National
Qualifications
2018

X757/76/02

Physics
Section 1 — Questions

TUESDAY, 8 MAY

9:00 AM – 11:30 AM

Instructions for the completion of Section 1 are given on *page 02* of your question and answer booklet X757/76/01.

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 X757/76/11.

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.

DATA SHEET

COMMON PHYSICAL QUANTITIES

Quantity	*Symbol*	*Value*	*Quantity*	*Symbol*	*Value*
Speed of light in vacuum	c	$3{\cdot}00 \times 10^{8}\ \text{m s}^{-1}$	Planck's constant	h	$6{\cdot}63 \times 10^{-34}\ \text{J s}$
Magnitude of the charge on an electron	e	$1{\cdot}60 \times 10^{-19}\ \text{C}$	Mass of electron	m_e	$9{\cdot}11 \times 10^{-31}\ \text{kg}$
Universal Constant of Gravitation	G	$6{\cdot}67 \times 10^{-11}\ \text{m}^3\ \text{kg}^{-1}\ \text{s}^{-2}$	Mass of neutron	m_n	$1{\cdot}675 \times 10^{-27}\ \text{kg}$
Gravitational acceleration on Earth	g	$9{\cdot}8\ \text{m s}^{-2}$	Mass of proton	m_p	$1{\cdot}673 \times 10^{-27}\ \text{kg}$
Hubble's constant	H_0	$2{\cdot}3 \times 10^{-18}\ \text{s}^{-1}$			

REFRACTIVE INDICES

The refractive indices refer to sodium light of wavelength 589 nm and to substances at a temperature of 273 K.

Substance	*Refractive index*	*Substance*	*Refractive index*
Diamond	2·42	Water	1·33
Crown glass	1·50	Air	1·00

SPECTRAL LINES

Element	*Wavelength*/nm	*Colour*
Hydrogen	656	Red
	486	Blue-green
	434	Blue-violet
	410	Violet
	397	Ultraviolet
	389	Ultraviolet
Sodium	589	Yellow

Element	*Wavelength*/nm	*Colour*
Cadmium	644	Red
	509	Green
	480	Blue

Lasers

Element	*Wavelength*/nm	*Colour*
Carbon dioxide	9550 }	Infrared
	10590 }	
Helium-neon	633	Red

PROPERTIES OF SELECTED MATERIALS

Substance	*Density*/kg m^{-3}	*Melting Point*/K	*Boiling Point*/K
Aluminium	$2{\cdot}70 \times 10^{3}$	933	2623
Copper	$8{\cdot}96 \times 10^{3}$	1357	2853
Ice	$9{\cdot}20 \times 10^{2}$	273	. . . .
Sea Water	$1{\cdot}02 \times 10^{3}$	264	377
Water	$1{\cdot}00 \times 10^{3}$	273	373
Air	1·29	. . . .	. . . .
Hydrogen	$9{\cdot}0 \times 10^{-2}$	14	20

The gas densities refer to a temperature of 273 K and a pressure of $1{\cdot}01 \times 10^{5}$ Pa.

SECTION 1 — 20 marks

Attempt ALL questions

1. A car is moving at a speed of $2{\cdot}0\,m\,s^{-1}$.

The car now accelerates at $4{\cdot}0\,m\,s^{-2}$ until it reaches a speed of $14\,m\,s^{-1}$.

The distance travelled by the car during this acceleration is

A 1·5 m

B 18 m

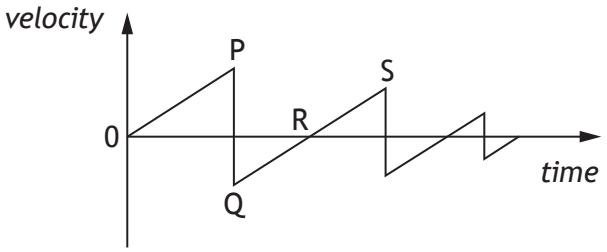
C 24 m

D 25 m

E 48 m.

2. A ball is dropped from rest and allowed to bounce several times.

The graph shows how the velocity of the ball varies with time.



A student makes the following statements about the ball.

I The ball hits the ground at P.

II The ball is moving upwards between Q and R.

III The ball is moving upwards between R and S.

Which of these statements is/are correct?

A I only

B II only

C III only

D I and II only

E I and III only

[Turn over

3. A block of mass 6·0 kg and a block of mass 8·0 kg are connected by a string.

A force of 32 N is applied to the blocks as shown.

A frictional force of 4·0 N acts on **each** block.

The acceleration of the 6·0 kg block is

A $1{\cdot}7\ m\ s^{-2}$

B $2{\cdot}0\ m\ s^{-2}$

C $2{\cdot}3\ m\ s^{-2}$

D $2{\cdot}9\ m\ s^{-2}$

E $5{\cdot}3\ m\ s^{-2}$.

4. A person stands on a weighing machine in a lift. When the lift is at rest, the reading on the weighing machine is 700 N.

The lift now descends and its speed increases at a constant rate.

The reading on the weighing machine

A is a constant value higher than 700 N

B is a constant value lower than 700 N

C continually increases from 700 N

D continually decreases from 700 N

E remains constant at 700 N.

5. Enceladus is a moon of Saturn. The mass of Enceladus is $1{\cdot}08 \times 10^{20}$ kg.

The mass of Saturn is $5{\cdot}68 \times 10^{26}$ kg.

The gravitational force of attraction between Enceladus and Saturn is $7{\cdot}24 \times 10^{19}$ N.

The orbital radius of Enceladus around Saturn is

A $2{\cdot}38 \times 10^{8}$ m

B $9{\cdot}11 \times 10^{13}$ m

C $5{\cdot}65 \times 10^{16}$ m

D $8{\cdot}30 \times 10^{27}$ m

E $3{\cdot}19 \times 10^{33}$ m.

6. A spacecraft is travelling at $0{\cdot}10c$ relative to a star.

An observer on the spacecraft measures the speed of light emitted by the star to be

A $0{\cdot}90c$

B $0{\cdot}99c$

C $1{\cdot}00c$

D $1{\cdot}01c$

E $1{\cdot}10c$.

7. A spacecraft is travelling at a speed of $0{\cdot}200c$ relative to the Earth.

The spacecraft emits a signal for 20·0 seconds as measured in the frame of reference of the spacecraft.

An observer on Earth measures the duration of the signal as

A 19·2 s

B 19·6 s

C 20·0 s

D 20·4 s

E 20·8 s.

8. How many types of quark are there?

A 8

B 6

C 4

D 3

E 2

9. An electron is a

A boson

B hadron

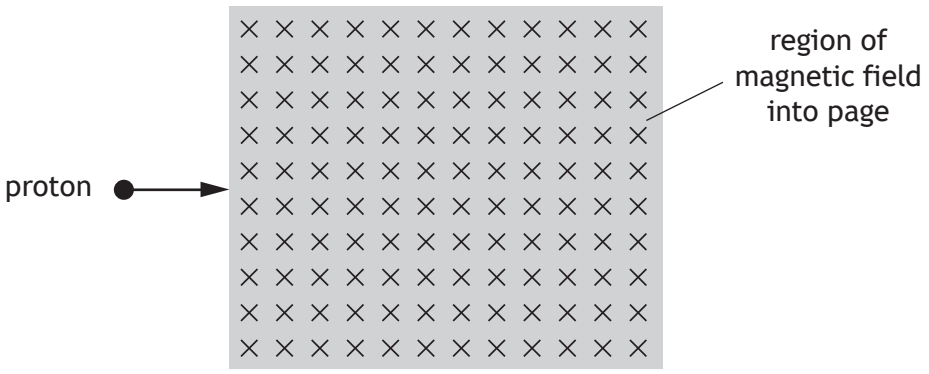
C baryon

D meson

E lepton.

[Turn over

10. A proton enters a region of magnetic field as shown.



On entering the magnetic field the proton

A deflects into the page

B deflects out of the page

C deflects towards the top of the page

D deflects towards the bottom of the page

E is not deflected.

11. A nuclear fission reaction is represented by the following statement.

$$ {}^{1}_{0}\mathrm{n} + {}^{235}_{92}\mathrm{U} \rightarrow {}^{141}_{56}\mathrm{Ba} + \mathrm{X} + 3\,{}^{1}_{0}\mathrm{n} $$

The nucleus represented by X is

A $ {}^{96}_{40}\mathrm{Zr} $

B $ {}^{92}_{36}\mathrm{Kr} $

C $ {}^{97}_{40}\mathrm{Zr} $

D $ {}^{93}_{36}\mathrm{Kr} $

E $ {}^{94}_{40}\mathrm{Zr} $.

12. The irradiance on a surface 0·50 m from a point source of light is I.
The irradiance on a surface 1·5 m from this source is

A $0{\cdot}11I$

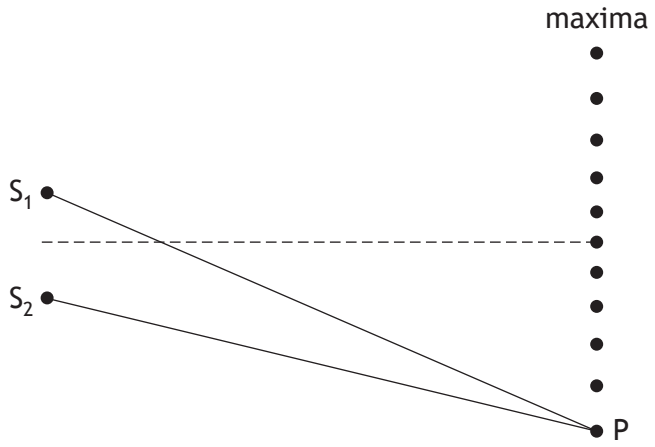
B $0{\cdot}33I$

C $1{\cdot}5I$

D $3{\cdot}0I$

E $9{\cdot}0I$.

13. Waves from two coherent sources, S_1 and S_2, produce an interference pattern. Maxima are detected at the positions shown below.



The path difference $S_1P - S_2P$ is 154 mm.

The wavelength of the waves is

A 15·4 mm

B 25·7 mm

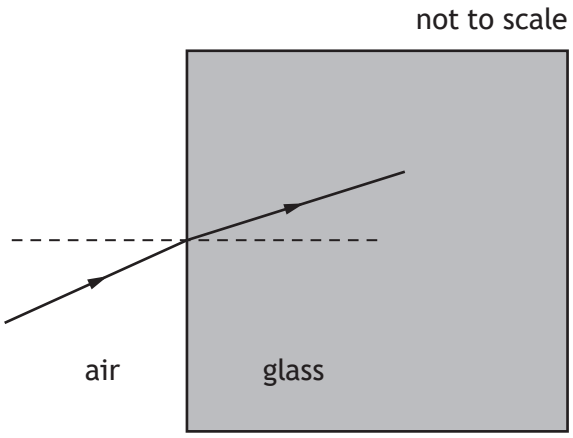
C 28·0 mm

D 30·8 mm

E 34·2 mm.

