National
Qualifications
2015

X757/76/02

Physics
Section 1—Questions

TUESDAY, 5 MAY
1:00 PM – 3:30 PM

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

Record your answers on the answer grid on *Page three* of your question and answer booklet.

Reference may be made to the Data Sheet on *Page two* 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

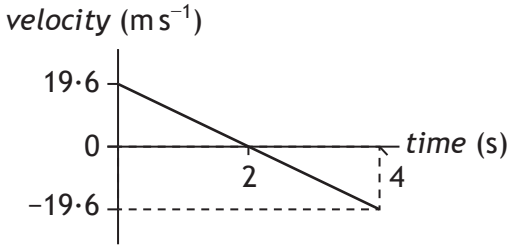
Substance	*Density*/kg m^{-3}	*Melting Point*/K	*Boiling Point*/K
Aluminium	$2{\cdot}70 \times 10^{3}$	933	2623
Copper	$8{\cdot}96 \times 10^{3}$	1357	2853
Ice	$9{\cdot}20 \times 10^{2}$	273	. . . .
Sea Water	$1{\cdot}02 \times 10^{3}$	264	377
Water	$1{\cdot}00 \times 10^{3}$	273	373
Air	1·29	. . . .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

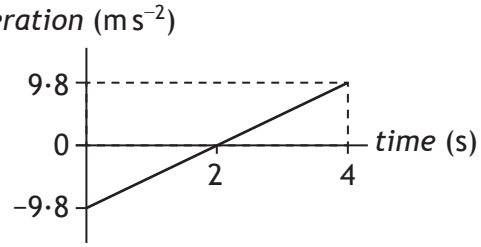
Attempt ALL questions

1. The following velocity-time graph represents the vertical motion of a ball.

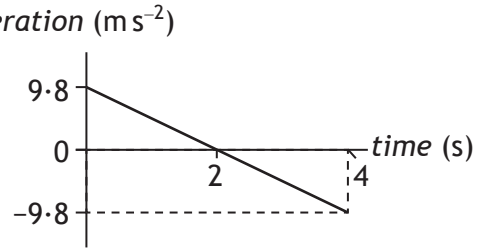


Which of the following acceleration-time graphs represents the same motion?

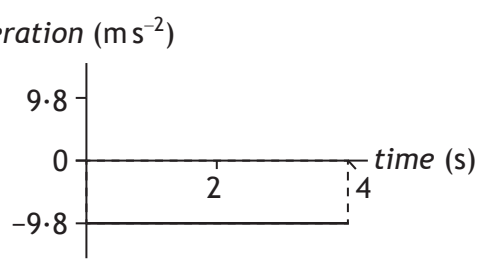
A



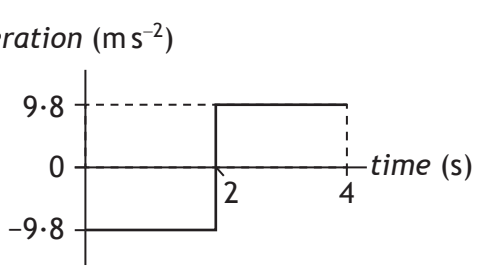
B



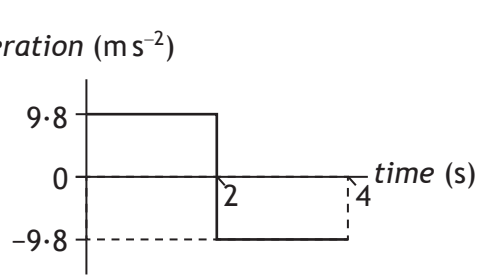
C



D



E



2. A car is travelling at $12\,m\,s^{-1}$ along a straight road. The car now accelerates uniformly at $-1{\cdot}5\,m\,s^{-2}$ for $6{\cdot}0\,s$.

