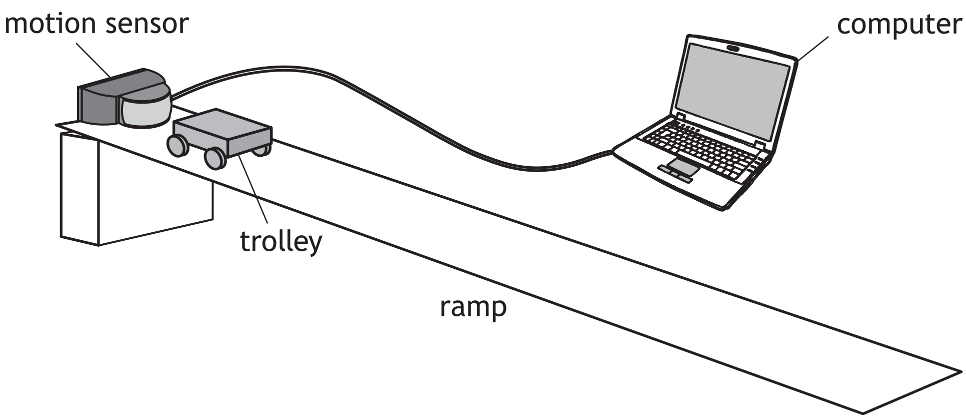
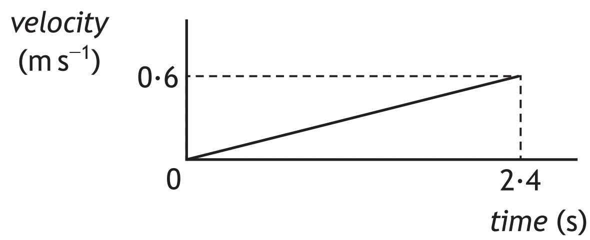
(b) The second student uses a motion sensor and a computer to determine the acceleration of the trolley.



The student releases the trolley. The computer displays the velocity-time graph for the motion of the trolley as it rolls down the ramp, as shown.

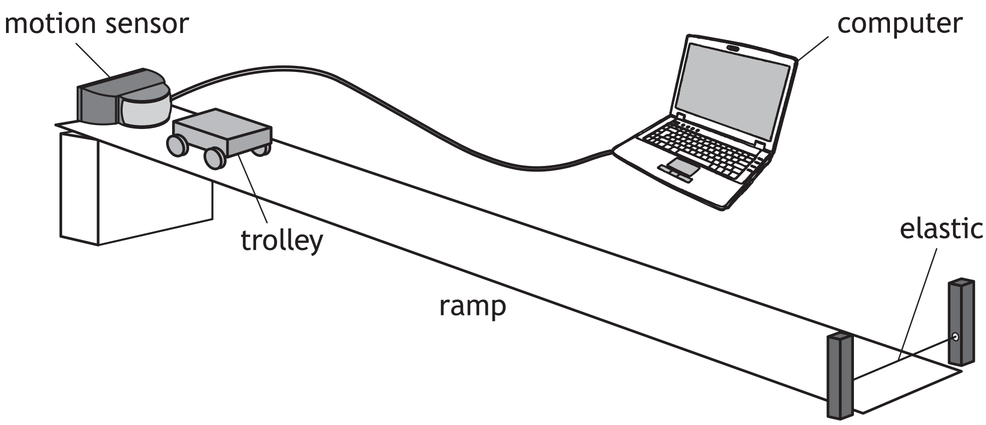


Determine the distance travelled by the trolley in the first 2·4 s after its release. **3**

Space for working and answer

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

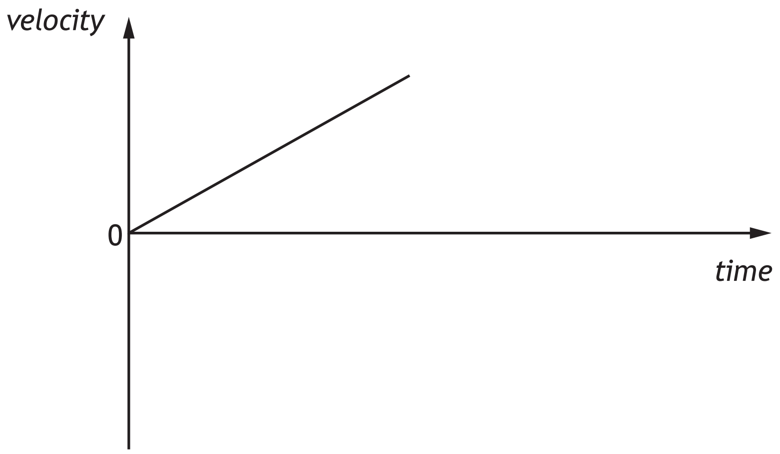
(c) In a further experiment the second student places a piece of elastic across the bottom of the ramp as shown.