[Turn over

14. A ray of monochromatic light passes from air into a block of glass as shown.



The wavelength of this light in air is $6{\cdot}30 \times 10^{-7}$ m.

The refractive index of the glass for this light is 1·50.

The frequency of this light in the glass is

A $2{\cdot}10 \times 10^{-15}$ Hz

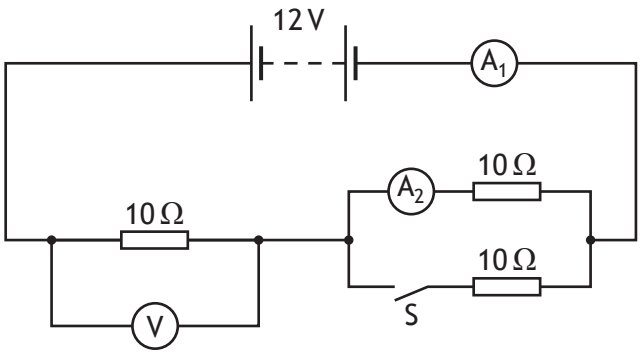
B $1{\cdot}26 \times 10^{2}$ Hz

C $1{\cdot}89 \times 10^{2}$ Hz

D $4{\cdot}76 \times 10^{14}$ Hz

E $7{\cdot}14 \times 10^{14}$ Hz.

15. A circuit is set up as shown.



The battery has negligible internal resistance.

A student makes the following statements about the readings on the meters in this circuit.

I When switch S is open the reading on the voltmeter will be 6·0 V.

II When switch S is open the reading on A_2 will be 0·60 A.

III When switch S is closed the reading on A_1 will be 0·80 A.

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

16. The power dissipated in a 120 Ω resistor is 4·8 W.

The current in the resistor is

A 0·020 A

B 0·040 A

C 0·20 A

D 5·0 A

E 25 A.

[Turn over

17. A 24·0 μF capacitor is charged until the potential difference across it is 125 V.
The charge stored on the capacitor is

A $5{\cdot}21 \times 10^{6}$ C

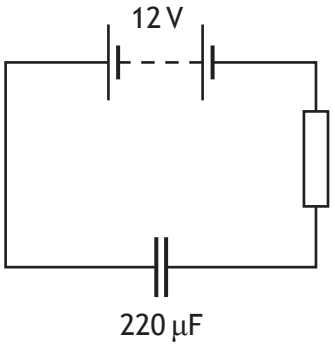
B $7{\cdot}75 \times 10^{-2}$ C

C $1{\cdot}50 \times 10^{-3}$ C

D $3{\cdot}00 \times 10^{-3}$ C

E $1{\cdot}92 \times 10^{-7}$ C.

18. A circuit is set up as shown.



When the capacitor is fully charged the energy stored in the capacitor is

A $1{\cdot}6 \times 10^{-5}$ J

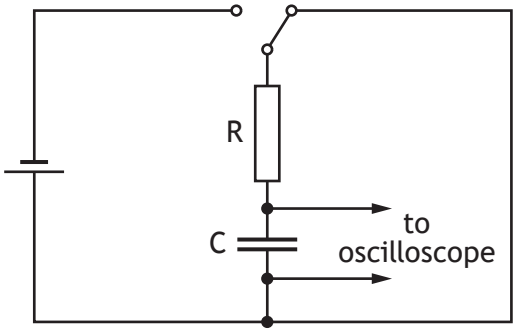
B $1{\cdot}3 \times 10^{-3}$ J

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

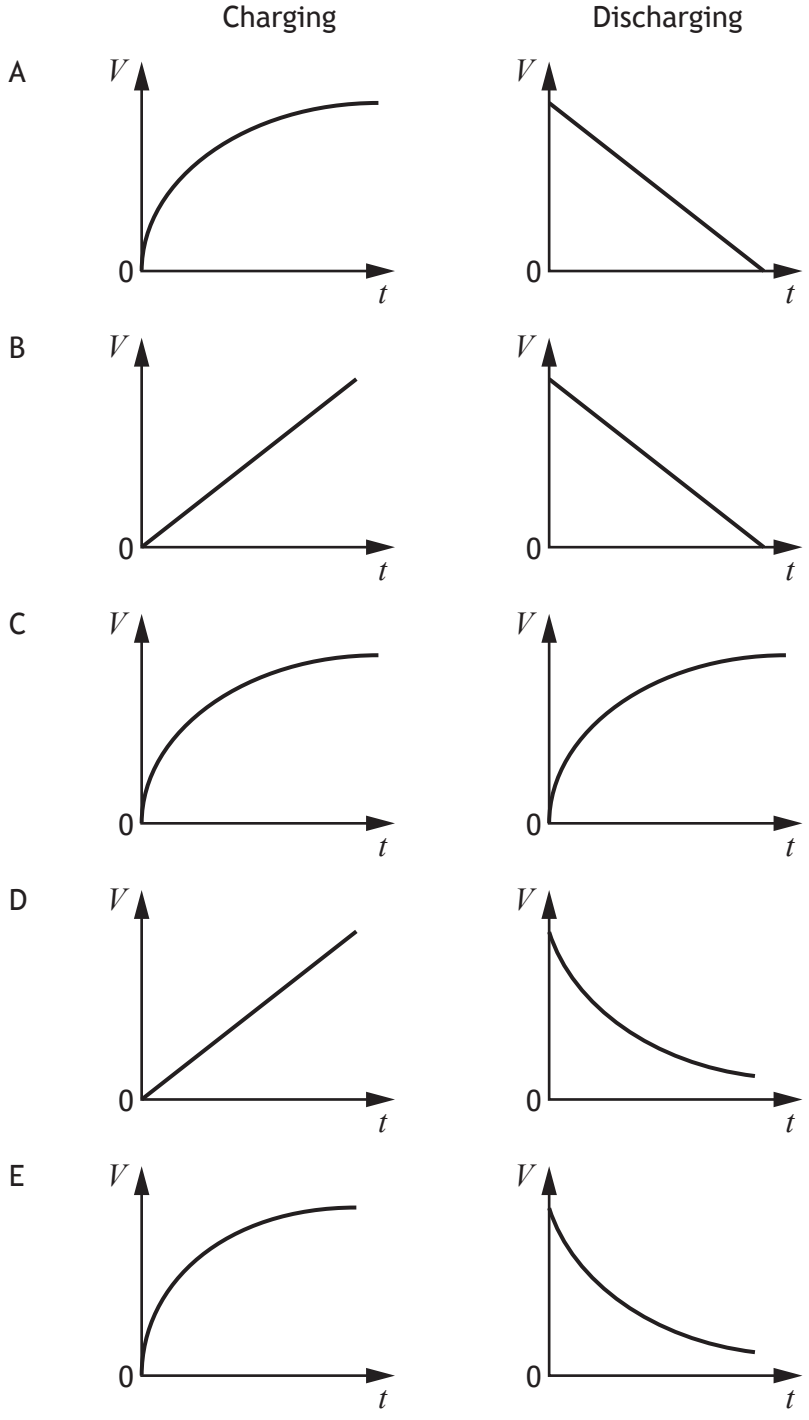
D $1{\cdot}6 \times 10^{-2}$ J

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

19. The circuit shown is used to charge and then discharge a capacitor C.



Which pair of graphs shows how the potential difference V across the capacitor varies with time t during charging and discharging?



[Turn over for next question

20. A student carries out an experiment to determine the specific heat capacity c of a solid.

The relationship used to calculate c is

$$c = \frac{E}{m\Delta T}$$

The recorded measurements and their percentage uncertainties are shown.

energy supplied, $E = 5000\,\text{J} \pm 1\%$

mass of solid, $m = 0{\cdot}20\,\text{kg} \pm 2\%$

change in temperature, $\Delta T = 4{\cdot}5\,°\text{C} \pm 5\%$

A good estimate of the percentage uncertainty in the calculated value of c is

A 8%

B 7%

C 5%

D 3%

E 1%.

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

FOR OFFICIAL USE

National Qualifications 2018

Mark

X757/76/01

Physics
Section 1 — Answer Grid and Section 2

TUESDAY, 8 MAY

9:00 AM – 11:30 AM

X7577601

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 — 130

SECTION 1 — 20 marks
Attempt ALL questions.
Instructions for the 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 X757/76/02 and to the Relationships Sheet X757/76/11.
Care should be taken to give an appropriate number of significant figures in the final answers to calculations.
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. You should 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.

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X7577601 01

SECTION 1 — 20 marks

The questions for Section 1 are contained in the question paper X757/76/02.

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.

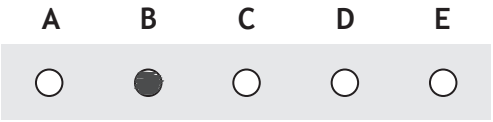
3. Any rough working should be done on the additional space for answers and rough work at the end of this booklet.

Sample question

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

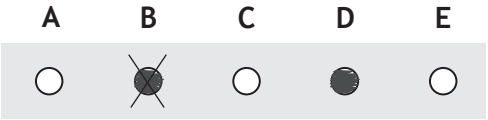
A ampere
B kilowatt-hour
C watt
D coulomb
E volt.

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

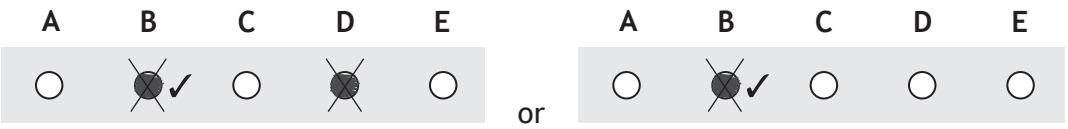


Changing an answer

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:



OBJ20AE1

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

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[Turn over for SECTION 2

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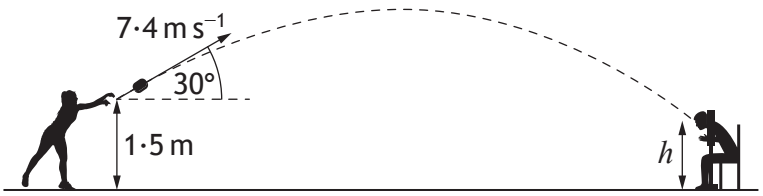
SECTION 2 — 110 marks

Attempt ALL questions

1. During a school funfair, a student throws a wet sponge at a teacher. The sponge is thrown with an initial velocity of $7{\cdot}4\,m\,s^{-1}$ at an angle of 30° to the horizontal.

