National Qualifications 2022

X857/75/02

Physics
Section 1 — Questions

FRIDAY, 13 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 Relationship 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.

Speed of light in materials

Material	Speed in m s^{-1}
Air	3.0×10^8
Carbon dioxide	3.0×10^8
Diamond	1.2×10^8
Glass	2.0×10^8
Glycerol	2.1×10^8
Water	2.3×10^8

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	0.99×10^5
Aluminium	3.95×10^5
Carbon Dioxide	1.80×10^5
Copper	2.05×10^5
Iron	2.67×10^5
Lead	0.25×10^5
Water	3.34×10^5

Specific latent heat of vaporisation of materials

Material	Specific latent heat of vaporisation in J kg^{-1}
Alcohol	11.2×10^5
Carbon Dioxide	3.77×10^5
Glycerol	8.30×10^5
Turpentine	2.90×10^5
Water	22.6×10^5

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
Lead	328	1737
Iron	1537	2737
Water	–	100

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 — 25 marks

Attempt ALL questions

1. Which of the following contains one scalar quantity and one vector quantity?

A acceleration; displacement

B kinetic energy; speed

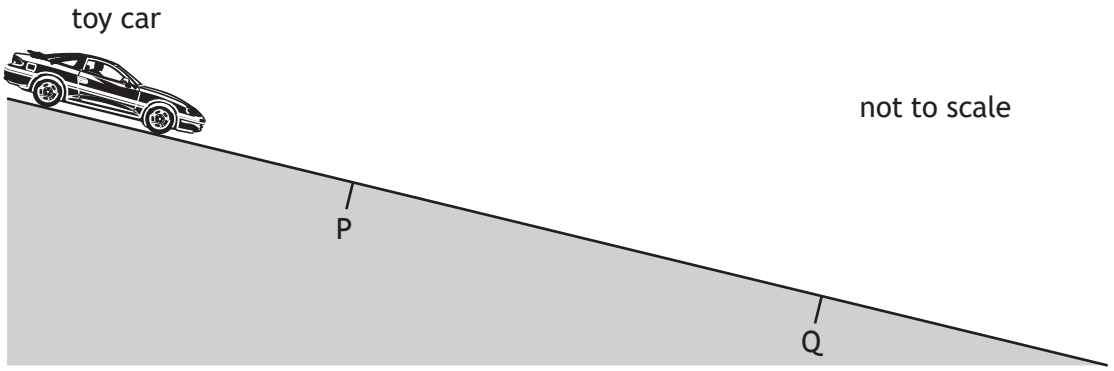
C velocity; weight

D potential energy; work

E distance; force

2. The diagram shows a toy car at rest at the top of a slope.

The car is released and travels with a constant acceleration down the slope.

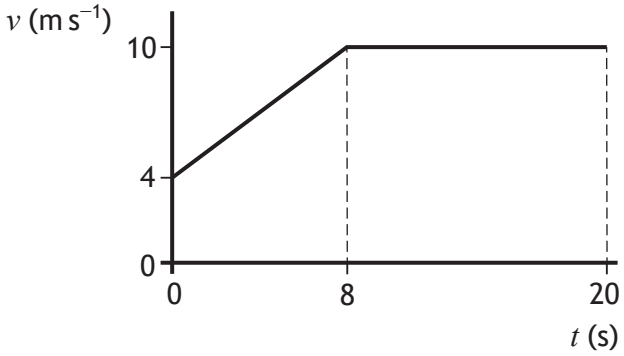


Which row in the table could show the speed of the toy car at P, the speed of the toy car at Q, and the average speed of the car between P and Q?

	Speed at P ($m\,s^{-1}$)	**Speed at Q ($m\,s^{-1}$)**	**Average speed between P and Q ($m\,s^{-1}$)**
A	0	2	1
B	1	1	1
C	1	3	2
D	2	3	2
E	2	3	4

[Turn over

3. The graph of speed v against time t represents the motion of a cyclist over a 20 second period.



The distance travelled by the cyclist in the 20 second period is:

A 56 m

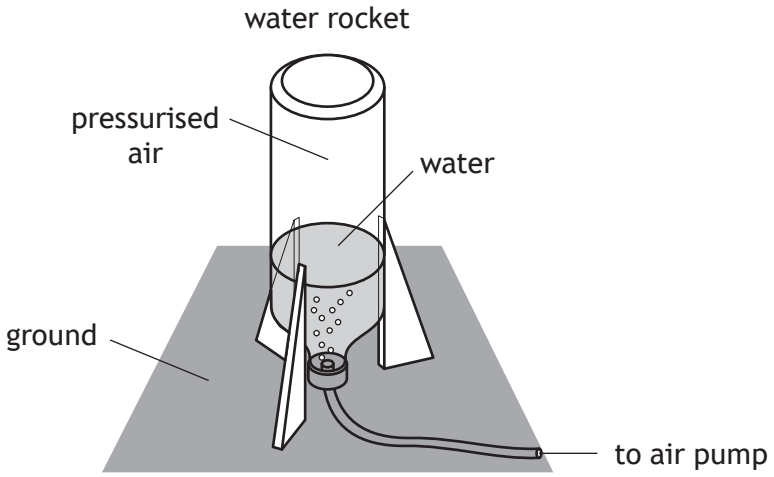
B 144 m

C 160 m

D 176 m

E 200 m.

4. A student is investigating the motion of water rockets.



Air is pumped into the rocket until the pressure of the air inside is large enough for the water rocket to launch upwards.

The rocket launches because:

A the rocket pushes down on the ground and the ground provides a reaction force pushing up on the rocket

B the rocket pushes down on the water and the water provides a reaction force pushing up on the rocket

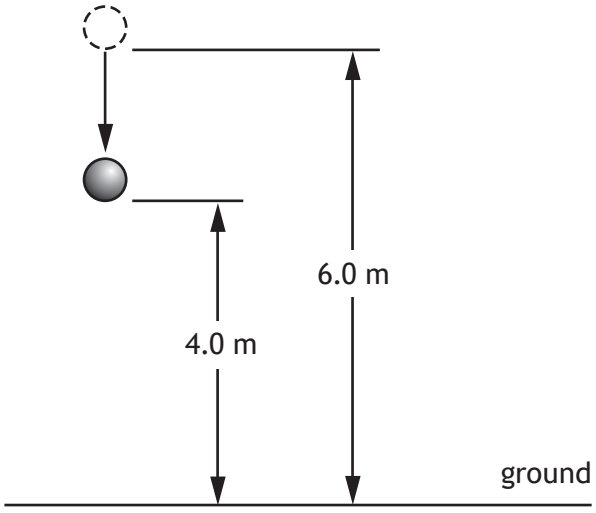
C the water pushes down on the ground and the ground provides a reaction force pushing up on the water

D the force applied by the water on the ground is greater than the weight of the rocket producing an unbalanced upward force

E the weight of the rocket decreases as water is pushed out of the rocket producing an unbalanced upward force.

[Turn over

5. A ball of mass 0.25 kg is released from a height of 6.0 m above the ground.



Which row in the table shows the change in gravitational potential energy and the kinetic energy of the ball when it is at a height of 4.0 m above the ground?

	Change in gravitational potential energy (J)	**Kinetic energy (J)**
A	14.7	0.0
B	4.9	4.9
C	9.8	4.9
D	4.9	9.8
E	14.7	14.7

6. Astronauts orbiting in the International Space Station experience 'weightlessness'.

A group of students make the following statements to explain 'weightlessness' in the orbiting space station:

I The gravitational field strength inside the space station is zero.

II The space station and astronauts are both accelerating at the same rate towards the Earth.

III The forces acting on the astronauts are balanced.

Which of these statements is/are correct?

A I only

B II only

C III only

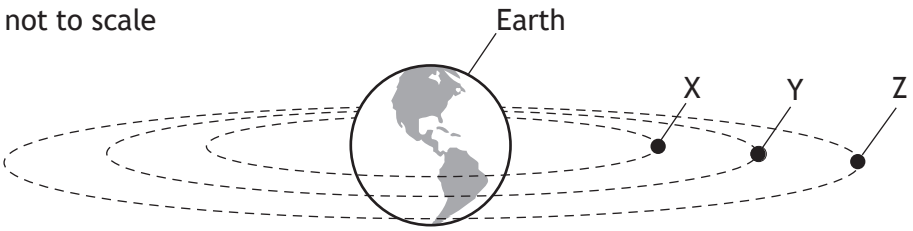
D I and II only

E II and III only

7. Which of the following lists the distances from longest to shortest?

A radius of Earth; radius of orbit of Moon; diameter of galaxy
B radius of orbit of Moon; radius of Earth; diameter of galaxy
C diameter of galaxy; radius of orbit of Moon; radius of Earth
D diameter of galaxy; radius of Earth; radius of orbit of Moon
E radius of orbit of Moon; diameter of galaxy; radius of Earth