The student again releases the trolley. The trolley rolls down the ramp and rebounds from the elastic to move back up the ramp.

Using the axes provided, complete the velocity-time graph for the motion of the trolley from the moment it contacts the elastic, until it reaches its maximum height back up the ramp. **2**

Numerical values are not required on either axis.

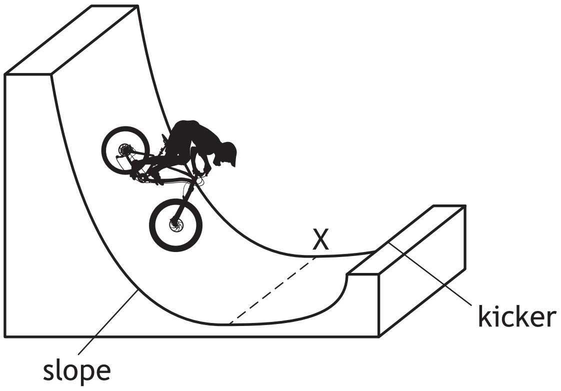


(An additional diagram, if required, can be found on *page 43*.)

[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

3. During a BMX competition, a cyclist freewheels down a slope and up a 'kicker' to complete a vertical jump.



The cyclist and bike have a combined mass of 75 kg.

At point X the cyclist and bike have a speed of $8{\cdot}0\,\mathrm{m\,s^{-1}}$.

(a) Calculate the kinetic energy of the cyclist and bike at point X. **3**

Space for working and answer

(b) (i) Calculate the maximum height of the jump above point X. **3**

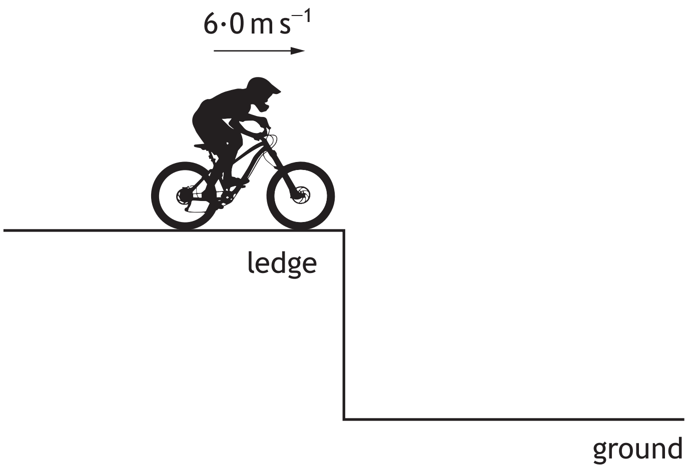
Space for working and answer

(ii) Explain why the actual height of the jump above point X would be less than the height calculated in (b) (i). **1**

* X 8 5 7 7 5 0 1 1 4 *

MARKS | DO NOT WRITE IN THIS MARGIN

(c) During another part of the competition, the cyclist and bike travel horizontally at $6{\cdot}0\,m\,s^{-1}$ off a ledge as shown.



(i) On the diagram above, sketch the path taken by the cyclist and bike between leaving the ledge and reaching the ground. **1**

(An additional diagram, if required, can be found on *page 43*.)

(ii) The cyclist and bike reach the ground $0{\cdot}40\,s$ after leaving the ledge.

Calculate the vertical velocity of the cyclist and bike as they reach the ground.

The effects of air resistance can be ignored. **3**

Space for working and answer

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

4. Within our solar system distances are often measured in astronomical units (AU).

$1\ \text{AU} = 1{\cdot}50 \times 10^{11}\ \text{m}$.

Mars orbits the Sun at an average distance of 1·52 AU.

(a) (i) Determine the average distance, in metres, at which Mars orbits the Sun. **1**

Space for working and answer

(ii) Calculate the average time for light from the Sun to reach Mars. **3**

Space for working and answer

4. **(continued)**

MARKS DO NOT WRITE IN THIS MARGIN

(b) In the future it is hoped that humans will be able to travel to Mars. One challenge of space travel to Mars is maintaining sufficient energy to operate life support systems.

(i) Suggest one solution to this challenge. **1**

(ii) State another challenge of space travel to Mars. **1**

[Turn over

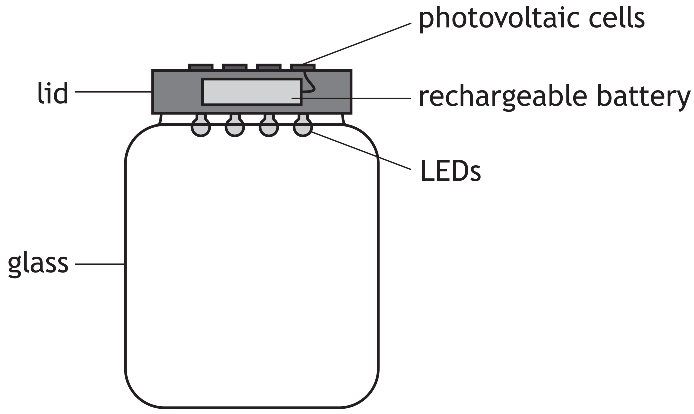
5. A group of students are watching a video clip of astronauts on board the International Space Station (ISS) as it orbits the Earth.