The sponge leaves the student's hand at a height of 1·5 m above the ground.

not to scale



The sponge hits the teacher.

The effects of air resistance can be ignored.

(a) (i) Calculate:

(A) the horizontal component of the initial velocity of the sponge; **1**

Space for working and answer

(B) the vertical component of the initial velocity of the sponge. **1**

Space for working and answer

1. (a) (continued)

(ii) Calculate the time taken for the sponge to reach its maximum height. **3**

Space for working and answer

(iii) The sponge takes a further 0·45 s to travel from its maximum height until it hits the teacher.

Determine the height h above the ground at which the sponge hits the teacher. **4**

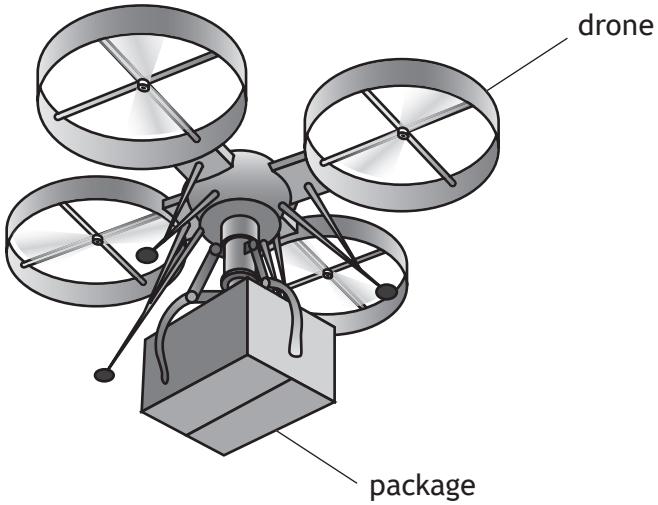
Space for working and answer

(b) The student throwing the sponge makes the following statement.

"If the sponge is thrown with a higher speed at the same angle from the same height then it would take a shorter time to hit the teacher in the same place."

Explain why the student's statement is incorrect. **2**

2. An internet shopping company is planning to use drones to deliver packages.



(a) During a test the drone is hovering at a constant height above the ground.

The mass of the drone is 5·50 kg.

The mass of the package is 1·25 kg.

(i) Determine the upward force produced by the drone. **3**

Space for working and answer

2. (a) (continued)

(ii) The package is now lowered using a motor and a cable.

A battery supplies 12 V across the motor. The resistance of the motor is 9·6 Ω.

Calculate the power dissipated by the motor. **3**

Space for working and answer

(iii) While the package is being lowered the cable breaks.

The upward force produced by the drone remains constant.

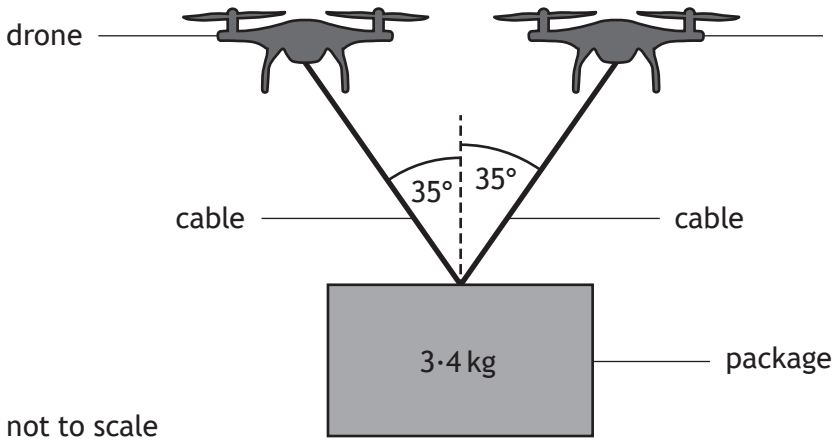
Describe the vertical motion of the drone immediately after the cable breaks. **2**

Justify your answer.

[Turn over

2. (continued)

(b) To carry a package with a greater mass two drones are used as shown.



The drones are hovering at a constant height above the ground.

The mass of the package suspended from the two drones is 3·4 kg.

Determine the tension in each cable. **4**

Space for working and answer

[Turn over for next question

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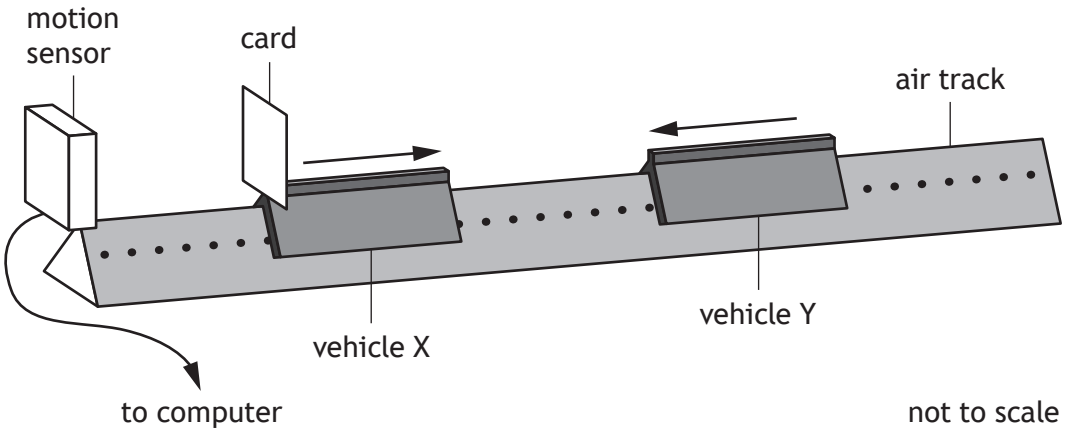
3. A student sets up an experiment to investigate a collision between two vehicles on a frictionless air track.



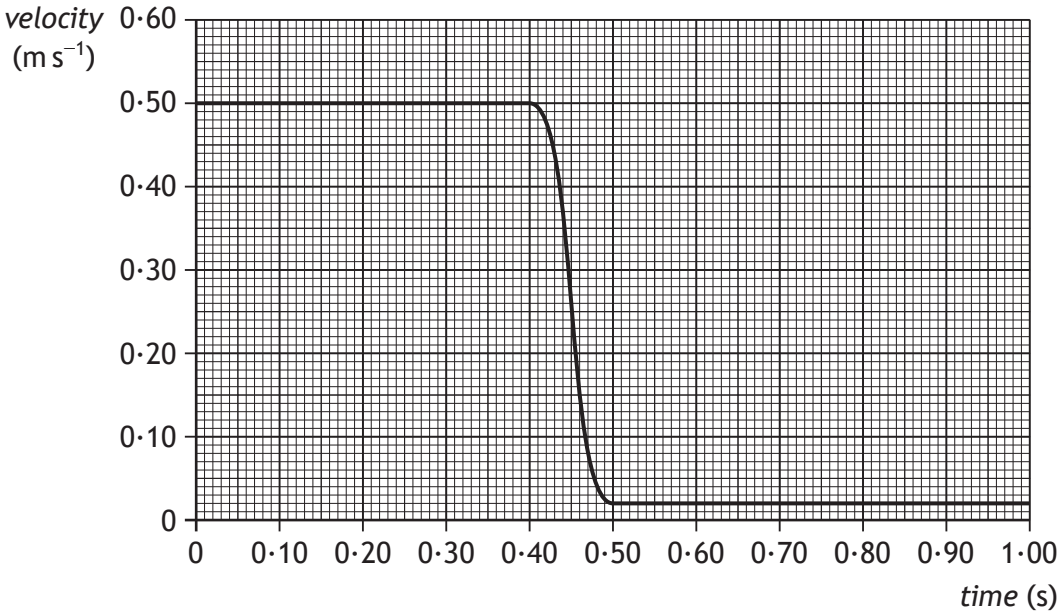
not to scale

Vehicle X of mass 0·75 kg is travelling to the right along the track.

Vehicle Y of mass 0·50 kg is travelling to the left along the track with a speed of 0·30 m s^{-1}.

The vehicles collide and move off separately.

A computer displays a graph showing the velocity of vehicle X from just before the collision to just after the collision.



MARKS | DO NOT WRITE IN THIS MARGIN

3. (continued)

(a) Show that the velocity of vehicle Y after the collision is $0{\cdot}42\ m\ s^{-1}$. **2**

Space for working and answer

(b) Determine the impulse on vehicle Y during the collision. **3**

Space for working and answer

[Turn over

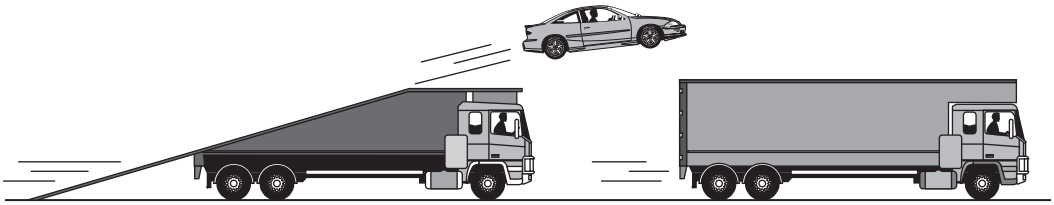
MARKS | DO NOT WRITE IN THIS MARGIN

3. (continued)

(c) Explain how the student would determine whether the collision was elastic or inelastic. **2**

4. A stunt is being carried out during the making of a film.

A car is to be driven up a ramp on a moving lorry by a stunt driver, who will attempt to land the car safely on the roof of a second moving lorry. The car is to stop on the roof of the second lorry while this lorry is still moving.