The distance travelled during this time is

A 18 m

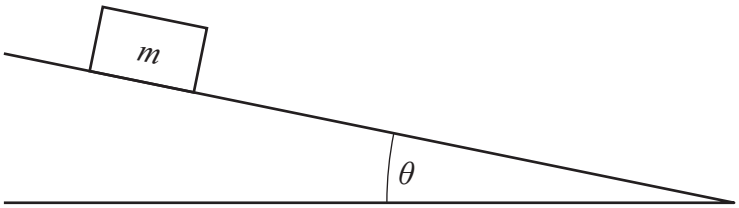
B 45 m

C 68 m

D 72 m

E 99 m.

3. A box of mass m rests on a slope as shown.



Which row in the table shows the component of the weight acting down the slope and the component of the weight acting normal to the slope?

	Component of weight acting down the slope	*Component of weight acting normal to the slope*
A	$mg\sin\theta$	$mg\cos\theta$
B	$mg\tan\theta$	$mg\sin\theta$
C	$mg\cos\theta$	$mg\sin\theta$
D	$mg\cos\theta$	$mg\tan\theta$
E	$mg\sin\theta$	$mg\tan\theta$

4. A person stands on bathroom scales in a lift.

The scales show a reading greater than the person's weight.

The lift is moving

A upwards with constant speed

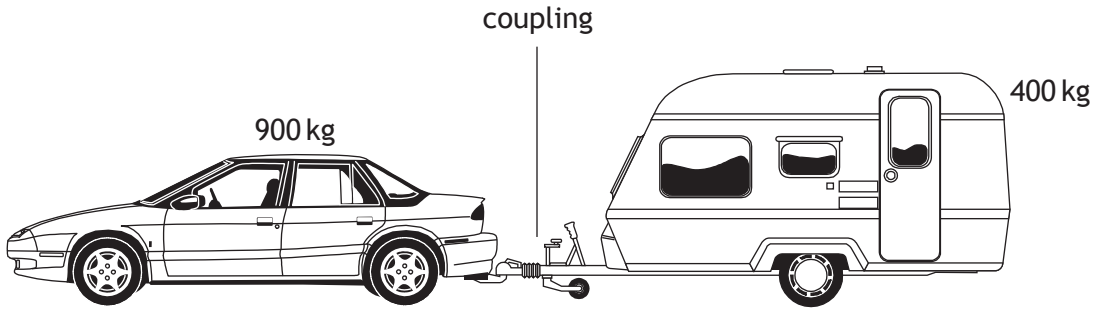
B downwards with constant speed

C downwards with increasing speed

D downwards with decreasing speed

E upwards with decreasing speed.

5. A car of mass 900 kg pulls a caravan of mass 400 kg along a straight, horizontal road with an acceleration of $2{\cdot}0\,\text{m}\,\text{s}^{-2}$.



Assuming that the frictional forces on the caravan are negligible, the tension in the coupling between the car and the caravan is

A 400 N
B 500 N
C 800 N
D 1800 N
E 2600 N.

6. Water flows at a rate of $6{\cdot}25 \times 10^8$ kg per minute over a waterfall.

The height of the waterfall is 108 m.

The total power delivered by the water in falling through the 108 m is

A $1{\cdot}13 \times 10^9$ W
B $1{\cdot}10 \times 10^{10}$ W
C $6{\cdot}62 \times 10^{11}$ W
D $4{\cdot}05 \times 10^{12}$ W
E $3{\cdot}97 \times 10^{13}$ W.

7. A spacecraft is travelling at a constant speed of $0{\cdot}60c$ relative to the Moon.

An observer on the Moon measures the length of the moving spacecraft to be 190 m.

The length of the spacecraft as measured by an astronaut on the spacecraft is

A 120 m
B 152 m
C 238 m
D 297 m
E 300 m.

[Turn over

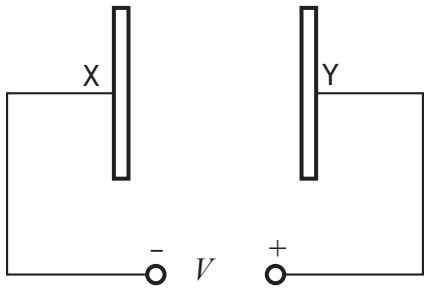
8. A siren on an ambulance emits sound at a constant frequency of 750 Hz.
The ambulance is travelling at a constant speed of 25·0 m s^{-1} towards a stationary observer.
The speed of sound in air is 340 m s^{-1}.
The frequency of the sound heard by the observer is

A 695 Hz
B 699 Hz
C 750 Hz
D 805 Hz
E 810 Hz.