One student states, 'I would love to be weightless and float like the astronauts do on the ISS.'

Using your knowledge of physics, comment on the statement made by the student. **3**

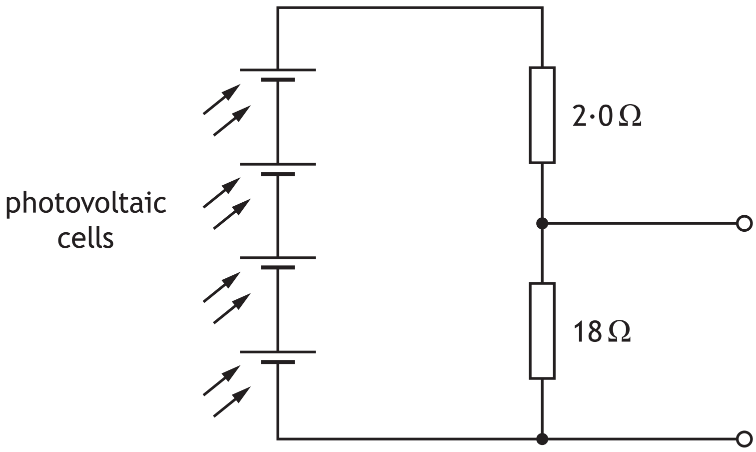
6. A solar jar is designed to collect energy from the Sun during the day and release this energy as light at night.

When the solar jar is placed in sunlight, photovoltaic cells on the lid are used to charge a rechargeable battery.



At night, the rechargeable battery is used to power four identical LEDs.

(a) Part of the circuit in the solar jar is shown.



In direct sunlight the photovoltaic cells produce a combined voltage of 4·0 V.

Calculate the voltage across the 18 Ω resistor. **3**

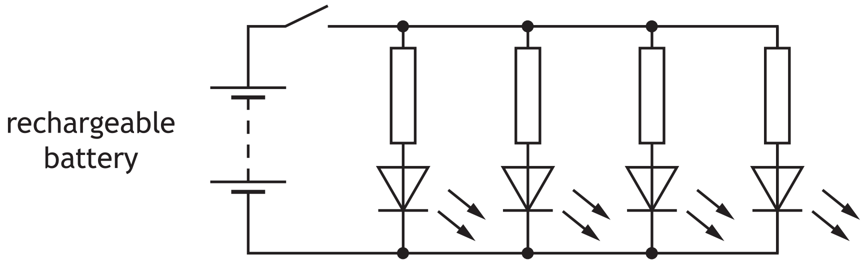
Space for working and answer

[Turn over

6. (continued)

MARKS DO NOT WRITE IN THIS MARGIN

(b) Another part of the circuit containing the LEDs is shown.



The switch is now closed and the LEDs light.

(i) State the purpose of the resistor connected in series with each LED. **1**

(ii) After a few hours the rechargeable battery produces a voltage of 3·4 V.

At this point in time the voltage across each LED is 1·6 V and the current in each LED is 25 mA.

Determine the value of the resistor in series with each LED. **4**

Space for working and answer

6. **(continued)**

MARKS | DO NOT WRITE IN THIS MARGIN

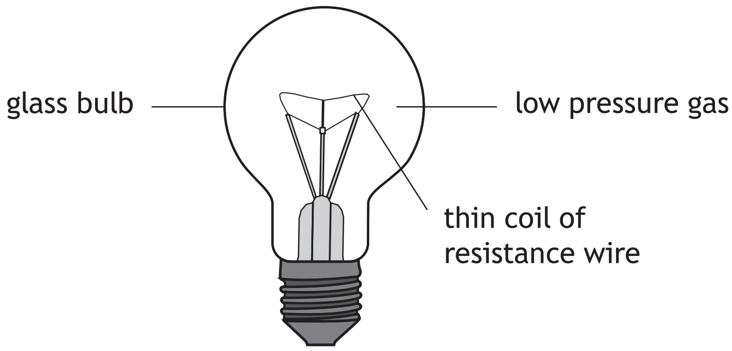
(c) When the battery is completely discharged it then takes 6·0 hours of direct sunlight to fully charge the battery. During this time, there is a constant current of 0·135 A to the battery.

Calculate the total charge supplied to the battery during this time. **3**

Space for working and answer

[Turn over

7. A filament lamp consists of a thin coil of resistance wire surrounded by a low pressure gas, enclosed in a glass bulb.