Using your knowledge of physics, comment on the challenges involved in carrying out the stunt successfully. **3**

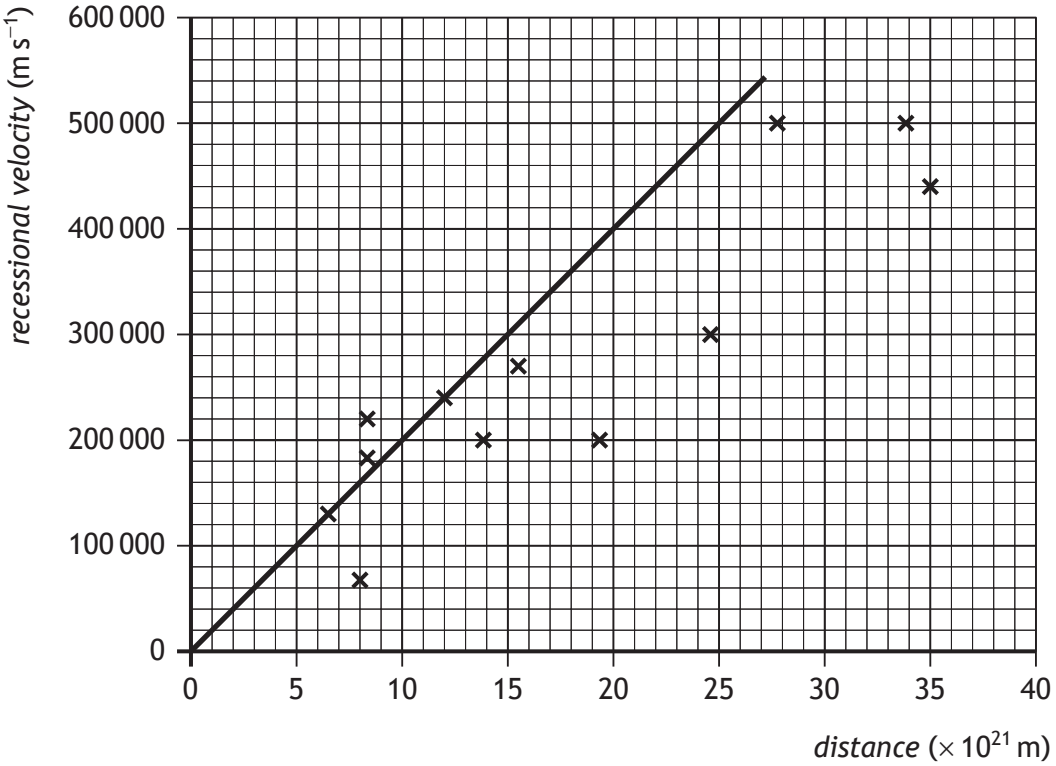
[Turn over

MARKS | DO NOT WRITE IN THIS MARGIN

5. Hubble's Law states that the universe is expanding. The expanding universe is one piece of evidence that supports the Big Bang theory.

(a) State one other piece of evidence that supports the Big Bang theory. **1**

(b) A student plots some of the original data from the 1929 paper by Edwin Hubble and adds the line shown in order to determine a value for the Hubble constant H_0.



The student calculates the gradient of their line and obtains a value for the Hubble constant of $2{\cdot}0 \times 10^{-17}\,s^{-1}$.

The age of the universe can be calculated using the relationship

$$\text{age of universe} = \frac{1}{H_0}$$

5. (b) (continued)

(i) Calculate the age of the universe, in years, obtained when using the student's value for the Hubble constant. **2**

Space for working and answer

(ii) The current estimate for the age of the universe is $13{\cdot}8 \times 10^9$ years.

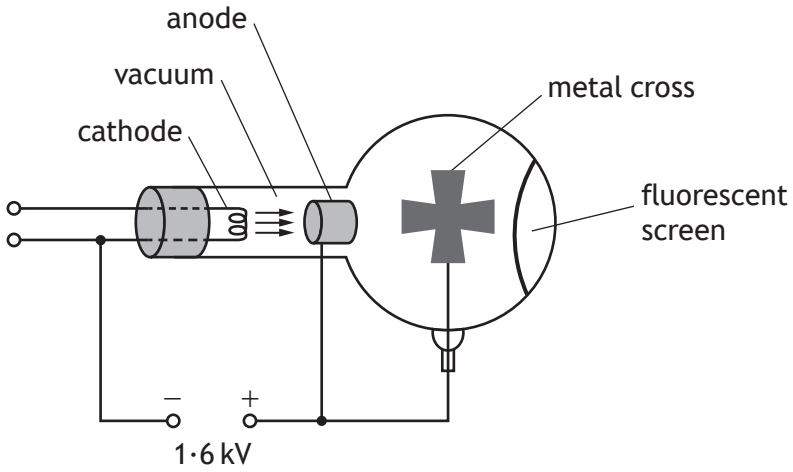
(A) State why the value obtained in (b)(i) is different from the current estimate for the age of the universe. **1**

(B) Suggest a change that the student could make to their graph to obtain a value closer to the current estimate for the age of the universe. **1**

(c) It has been discovered that the rate of expansion of the universe is increasing.

State what physicists think is responsible for this increase. **1**

6. An experiment is set up to demonstrate a simple particle accelerator.



(a) Electrons are accelerated from rest between the cathode and the anode by a potential difference of 1·6 kV.

(i) Show that the work done in accelerating an electron from rest is $2{\cdot}6 \times 10^{-16}$ J. **2**

Space for working and answer

(ii) Calculate the speed of the electron as it reaches the anode. **3**

Space for working and answer

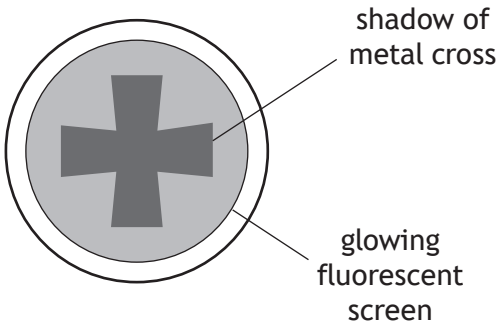
6. (continued)

(b) As the electrons travel through the vacuum towards the fluorescent screen they spread out.

In the path of the electrons there is a metal cross, which is connected to the positive terminal of the supply. The electrons that hit the cross are stopped by the metal.

Electrons that get past the metal cross hit a fluorescent screen at the far side of the tube.

When electrons hit the fluorescent screen, the screen glows.



The potential difference between the anode and the cathode is now increased to 2·2 kV. This changes what is observed on the screen.

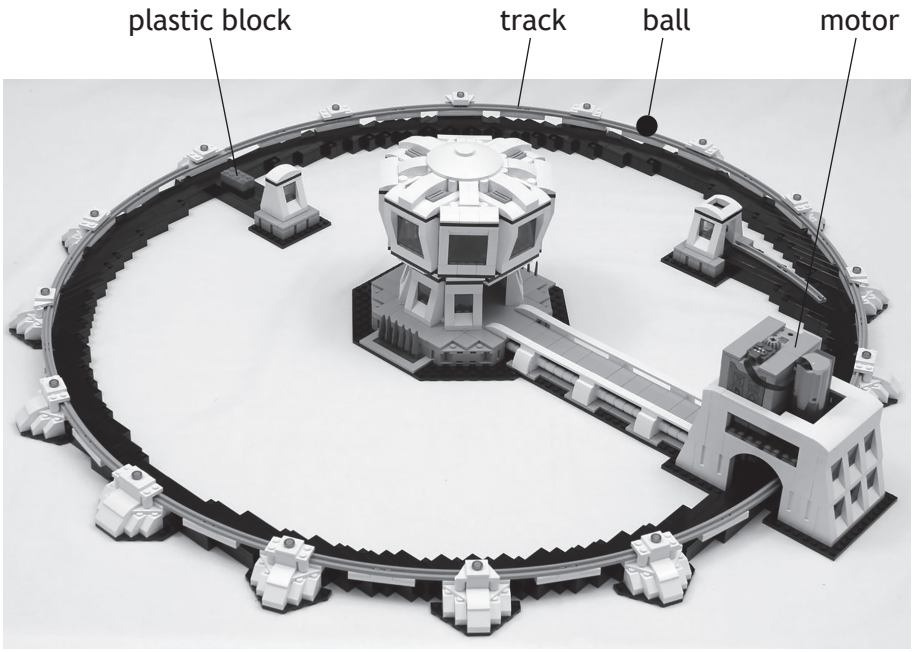
Suggest one change that is observed. **2**

You must justify your answer.

[Turn over

6. (continued)

(c) A student builds a model of a particle accelerator. The model accelerates a small ball on a circular track. A battery-operated motor accelerates the ball each time it passes the motor. To cause a collision a plastic block is pushed onto the track. The ball then hits the block.



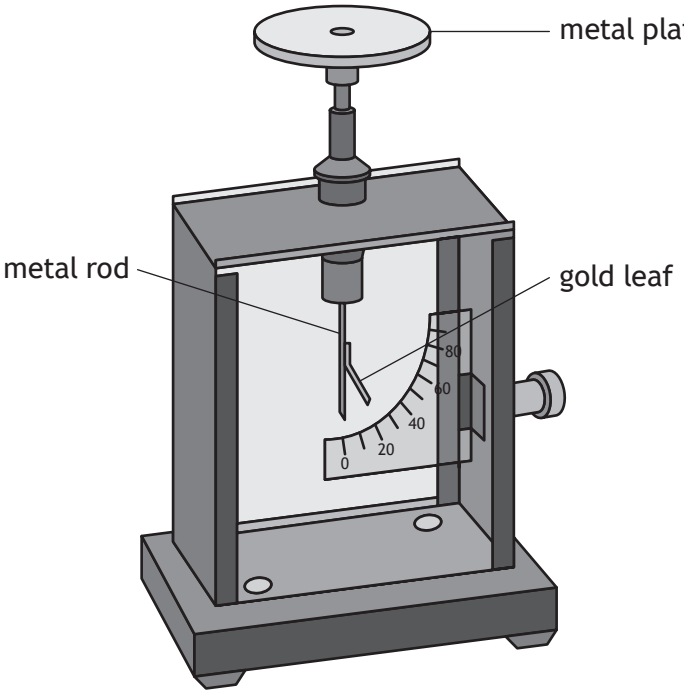
Using your knowledge of physics comment on the model compared to a real particle accelerator, such as the large hadron collider at CERN. **3**

DO NOT WRITE IN THIS MARGIN

6. (c) (continued)

7. A student uses a gold-leaf electroscope to investigate the photoelectric effect. A deflection of the gold leaf on the electroscope shows that the metal plate is charged.

The student charges the metal plate on the electroscope and the gold leaf is deflected.



gold-leaf electroscope

(a) Ultraviolet light is shone onto the negatively charged metal plate. The gold-leaf electroscope does not discharge. This indicates that photoelectrons are not ejected from the surface of the metal.

Suggest one reason why photoelectrons are not ejected from the surface of the metal. **1**

7. (continued)

(b) The student adjusts the experiment so that the gold-leaf electroscope now discharges when ultraviolet light is shone onto the plate.

The work function for the metal plate is $6{\cdot}94 \times 10^{-19}$ J.