8. Three satellites X, Y, and Z are orbiting the Earth as shown.



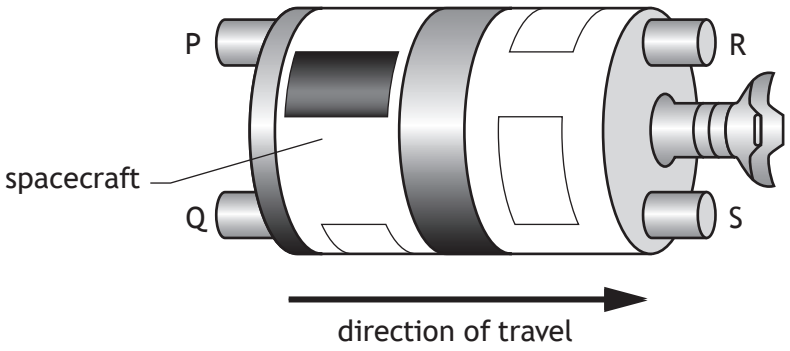
Satellite Z is a geostationary satellite.

Which row in the table shows possible periods for the orbits of satellites X, Y, and Z?

	Period of orbit of satellite X (hours)	**Period of orbit of satellite Y (hours)**	**Period of orbit of satellite Z (hours)**
A	12	18	24
B	24	18	12
C	24	24	24
D	40	36	24
E	4	6	12

[Turn over

9. A spacecraft has four rocket engines P, Q, R, and S and is travelling to the right as shown.



When switched on, each rocket engine produces the same amount of force.
Which rocket engines are switched on to reduce the speed of the spacecraft?

A R and S
B Q and S
C P and Q
D P and R
E P, Q, R, and S

10. The weights of three masses on the surface of a planet are shown in the table.

Mass (kg)	Weight (N)
0.50	4.4
2.5	22
4.0	35

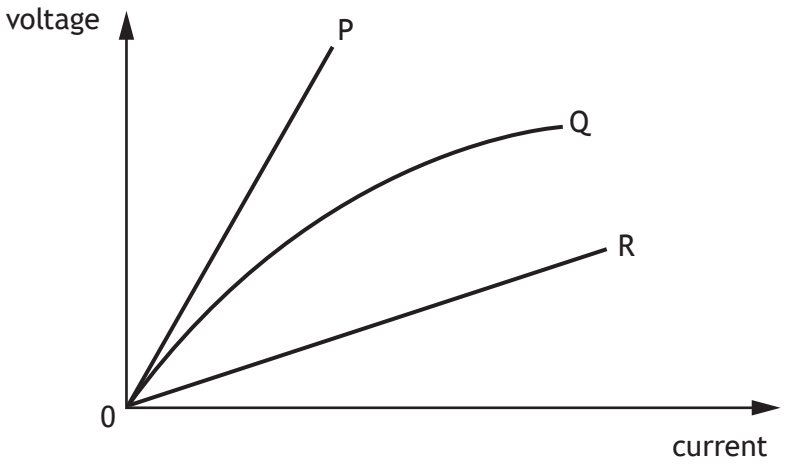
The weight of a 6.0 kg mass on the surface of the planet is:

A 0.68 N
B 1.5 N
C 8.8 N
D 53 N
E 59 N.

11. A hair dryer is connected to a 230 V supply. The current in the hair dryer is 2.0 A.
The electrical charge that passes through the hair dryer in 5 minutes is:

A 10 C
B 460 C
C 600 C
D 1150 C
E 2300 C.