Using your knowledge of physics, comment on the suitability of this design as a light source. **3**

[Turn over for next question

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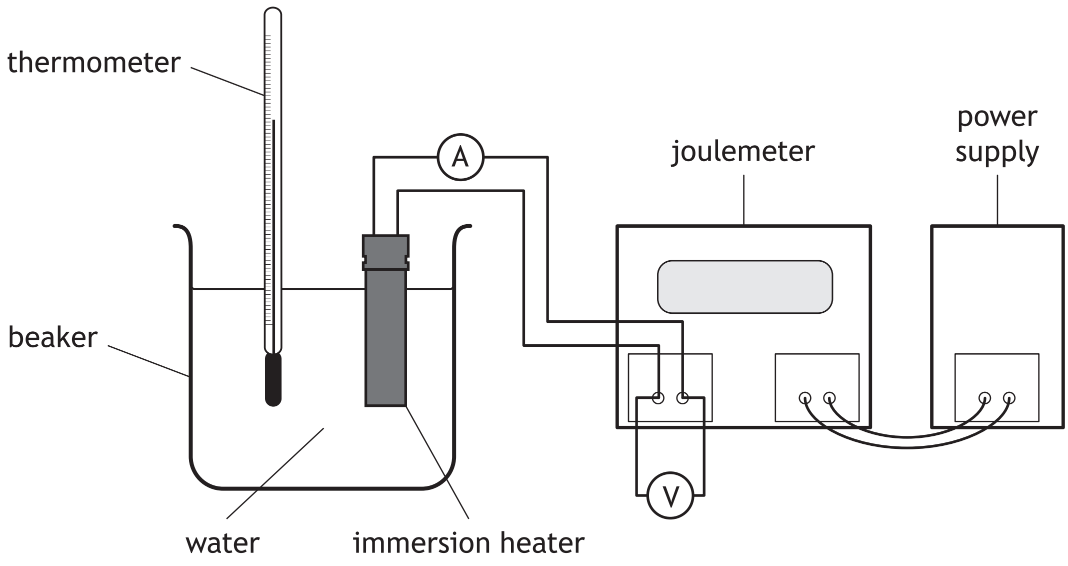
8. A student carries out an experiment, using the apparatus shown, to determine a value for the specific heat capacity of water.



The student switches on the power supply and the immersion heater heats the water.

The joulemeter measures the energy supplied to the immersion heater.

The student records the following measurements.

energy supplied to immersion heater = 21 600 J

mass of water = 0·50 kg

initial temperature of the water = 16 °C

final temperature of the water = 24 °C

reading on voltmeter = 12 V

reading on ammeter = 4·0 A

(a) (i) Determine the value of the specific heat capacity of water obtained from these measurements. **3**

Space for working and answer

8. (a) (continued)

MARKS | DO NOT WRITE IN THIS MARGIN

(ii) Explain why the value determined from the experiment is different from the value quoted in the data sheet. 1

(b) Calculate the time for which the immersion heater is switched on in this experiment. 4

Space for working and answer

[Turn over

* X 8 5 7 7 5 0 1 2 5 *

8. (continued) MARKS

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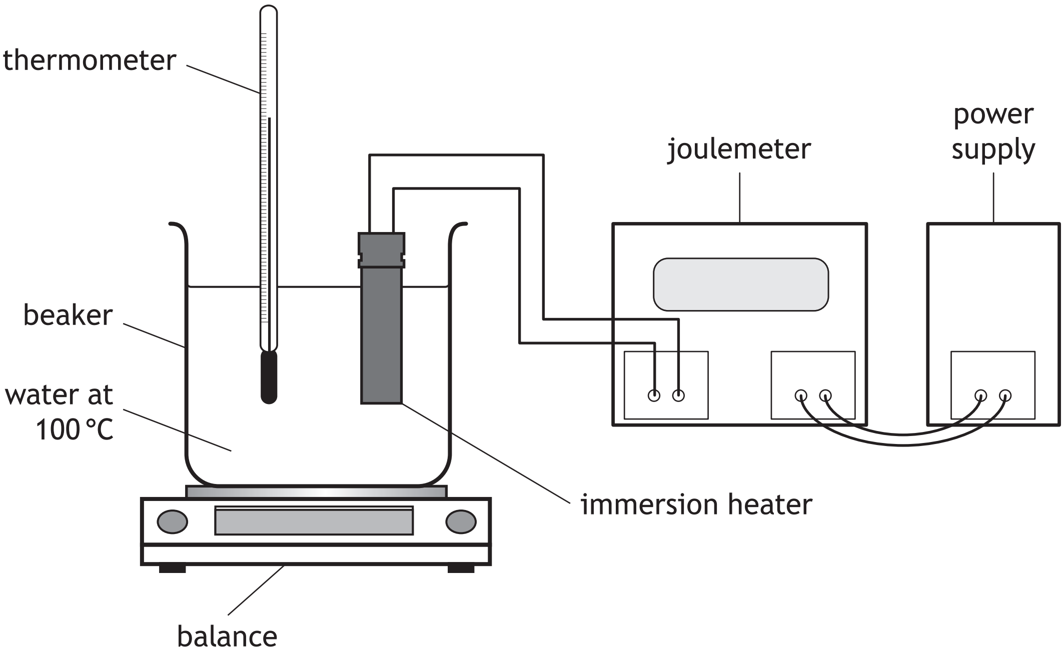
(c) The student then carries out a second experiment, using the apparatus shown, to determine a value for the specific latent heat of vaporisation of water.