(i) State what is meant by a *work function of* $6{\cdot}94 \times 10^{-19}$ *J*. **1**

(ii) The irradiance of the ultraviolet light on the metal plate is reduced by increasing the distance between the gold-leaf electroscope and the ultraviolet light source.

State what effect, if any, this has on the maximum kinetic energy of the photoelectrons ejected from the surface of the metal. **2**

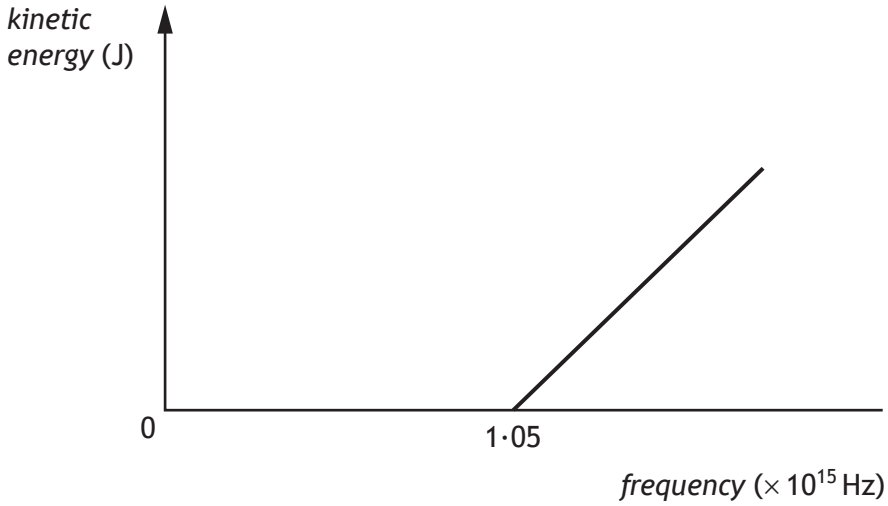
Justify your answer.

[Turn over

7. (continued)

(c) The graph shows how the kinetic energy of the photoelectrons ejected from the metal plate varies as the frequency of the incident radiation increases.

The threshold frequency for the metal plate is $1{\cdot}05 \times 10^{15}$ Hz.



The metal plate is now replaced with a different metal plate made of aluminium.

The aluminium has a threshold frequency of $0{\cdot}99 \times 10^{15}$ Hz.

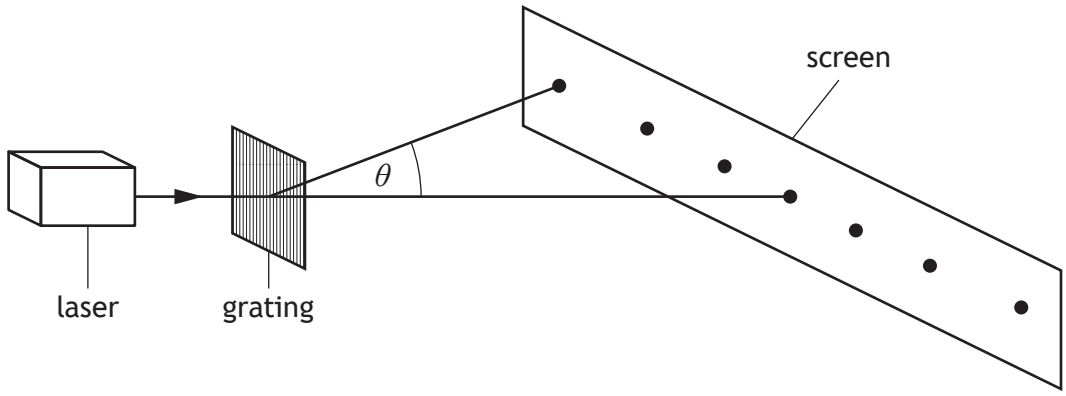
Add a line to the graph to show how the kinetic energy of the photoelectrons ejected from the aluminium plate varies as the frequency of the incident radiation increases. **2**

(An additional graph, if required, can be found on *page 45*.)

(d) Explain why the photoelectric effect provides evidence for the particle nature of light. **1**

8. A student investigates interference of light by directing laser light of wavelength 630 nm onto a grating as shown.

not to scale



(a) A pattern of bright spots is observed on a screen.

(i) Explain, in terms of waves, how bright spots are produced on the screen. **1**

(ii) The grating has 250 lines per millimetre.

Calculate the angle θ between the central maximum and the third order maximum. **3**

Space for working and answer

[Turn over

8. (a) (continued)

(iii) The grating is now replaced by one which has 600 lines per millimetre.

State the effect of this change on the pattern observed. **2**

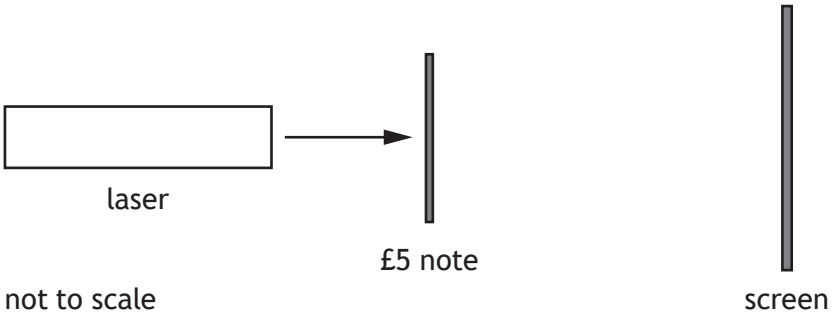
Justify your answer.

(iv) The interference pattern is produced by coherent light.

State what is meant by the term *coherent*. **1**

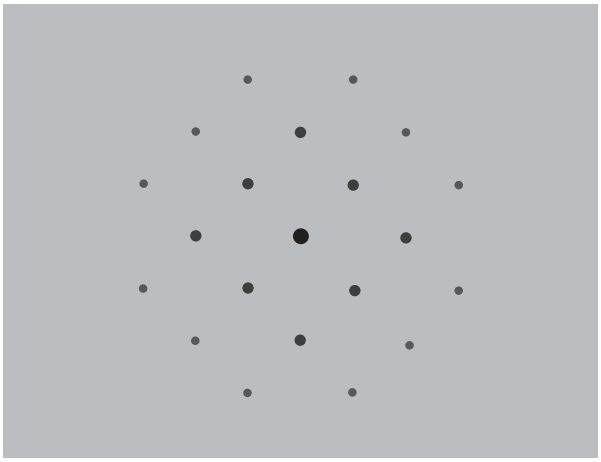
8. (continued)

(b) The student now shines light from the laser onto a £5 note.



When it is shone through the transparent section of the note the student observes a pattern of bright spots on the screen.

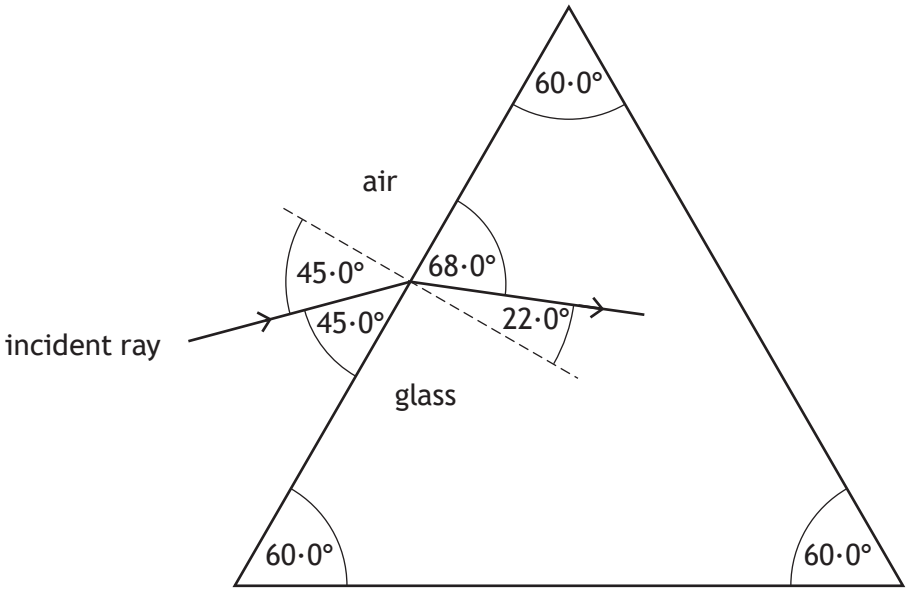
The diagram below shows the pattern that the student observes on the screen.



Suggest a reason for the difference in the pattern produced using the £5 note and the pattern produced using the grating. **1**

[Turn over

9. A ray of monochromatic light is incident on a glass prism as shown.



(a) Show that the refractive index of the glass for this ray of light is 1·89. **2**

Space for working and answer

(b) (i) State what is meant by the term *critical angle*. **1**

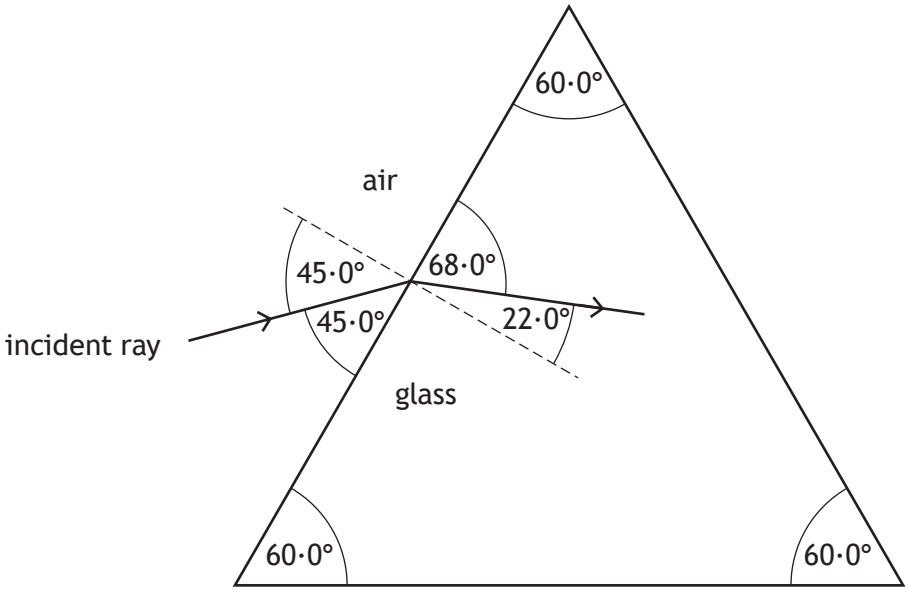
9. (b) (continued)

(ii) Calculate the critical angle for this light in the prism. **3**

Space for working and answer

(iii) Complete the diagram below to show the path of the ray as it passes through the prism and emerges into the air.

