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.

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

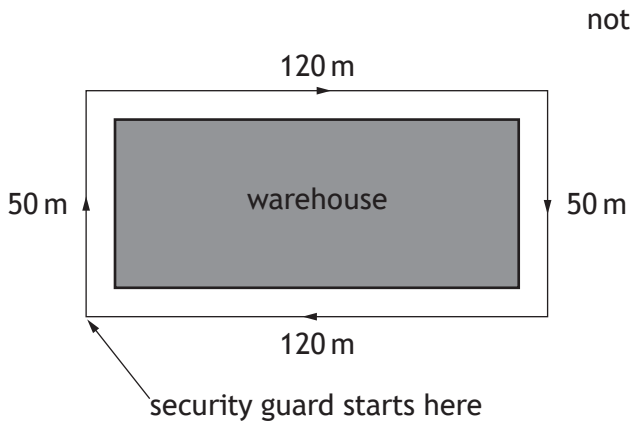
B displacement

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.

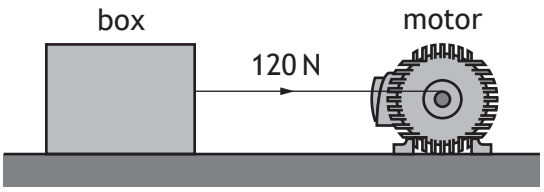
B There is only a horizontal force acting on the ball.

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

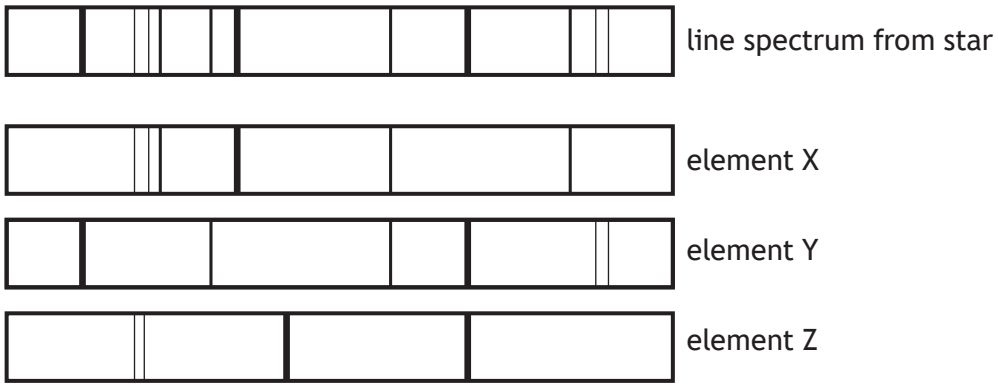
C $3{\cdot}4 \times 10^{15}$ m

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

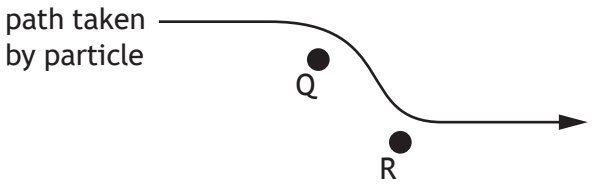
D I and III only

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.

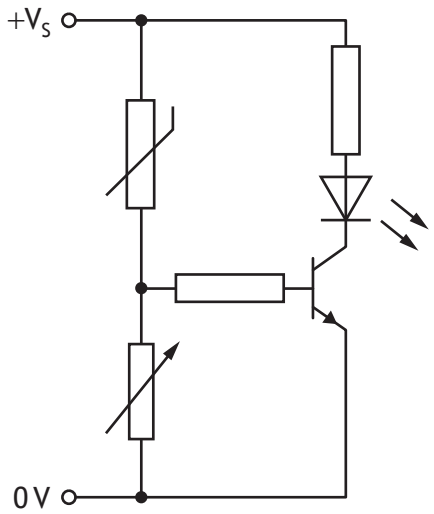


Which row in the table identifies the charge on the particle, the charge on Q and the charge on R?