Describe how this apparatus would be used to determine a value for the specific latent heat of vaporisation of water. **3**

Your description must include:

- measurements made
- any necessary calculations

[Turn over for next question

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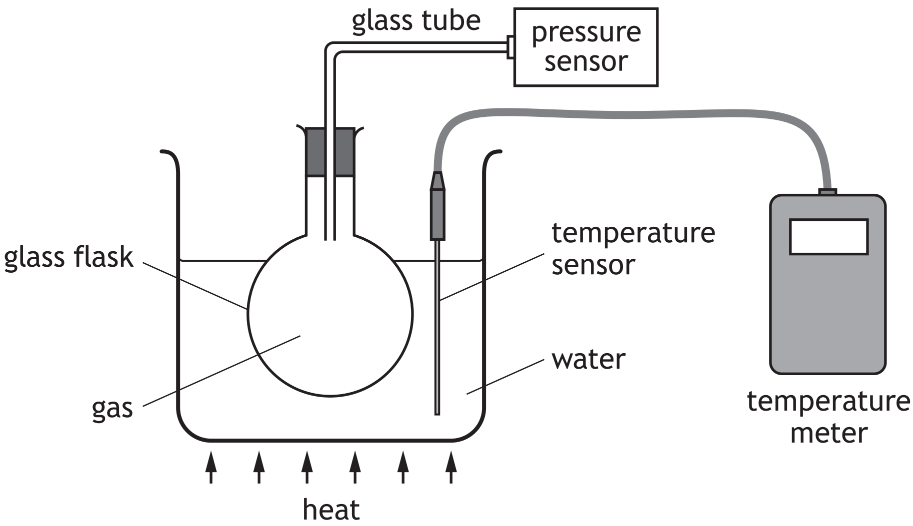
9. A student sets up an experiment to investigate the relationship between the pressure and temperature of a fixed mass of gas as shown.



(a) The student heats the water and records the following readings of pressure and temperature.

Pressure (kPa)	101	107	116	122
Temperature (K)	293	313	333	353

(i) Using **all** the data, establish the relationship between the pressure and the temperature of the gas. 3

Space for working and answer

9. (a) (continued)

MARKS | DO NOT WRITE IN THIS MARGIN

(ii) Using the kinetic model, explain why the pressure of the gas increases as its temperature increases. **3**

(iii) Predict the pressure reading which would be obtained if the student was to cool the gas to 253 K. **1**

(b) State one way in which the set-up of the experiment could be improved to give more reliable results.

Justify your answer. **2**

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

10. A student connects a mobile phone to a speaker wirelessly using a microwave signal.

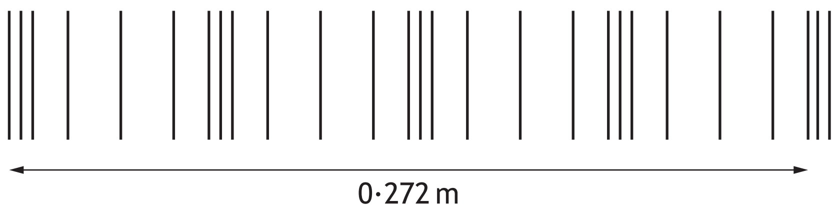
(a) The time taken for the microwave signal to travel from the mobile phone to the speaker is $2{\cdot}1 \times 10^{-8}$ s.

Calculate the distance between the mobile phone and the speaker. **3**

Space for working and answer

(b) Sound is a longitudinal wave.

The sound produced by the speaker is represented by the following diagram.



(i) State what is meant by the term *longitudinal wave*. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

10. (b) (continued)