Mark on the diagram the values of all relevant angles. **4**

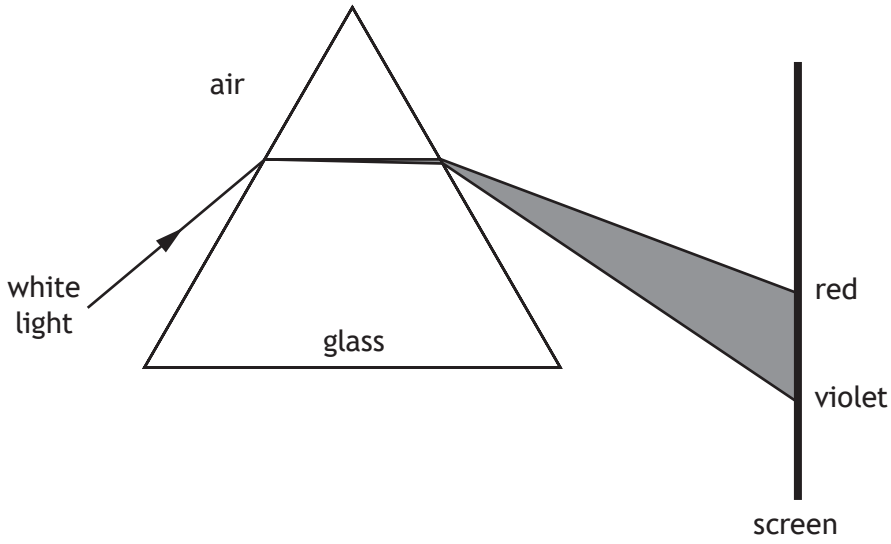


(An additional diagram, if required, can be found on *page 45*.)

[Turn over

9. (continued)

(c) A ray of white light is shone through the prism and a spectrum is observed as shown.



The prism is now replaced with another prism made from a different type of glass with a lower refractive index.

Describe one difference in the spectrum produced by this prism compared to the spectrum produced by the first prism. **1**

10. In a laboratory experiment, light from a hydrogen discharge lamp is used to produce a line emission spectrum. The line spectrum for hydrogen has four lines in the visible region as shown.

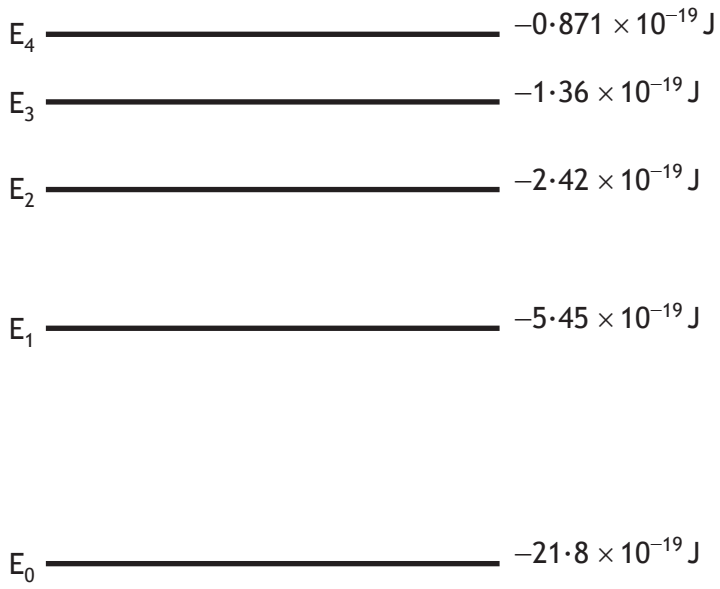
(a) The production of the line spectrum can be explained using the Bohr model of the atom.

State **two** features of the *Bohr model* of the atom. **2**

[Turn over

10. (continued)

(b) Some of the energy levels of the hydrogen atom are shown.



One of the spectral lines is due to electron transitions from E_3 to E_1.

Determine the frequency of the photon emitted when an electron makes this transition. **3**

Space for working and answer

10. (continued)

(c) In the laboratory, a line in the hydrogen spectrum is observed at a wavelength of 656 nm.

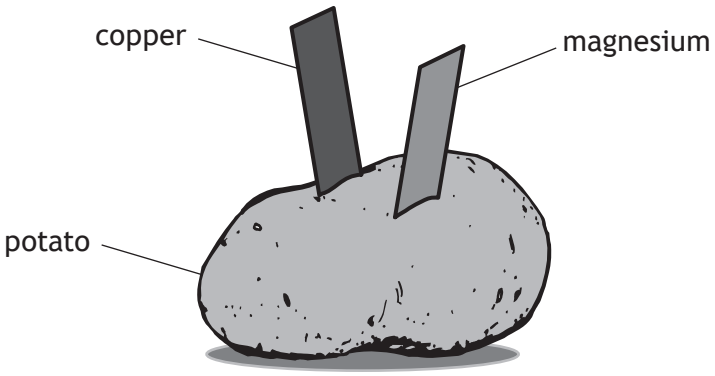
When the spectrum of light from a distant galaxy is viewed, this hydrogen line is now observed at a wavelength of 661 nm.

Determine the recessional velocity of the distant galaxy. **5**

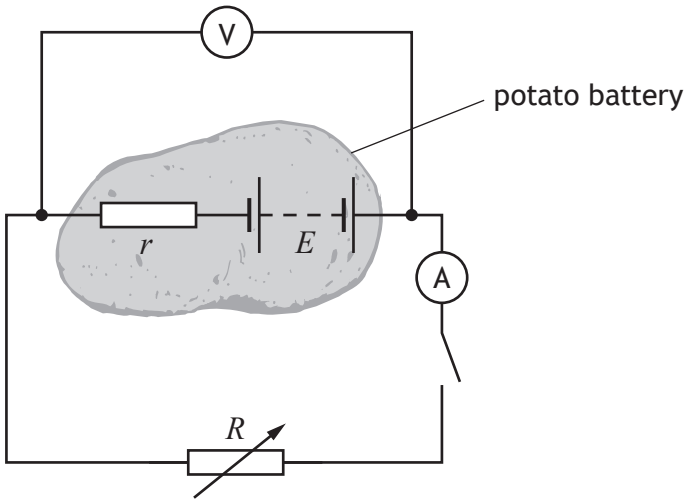
Space for working and answer

[Turn over

11. A student constructs a battery using a potato, a strip of copper and a strip of magnesium.



The student then sets up the following circuit with the potato battery connected to a variable resistor R, in order that the electromotive force (e.m.f.) and internal resistance of the battery may be determined.



(a) State what is meant by the term *electromotive force* (*e.m.f.*). **1**

MARKS

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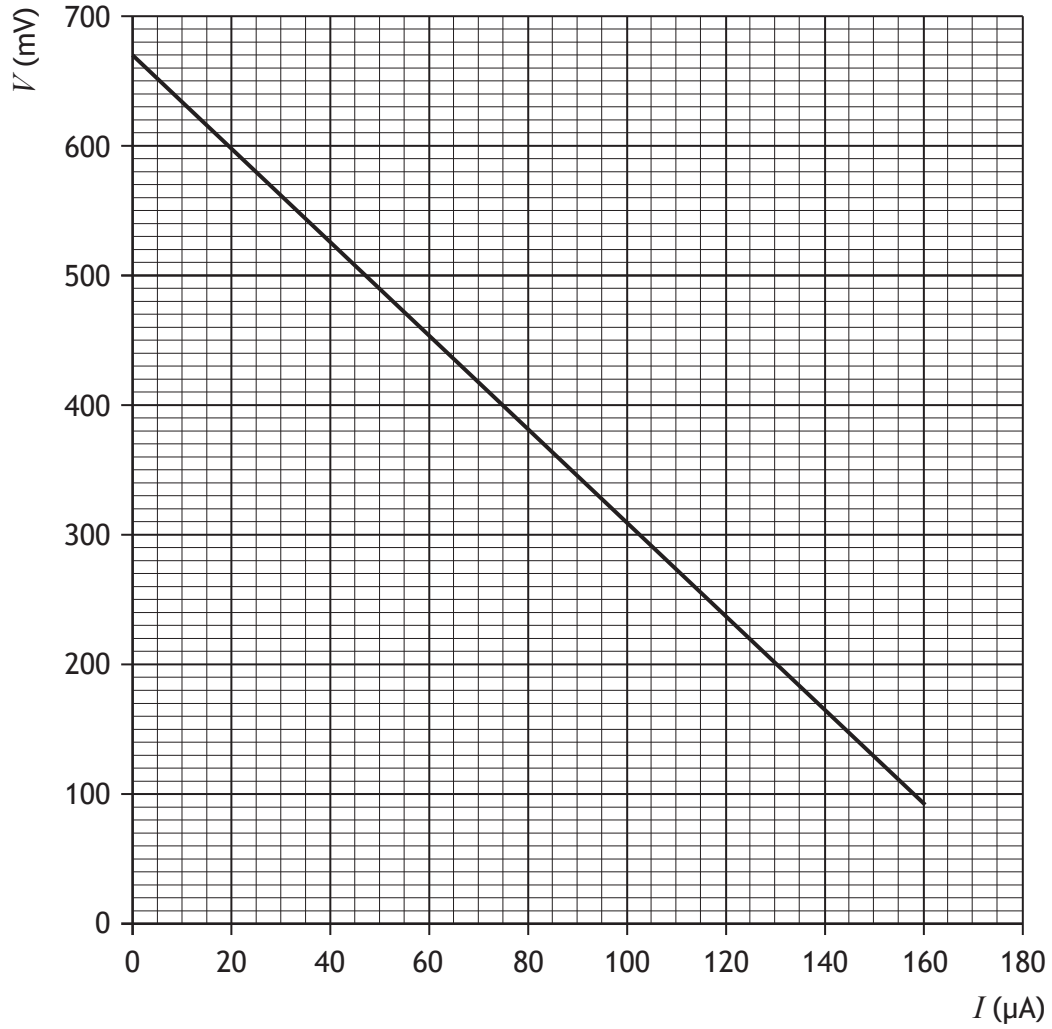
(b) The student uses readings of current I and terminal potential difference V from this circuit to produce the graph shown.