12. The graph shows how the voltages across the components P, Q, and R vary with current.



Based on this graph, a group of students make the following statements:

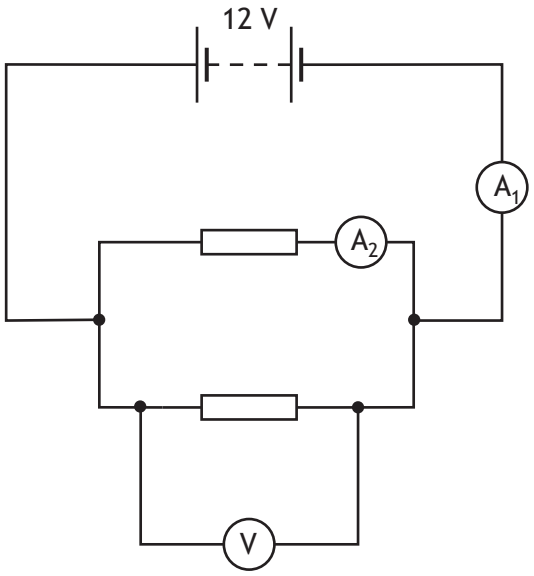
I Component P has a greater resistance than component R.
II Component R has a greater resistance than component Q.
III Component Q has a resistance that decreases as the current increases.

Which of these statements is/are correct?

A I only
B II only
C III only
D I and III only
E II and III only

[Turn over

13. A circuit is set up as shown.



The resistors are identical.

Which row in the table shows the reading on the voltmeter and possible readings on ammeters A_1 and A_2?

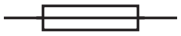
	Reading on voltmeter (V)	**Reading on ammeter A_1 (A)**	**Reading on ammeter A_2 (A)**
A	6	0.3	0.3
B	6	0.6	0.3
C	12	0.3	0.3
D	12	0.3	0.6
E	12	0.6	0.3

14. Which of the following symbols represents a thermistor?

A 

B 

C 

D 

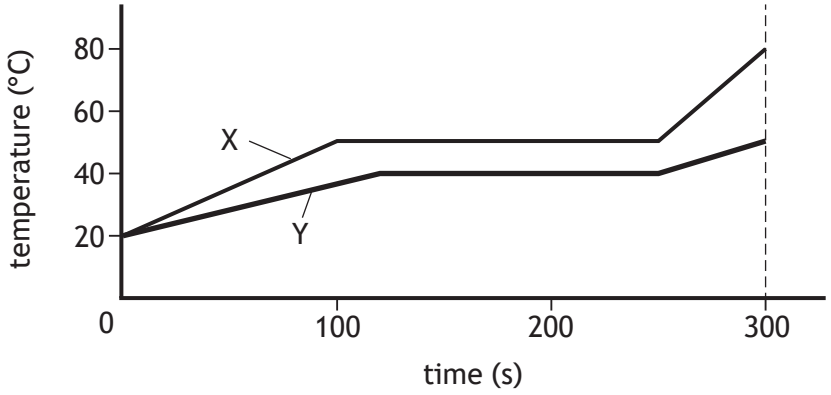
E 

[Turn over

15. Two substances X and Y are both solid at 20 °C.

The substances have the same mass and are supplied with the same amount of energy per second.

The graph shows how the temperature of each substance varies with time.



A student uses information from the graph to make the following statements:

I The specific heat capacity of the solid substance X is greater than that of the solid substance Y.

II Substance X changes state at a higher temperature than substance Y.

III The specific latent heat of fusion of substance X is greater than that of substance Y.

Which of these statements is/are correct?

A I only

B I and II only

C III only

D II and III only

E I, II and III

16. Heat from the Sun melts 1.6 kg of ice in 40 minutes.

The minimum heat energy required to change 1.6 kg of ice at 0 °C into water at 0 °C is:

A 6.7×10^3 J

B 1.3×10^4 J

C 2.1×10^5 J

D 5.3×10^5 J

E 3.6×10^6 J.

17. A cyclist is riding a bicycle along a level road.

The combined mass of the cyclist and bicycle is 70.0 kg.

The total contact area between the tyres and the road is 8.0×10^{-4} m^2.

The average pressure exerted by the tyres on the road is:

A 1.2×10^{-6} Pa

B 5.6×10^{-2} Pa

C 8.8×10^{4} Pa

D 4.3×10^{5} Pa

E 8.6×10^{5} Pa.

18. The average kinetic energy of a gas molecule can be determined using the following relationship.

$$E_k = \frac{3}{2} k_B T$$

where: E_k is the average kinetic energy of a gas molecule in joules, J

k_B is Boltzmann's constant $= 1.38 \times 10^{-23}$ J K^{-1}

T is the temperature of a gas molecule in kelvin, K.