(ii) Determine the wavelength of the sound wave. **1**

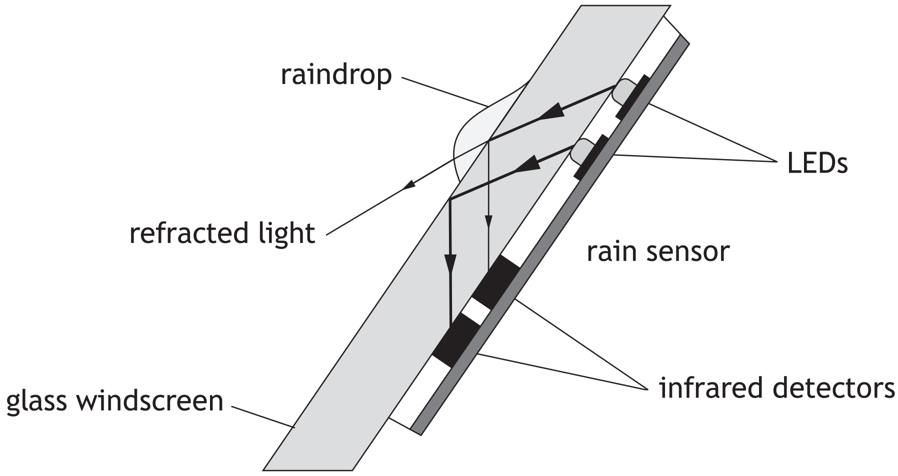
Space for working and answer

(iii) Calculate the frequency of the sound wave in air. **3**

Space for working and answer

[Turn over

11. A rain sensor is attached to the glass windscreen of a vehicle to automatically control the windscreen wipers.

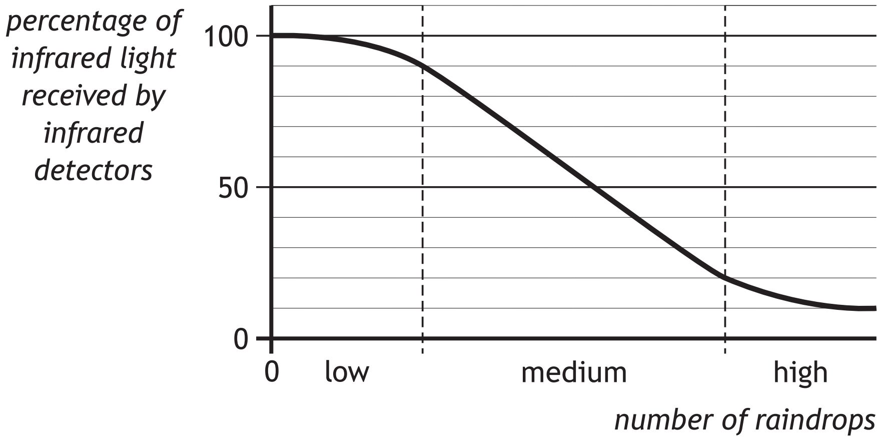


Infrared light is emitted from LEDs and is received by infrared detectors.

(a) State a suitable detector of infrared radiation for this rain sensor. **1**

MARKS | DO NOT WRITE IN THIS MARGIN

(b) The graph shows how the number of raindrops affects the percentage of infrared light received by the infrared detectors.



The percentage of infrared light received by the infrared detectors from the LEDs controls the frequency with which the windscreen wipers move back and forth.

The table shows how the number of times the windscreen wipers move back and forth per minute relates to the number of raindrops.

Number of raindrops	*Number of times the windscreen wipers move back and forth per minute*
low	18
medium	54
high	78

At one point in time the infrared detectors receive 70% of the infrared light emitted from the LEDs.

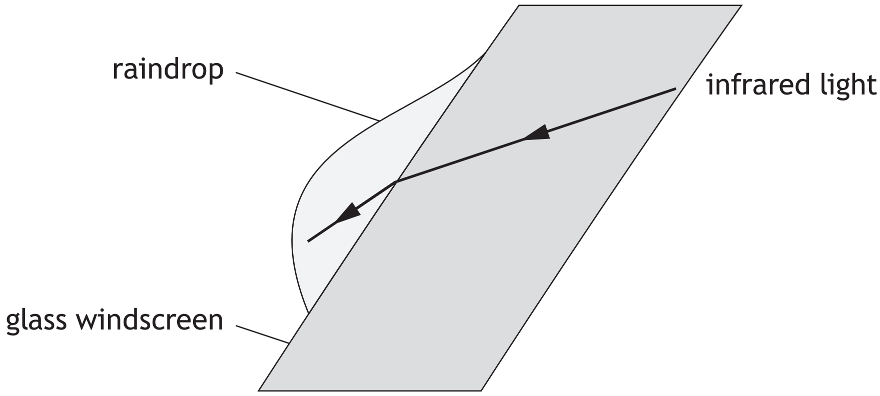
Show that the frequency of the windscreen wipers at this time is 0·90 Hz. **3**

Space for working and answer

[Turn over

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

(c) Some of the infrared light is refracted when travelling from the glass windscreen into a raindrop.



(i) On the diagram, draw and label:

(A) a normal; **1**

(B) an angle of incidence i and an angle of refraction r. **1**

(An additional diagram, if required, can be found on *page 44*.)

(ii) State whether the wavelength of the infrared light in the raindrop is less than, equal to or greater than the wavelength of the infrared light in the glass.