Determine the internal resistance of the potato battery. **3**

Space for working and answer

[Turn over

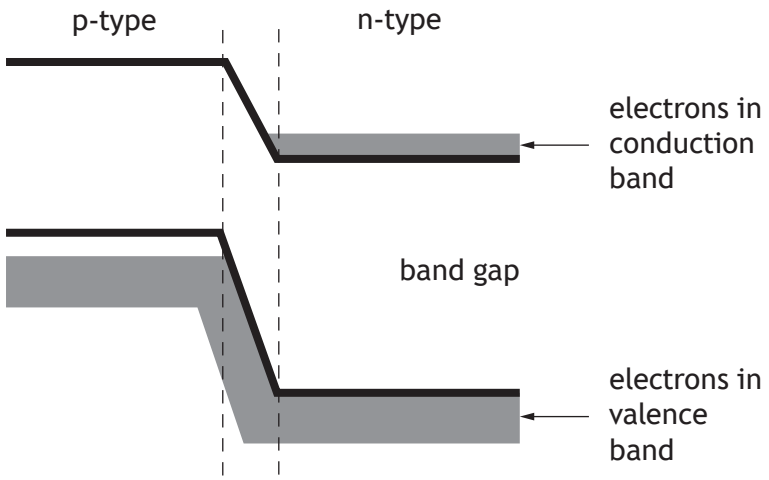
11. (continued)

(c) The student connects a red LED and a blue LED, in turn, to the battery.

The LEDs are forward biased when connected.

The student observes that the battery will operate the red LED but not the blue LED.

The diagram represents the band structure of the blue LED.



LEDs emit light when electrons fall from the conduction band into the valence band of the p-type semiconductor.

Explain, using **band theory**, why the blue LED will not operate with this battery. **1**

[Turn over for next question

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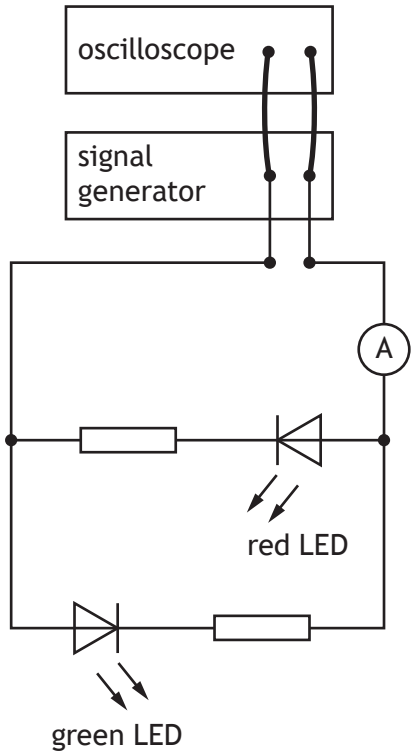
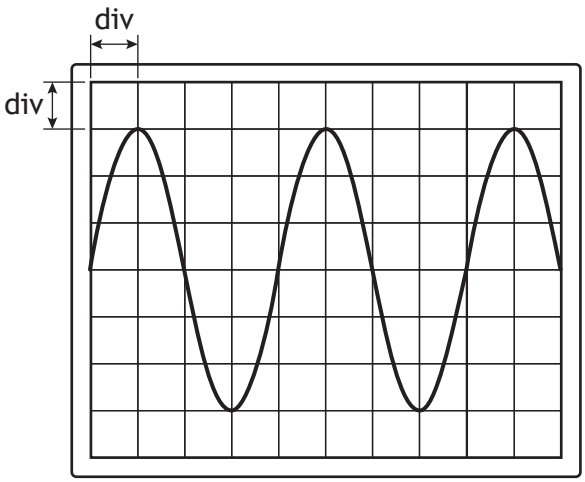
12. A student carries out a series of experiments to investigate alternating current.

(a) A signal generator is connected to an oscilloscope and a circuit as shown.



The output of the signal generator is displayed on the oscilloscope.



The Y-gain setting on the oscilloscope is 1·0 V/div.

The timebase setting on the oscilloscope is 0·5 s/div.

12. (a) (continued)

(i) Determine the peak voltage of the output of the signal generator. **1**

Space for working and answer

(ii) Determine the frequency of the output of the signal generator. **3**

Space for working and answer

(iii) The student observes that the red LED is only lit when the ammeter gives a positive reading and the green LED is only lit when the ammeter gives a negative reading.

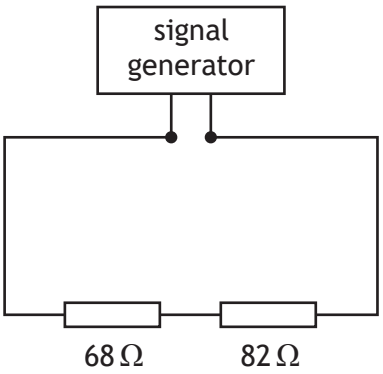
Explain these observations. **2**

12. (continued)

(b) The signal generator is now connected in a circuit as shown.

The settings on the signal generator are unchanged.

The signal generator has negligible internal resistance.



Determine the r.m.s. voltage across the 82 Ω resistor. **5**

Space for working and answer

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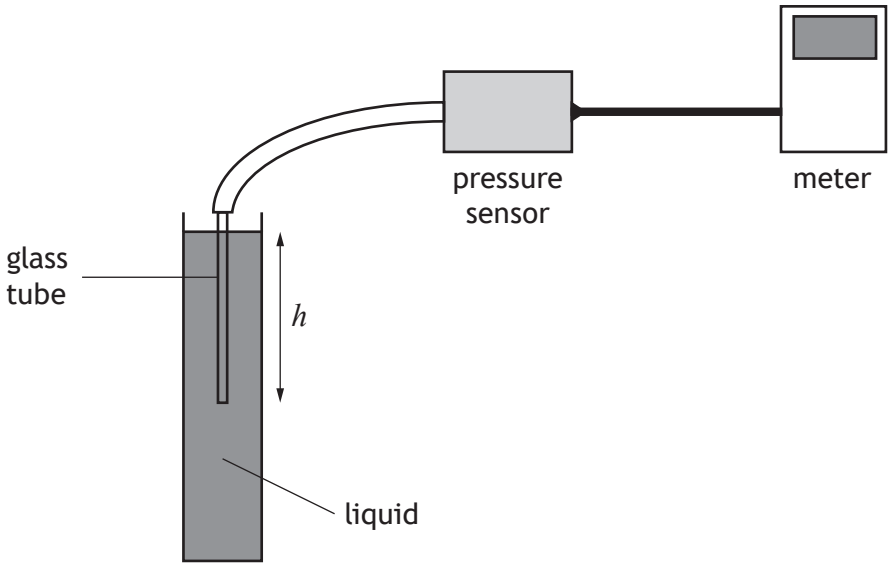
13. A student sets up an experiment to investigate the pressure due to a liquid as shown.



The pressure due to a liquid is given by the relationship

$$p = \rho g h$$

where p is the pressure due to the liquid in pascals (Pa),

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

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

and h is the depth in the liquid in m.

(a) The student initially carries out the investigation using water.

The density of water is $1{\cdot}00 \times 10^3$ kg m^{-3}.

Calculate the pressure due to the water at a depth of 0·35 m. **2**

Space for working and answer

13. **(continued)**

(b) The student repeats the experiment with a different liquid.

The pressure meter is set to zero before the glass tube is lowered into the liquid.

The student takes measurements of the pressure at various depths below the surface of the liquid.

The student records the following information.

Depth, h (m)	Pressure, p (kPa)
0·10	1·2
0·20	2·5
0·30	3·6
0·40	4·9
0·50	6·2

(i) Using the square-ruled paper on *page 43*, draw a graph of p against h. **3**

(Additional graph paper, if required, can be found on *page 44*.)

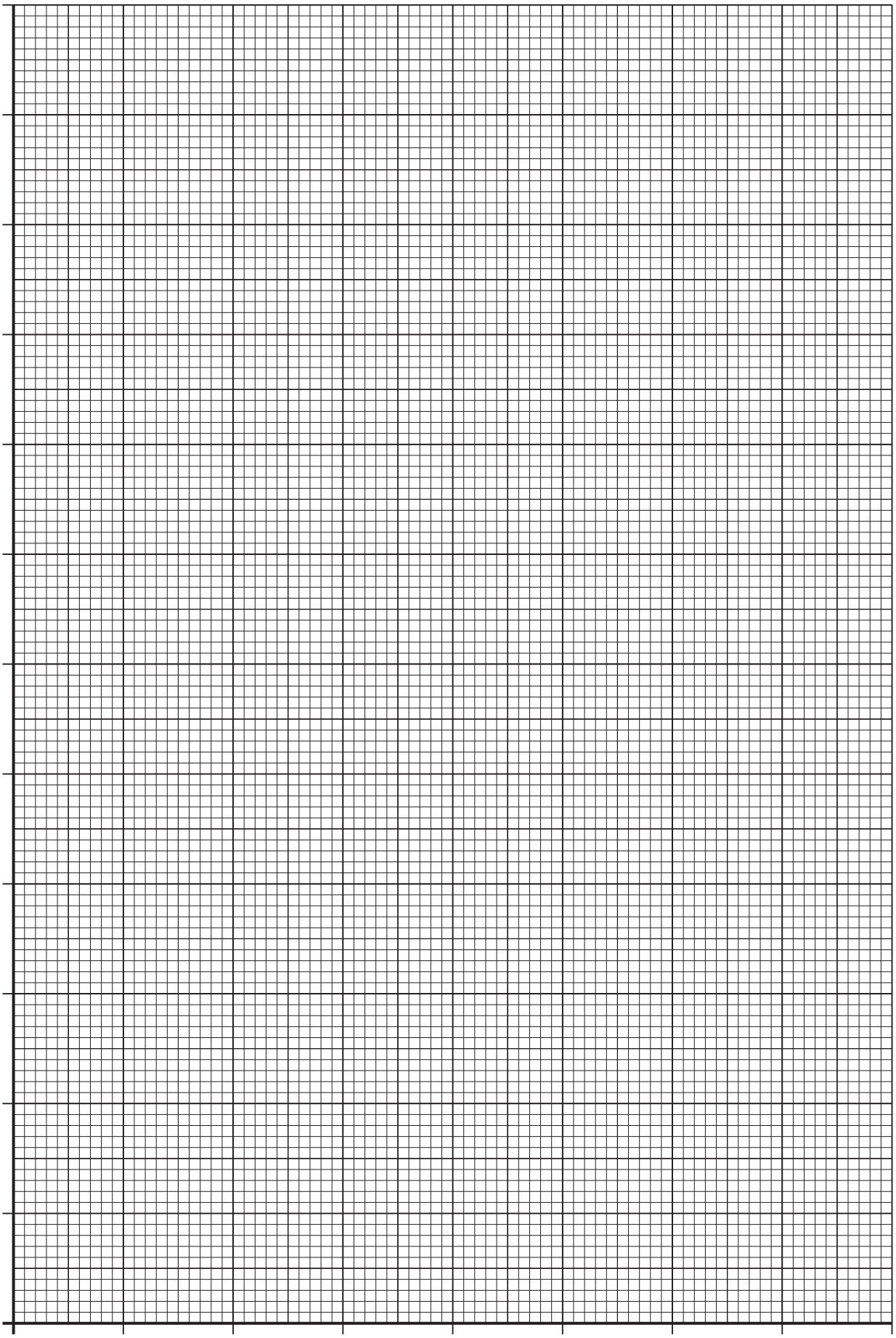
(ii) Calculate the gradient of your graph. **2**

