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.

X7577602

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

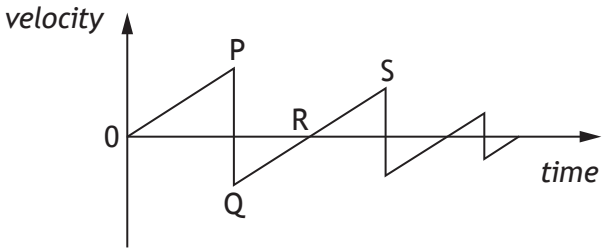
C 24 m

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 0·10c relative to a star.

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

A 0·90c

B 0·99c

C 1·00c

D 1·01c

E 1·10c.

7. A spacecraft is travelling at a speed of 0·200c 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

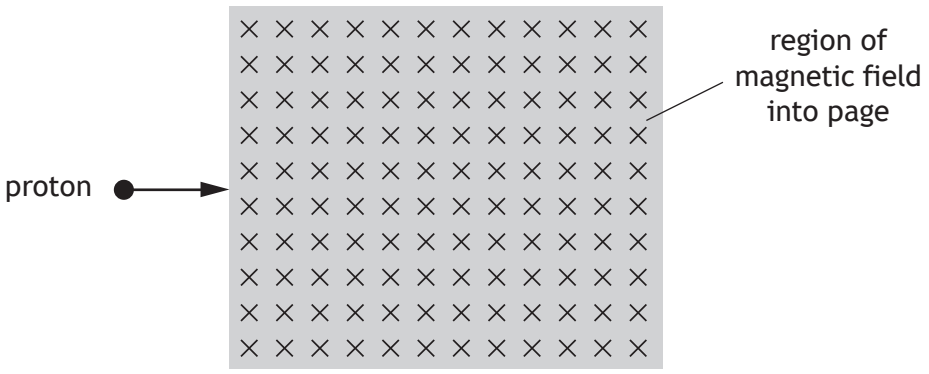
C baryon

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 $0{\cdot}11I$

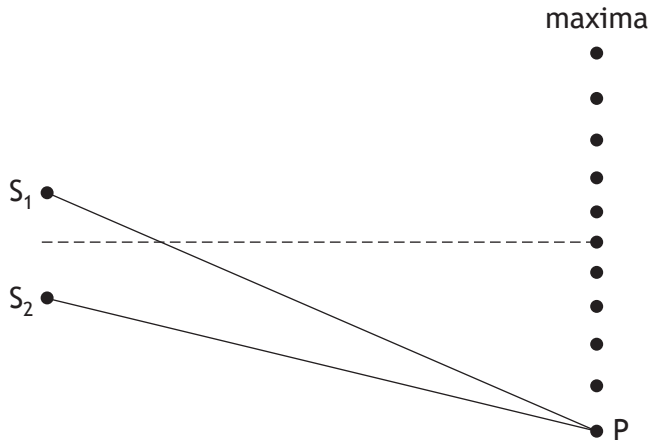
B $0{\cdot}33I$

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