You **must** justify your answer. **2**

[Turn over for next question

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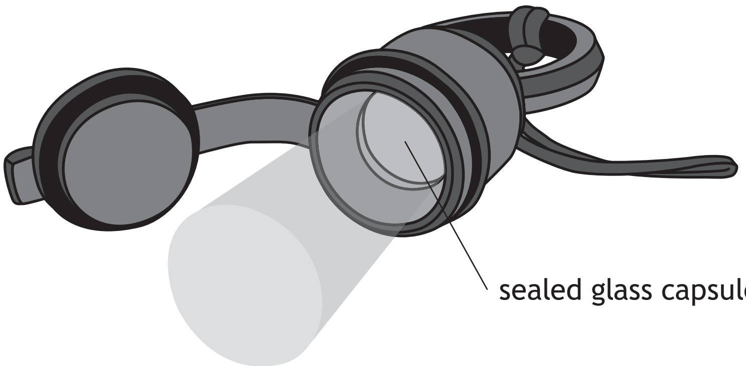
12. A tritium torch includes a sealed glass capsule containing radioactive tritium gas.



Beta particles emitted by the tritium gas are absorbed by a coating on the inside of the glass capsule.

The coating then emits visible light.

(a) State what is meant by a *beta particle*. **1**

(b) The half-life of tritium gas is 12·3 years.

The manufacturer states that the torch will work effectively for 15 years.

Explain why the torch will be less effective after this time. **2**

MARKS | DO NOT WRITE IN THIS MARGIN

(c) During the manufacturing process a glass capsule cracks and a worker receives an absorbed dose of 0·40 mGy throughout their body from the tritium gas.

The mass of the worker is 85 kg.

(i) Calculate the energy of the radiation absorbed by the worker. **3**

Space for working and answer

(ii) Calculate the equivalent dose received by the worker. **3**

Space for working and answer

[Turn over

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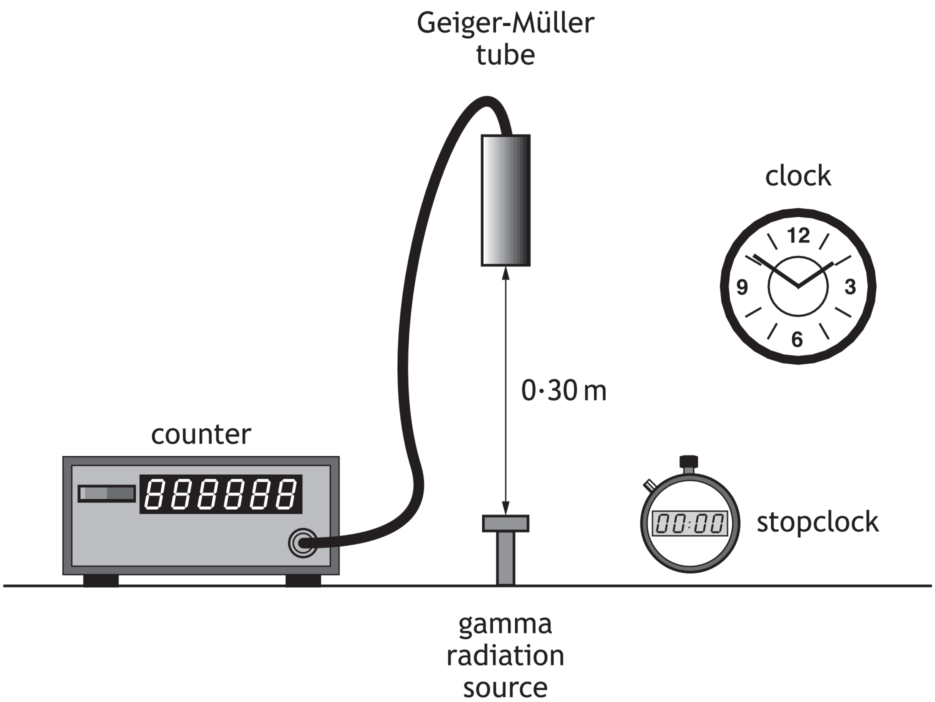
MARKS | DO NOT WRITE IN THIS MARGIN

13. A technician carries out an experiment, using the apparatus shown, to determine the half-life of a gamma radiation source.



(a) Before carrying out the experiment the technician measures the background count rate.

(i) Explain why this measurement is made. **1**

(ii) State a source of background radiation. **1**

[Turn over

13. (continued)

(b) The technician's results are shown in the table.

Time (minutes)	*Corrected count rate* (counts per minute)
0	680
20	428
40	270
60	170
80	107
100	68

(i) Using the graph paper below, draw a graph of these results. **3**

(Additional graph paper, if required, can be found on *page 45*.)

13. (b) (continued) MARKS DO NOT WRITE IN THIS MARGIN

(ii) Use your graph to determine the half-life of the gamma radiation source. **1**

(c) The technician repeats the experiment with an alpha radiation source.

(i) Suggest a change the technician must make to the experimental set-up to determine the half-life of the alpha radiation source.