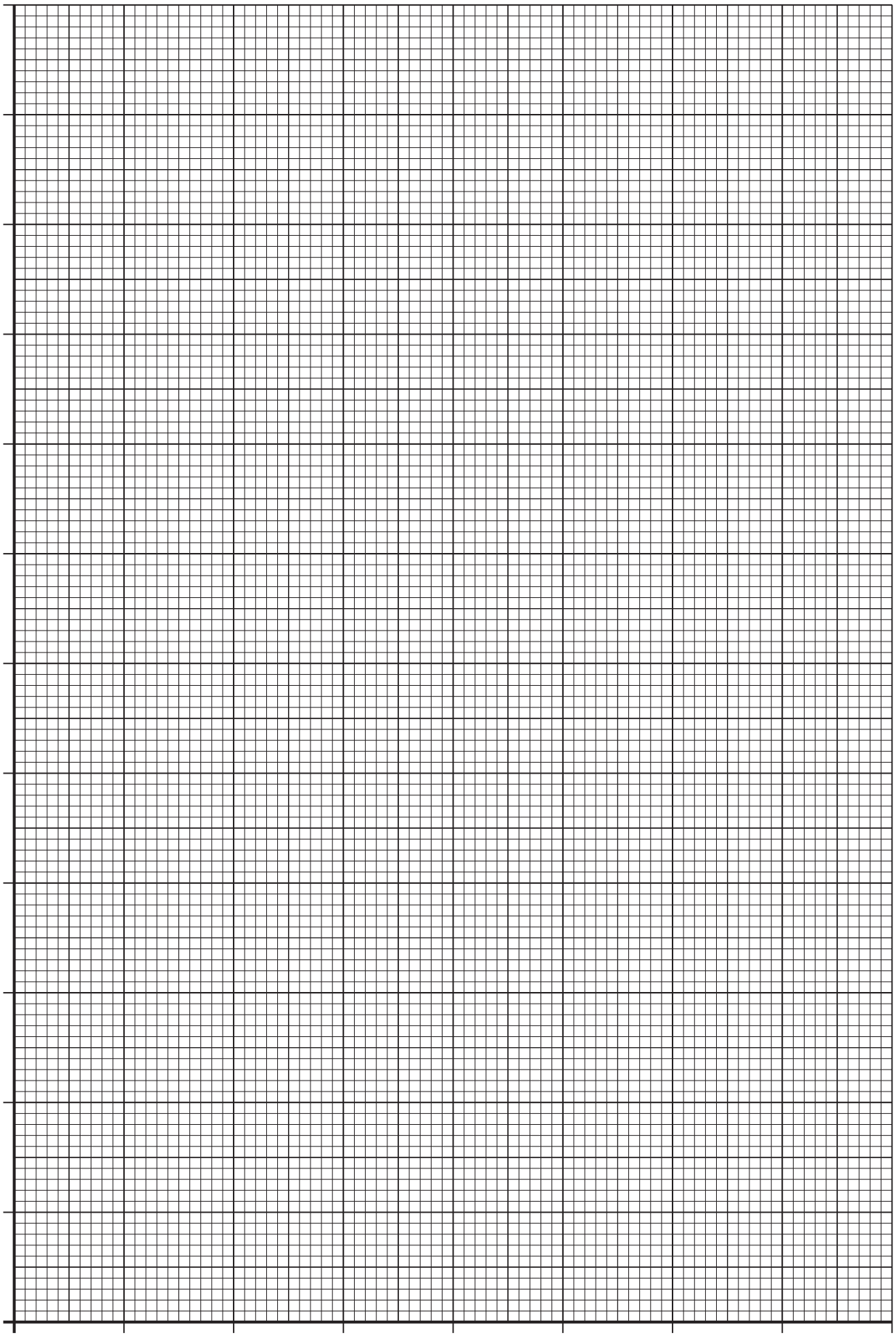
Space for working and answer

(iii) Determine the density of this liquid. **2**

Space for working and answer

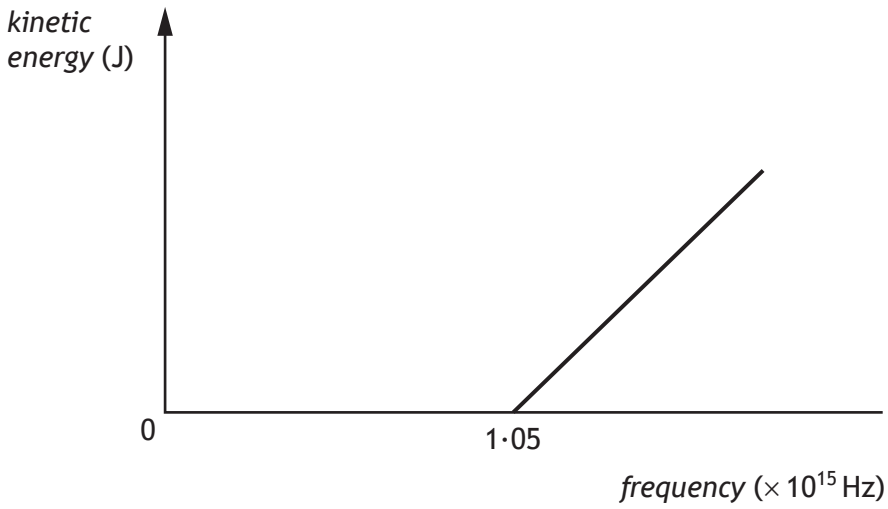
[END OF QUESTION PAPER]



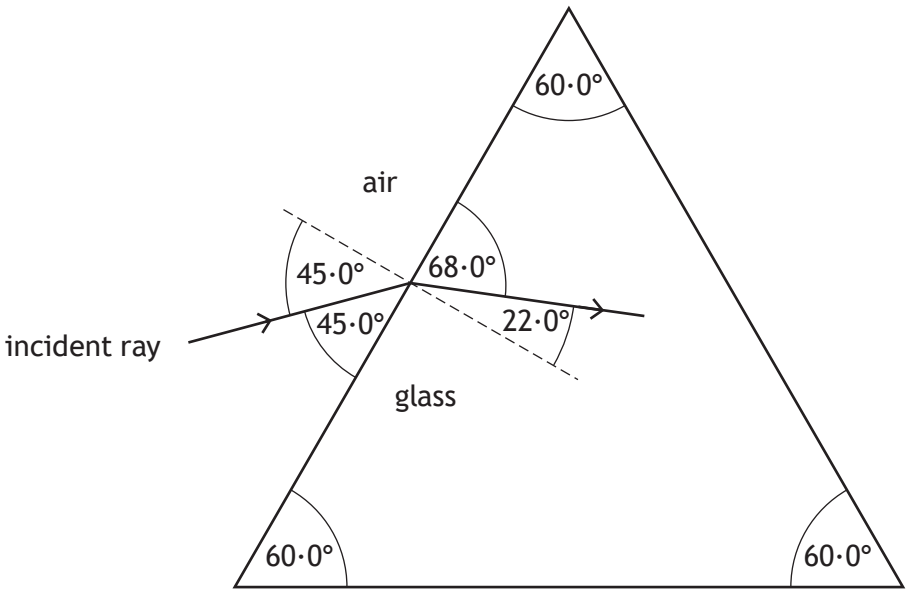


ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional graph for use with Question 7 (c)



Additional diagram for use with Question 9 (b) (iii)



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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

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ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

ACKNOWLEDGEMENTS

Question 1 – Snap2Art/Shutterstock.com

Question 2 (b) – Studio Caramel/Shutterstock.com

Question 6 (c) – Image is taken from http://jkbrickworks.com/jkbw/wp-content/uploads/2014/11/accelerator.jpg?x84406. Reproduced by kind permission of Jason Allemann.

National
Qualifications
2018

X757/76/11

Physics
Relationships Sheet

TUESDAY, 8 MAY
9:00 AM – 11:30 AM

X7577611

A/PB

Relationships required for Physics Higher

$d = \bar{v}t$

$s = \bar{v}t$

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

$s = \frac{1}{2}(u + v)t$

$W = mg$

$F = ma$

$E_W = Fd$

$E_p = mgh$

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

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

$p = mv$

$Ft = mv - mu$

$F = G\dfrac{m_1 m_2}{r^2}$

$t' = \dfrac{t}{\sqrt{1-\left(v/c\right)^2}}$

$l' = l\sqrt{1-\left(v/c\right)^2}$

$f_o = f_s\left(\dfrac{v}{v \pm v_s}\right)$

$z = \dfrac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}}$

$z = \dfrac{v}{c}$

$v = H_0 d$

$W = QV$

$E = mc^2$

$E = hf$

$E_k = hf - hf_0$

$E_2 - E_1 = hf$

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

$v = f\lambda$

$d\sin\theta = m\lambda$

$n = \dfrac{\sin\theta_1}{\sin\theta_2}$

$\dfrac{\sin\theta_1}{\sin\theta_2} = \dfrac{\lambda_1}{\lambda_2} = \dfrac{v_1}{v_2}$

$\sin\theta_c = \dfrac{1}{n}$

$I = \dfrac{k}{d^2}$

$I = \dfrac{P}{A}$

$V_{peak} = \sqrt{2}V_{rms}$

$I_{peak} = \sqrt{2}I_{rms}$

$Q = It$

$V = IR$

$P = IV = I^2R = \dfrac{V^2}{R}$

$R_T = R_1 + R_2 + ...$

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

$E = V + Ir$

$V_1 = \left(\dfrac{R_1}{R_1 + R_2}\right)V_s$

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

$C = \dfrac{Q}{V}$

$E = \frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\dfrac{Q^2}{C}$

path difference $= m\lambda$ or $\left(m + \frac{1}{2}\right)\lambda$ where $m = 0, 1, 2...$

random uncertainty $= \dfrac{\text{max. value} - \text{min. value}}{\text{number of values}}$

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

Group 1 (1)	Group 2 (2)	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	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	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	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						

Transition Elements

(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
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
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
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
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