The average kinetic energy of a gas molecule at 100 °C is:

A 2.07×10^{-21} J

B 3.58×10^{-21} J

C 5.15×10^{-21} J

D 5.65×10^{-21} J

E 7.72×10^{-21} J.

[Turn over

19. Which of the following is a longitudinal wave?

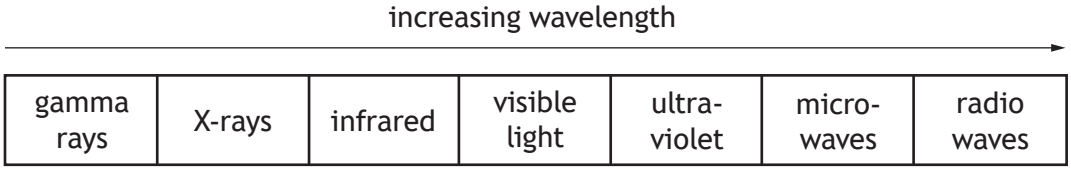
A sound
B radio
C ultraviolet
D infrared
E light

20. A radio station transmits radio signals with a frequency range from 3.0 MHz to 6.0 MHz.

The maximum wavelength of the radio signal transmitted is:

A 0.01 m
B 0.02 m
C 50 m
D 100 m
E 113 m.

21. A student draws a diagram to show the bands of the electromagnetic spectrum in order of increasing wavelength.



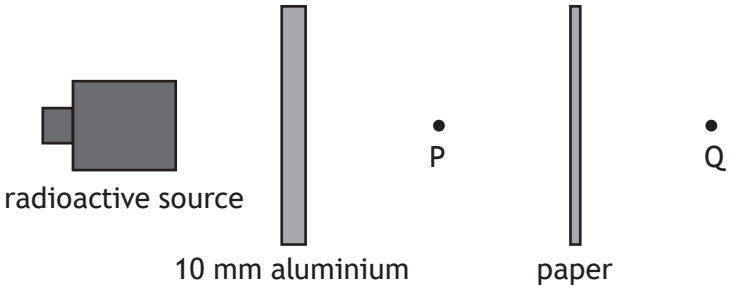
The diagram is **not** correct.

Which **two** bands of the electromagnetic spectrum are in the wrong position?

A gamma rays and radio waves
B X-rays and microwaves
C infrared and ultraviolet
D visible light and microwaves
E X-rays and visible light

22. A radioactive source emits alpha, beta, and gamma radiations.

Sheets of aluminium and paper are placed in front of the source as shown.



Which row in the table shows the radiation(s) from the source detected at points P and Q?

	Radiation(s) detected at P	**Radiation(s) detected at Q**
A	beta and gamma	gamma
B	beta	alpha
C	beta and gamma	beta and gamma
D	alpha and gamma	gamma
E	gamma	gamma

23. A radioactive sample emits 3000 alpha particles in 2 minutes.

The activity of the sample is:

A 25 Bq

B 1500 Bq

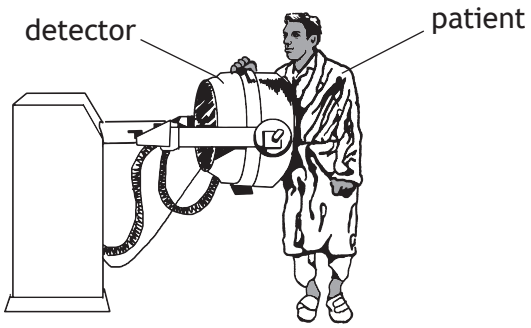
C 3000 Bq

D 6000 Bq

E 360 000 Bq.

[Turn over

24. A radioactive substance is to be injected into a patient so that blood flow can be monitored using a detector.



A number of different substances which emit either beta or gamma radiation are available.

The substances have different half-lives.

Which row in the table identifies the radiation emitted and the half-life of the most suitable substance?

	Radiation emitted	**Half-life**
A	beta	2 days
B	beta	2 years
C	gamma	2 seconds
D	gamma	2 days
E	gamma	2 years

25. Rhodium-106 has a half-life of 30 s.

A sample of rhodium-106 has an activity of 3200 Bq.

The activity of this sample after 120 s is:

A 27 Bq

B 107 Bq

C 200 Bq

D 400 Bq

E 800 Bq.

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

SPACE FOR ROUGH WORK

SPACE FOR ROUGH WORK

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