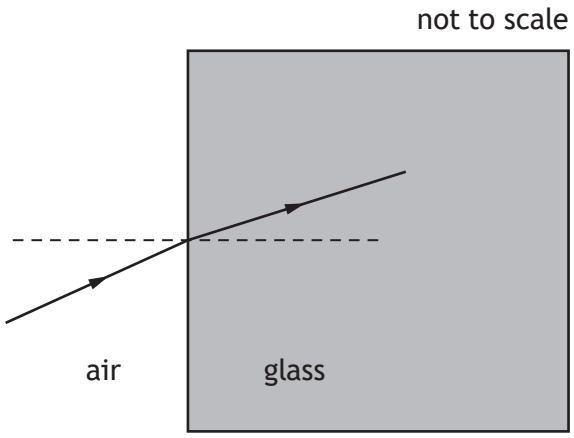
C 28·0 mm

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

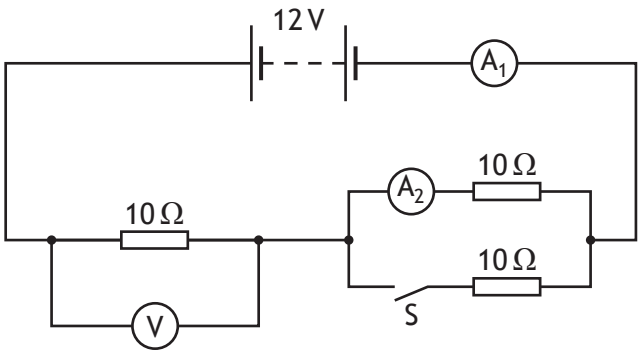
B $1{\cdot}26 \times 10^{2}$ Hz

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

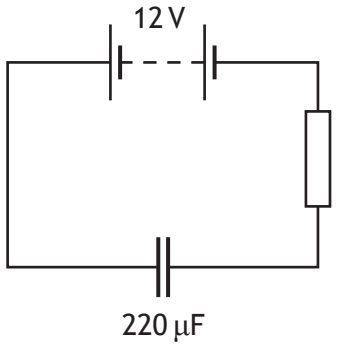
B $7{\cdot}75 \times 10^{-2}$ C

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

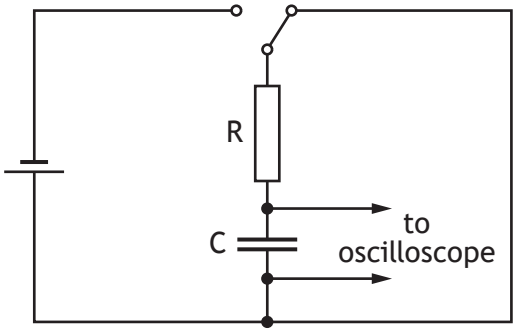
B $1{\cdot}3 \times 10^{-3}$ J

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

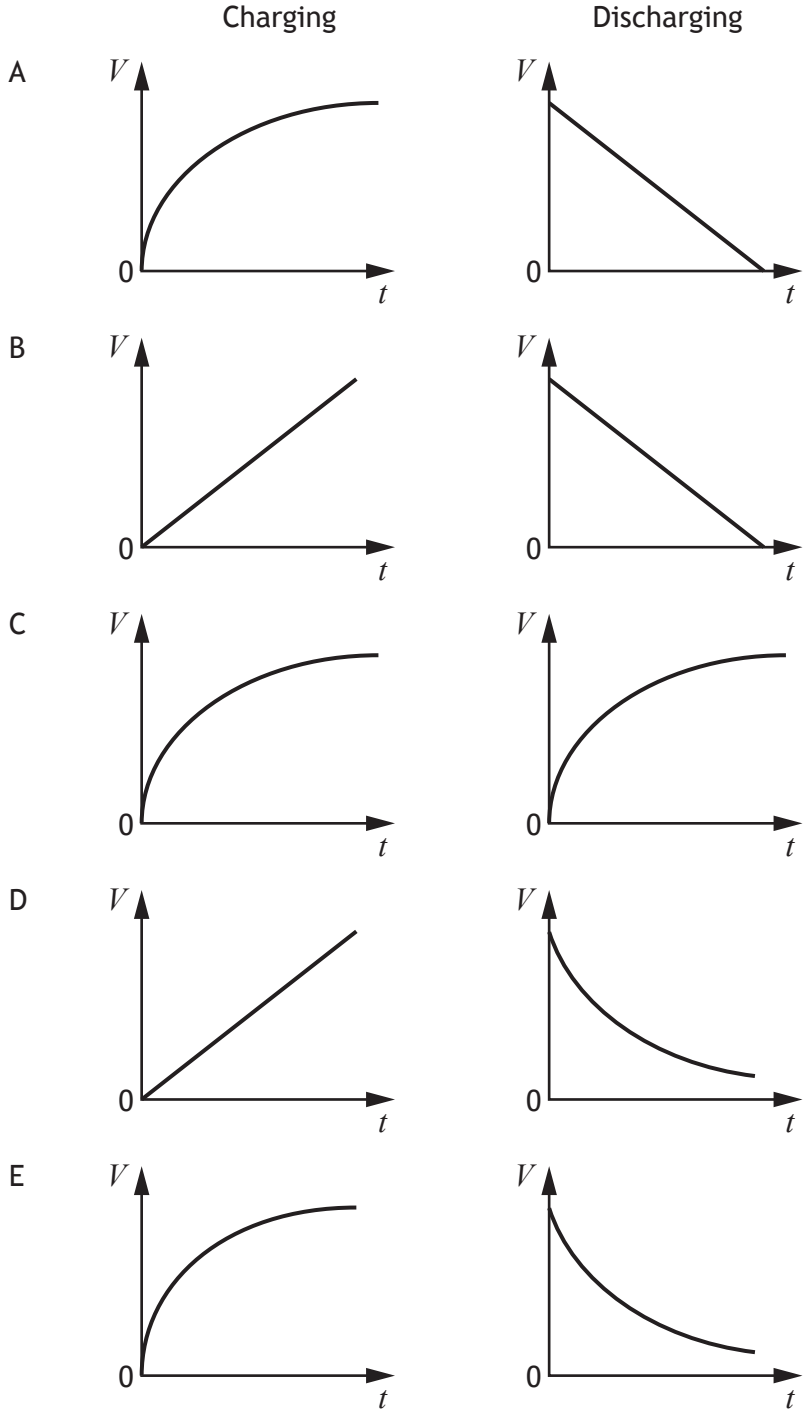
D $1{\cdot}6 \times 10^{-2}$ J

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?



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]