Justify your answer. **2**

(ii) During the first 15 s of the experiment the alpha radiation source has an average activity of 520 Bq.

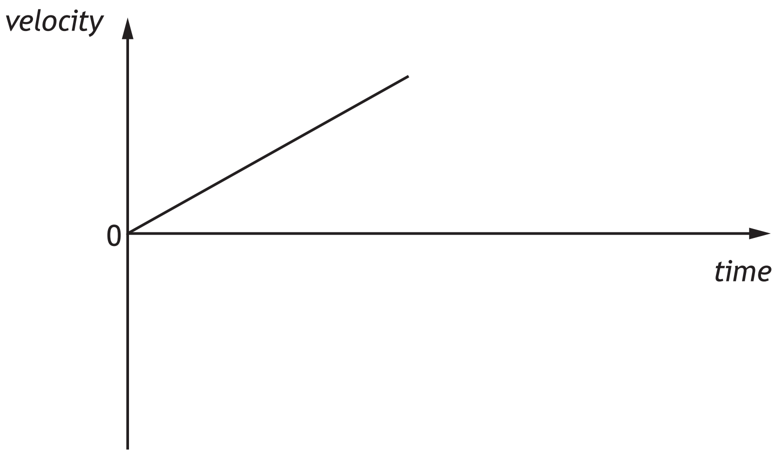
Calculate the number of nuclear disintegrations that occur in the source in the first 15 s of the experiment. **3**

Space for working and answer

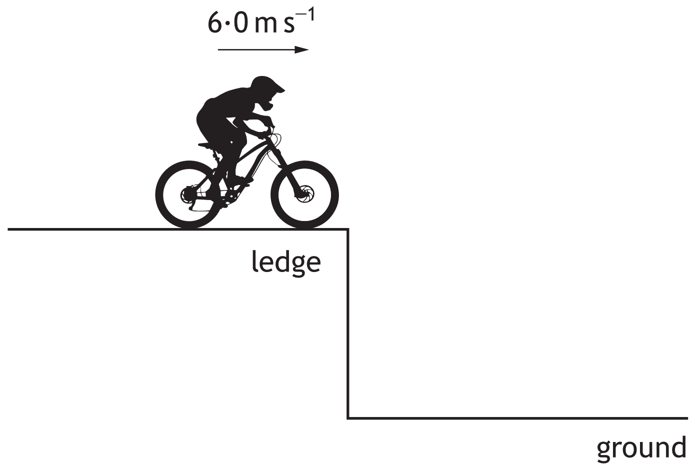
[END OF QUESTION PAPER]

ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORKING

Additional diagram for Q2 (c)

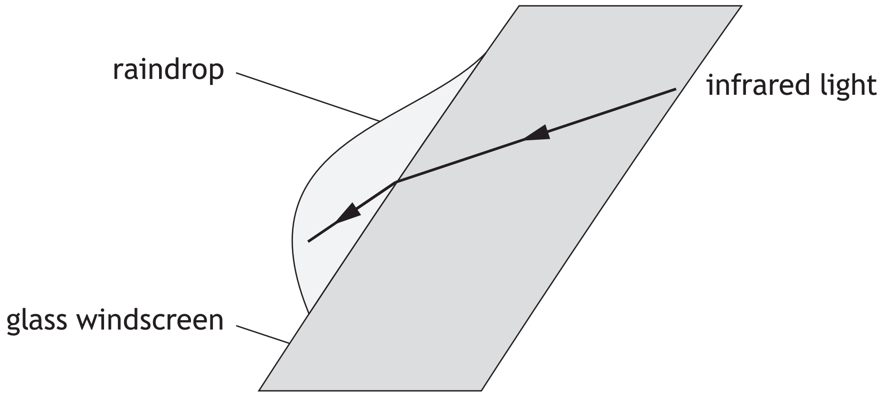


Additional diagram for Q3 (c)



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORKING

Additional diagram for Q11 (c)



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORKING

Additional graph paper for Q13 (b) (i)

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORKING

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORKING

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ACKNOWLEDGEMENTS

Question 5 – Image is taken from https://pixabay.com/en/astronauts-floating-fruit-space-625540/. Licensed under CCO Creative Commons.

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N5 National Qualifications 2018

X857/75/11

Physics
Relationships Sheet

TUESDAY, 8 MAY

1:00 PM – 3:30 PM

X85775 11

A/HTP

$d = vt$

$d = \bar{v}t$

$s = vt$

$s = \bar{v}t$

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

$F = ma$

$W = mg$

$E_w = Fd$

$E_p = mgh$

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

$Q = It$

$V = IR$

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

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

$R_T = R_1 + R_2 + \ldots.$

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

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

$P = IV$

$P = I^2R$

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

$E_h = cm\Delta T$

$E_h = ml$

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

$p_1V_1 = p_2V_2$

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

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

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

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

$v = f\lambda$

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

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

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

$H = Dw_r$

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

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