	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.

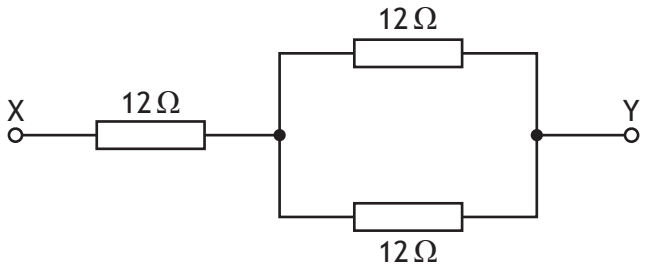
The temperature of the thermistor is now increased.

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

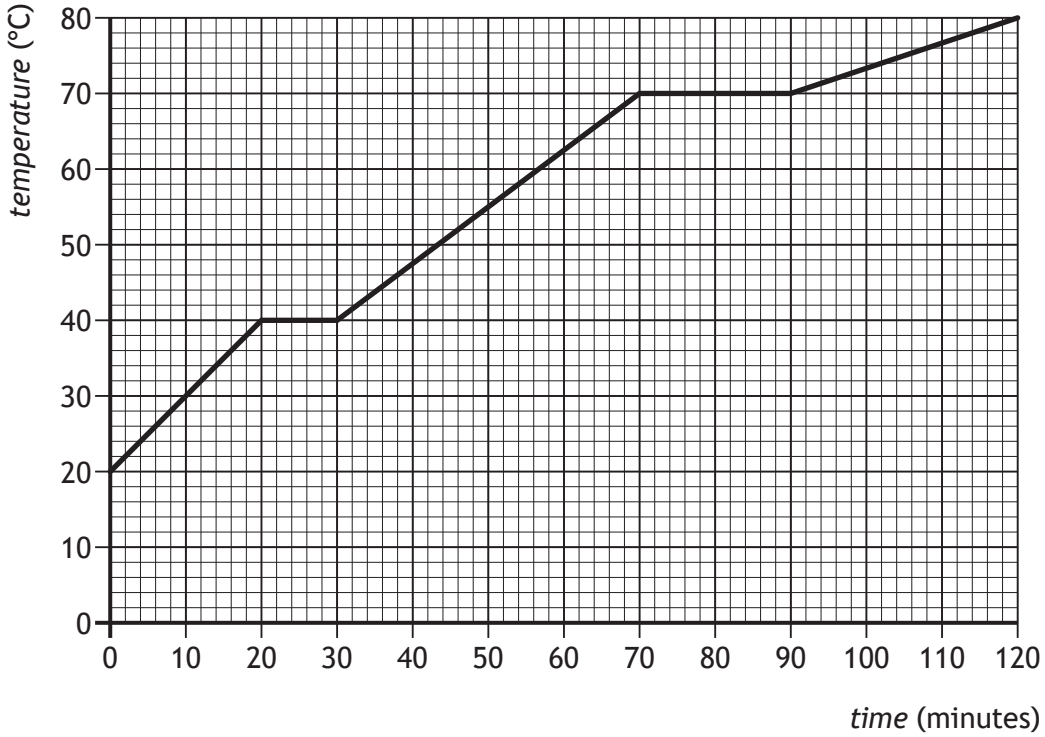
A 3 W
B 36 W
C 48 W
D 96 W
E 576 W.

[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

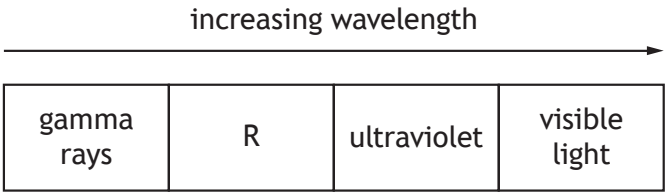
C I and II only

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.



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 0·40 mSv 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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