9. The emission of beta particles in radioactive decay is evidence for the existence of

A quarks
B electrons
C gluons
D neutrinos
E bosons.

10. Two parallel metal plates X and Y in a vacuum have a potential difference V across them.

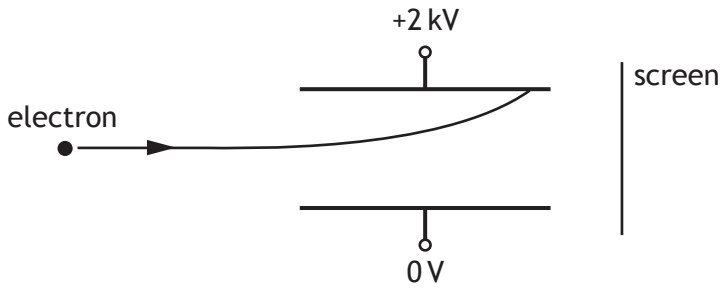


An electron of charge e and mass m, initially at rest, is released from plate X.
The speed of the electron when it reaches plate Y is given by

A $\frac{2eV}{m}$
B $\sqrt{\frac{2eV}{m}}$
C $\sqrt{\frac{2V}{em}}$
D $\frac{2V}{em}$
E $\frac{2mV}{e}$

11. A potential difference of 2 kV is applied across two metal plates.

An electron passes between the metal plates and follows the path shown.



A student makes the following statements about changes that could be made to allow the electron to pass between the plates and reach the screen.

I Increasing the initial speed of the electron could allow the electron to reach the screen.

II Increasing the potential difference across the plates could allow the electron to reach the screen.

III Reversing the polarity of the plates could allow the electron to reach the screen.

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

12. The following statement describes a fusion reaction.

$$^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{2}He + {}^{1}_{0}n + \text{energy}$$

The total mass of the particles before the reaction is $6{\cdot}684 \times 10^{-27}$ kg.

The total mass of the particles after the reaction is $6{\cdot}680 \times 10^{-27}$ kg.

The energy released in the reaction is

A $6{\cdot}012 \times 10^{-10}$ J

B $6{\cdot}016 \times 10^{-10}$ J

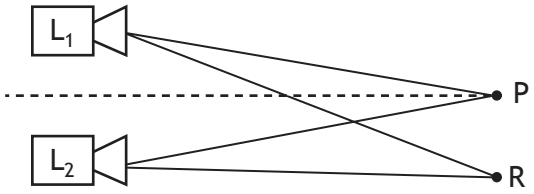
C $1{\cdot}800 \times 10^{-13}$ J

D $3{\cdot}600 \times 10^{-13}$ J

E $1{\cdot}200 \times 10^{-21}$ J.

[Turn over

13. Two identical loudspeakers, L_1 and L_2, are operated at the same frequency and in phase with each other. An interference pattern is produced.



At position P, which is the same distance from both loudspeakers, there is a maximum.

The next maximum is at position R, where $L_1R = 5{\cdot}6\,m$ and $L_2R = 5{\cdot}3\,m$.

The speed of sound in air is $340\,m\,s^{-1}$.

The frequency of the sound emitted by the loudspeakers is

A $8{\cdot}8 \times 10^{-4}\,Hz$

B $3{\cdot}1 \times 10^{1}\,Hz$

C $1{\cdot}0 \times 10^{2}\,Hz$

D $1{\cdot}1 \times 10^{3}\,Hz$

E $3{\cdot}7 \times 10^{3}\,Hz$.

14. An experiment is carried out to measure the wavelength of red light from a laser.

The following values for the wavelength are obtained.

650 nm 640 nm 635 nm 648 nm 655 nm

The mean value for the wavelength and the approximate random uncertainty in the mean is

A (645 ± 1) nm

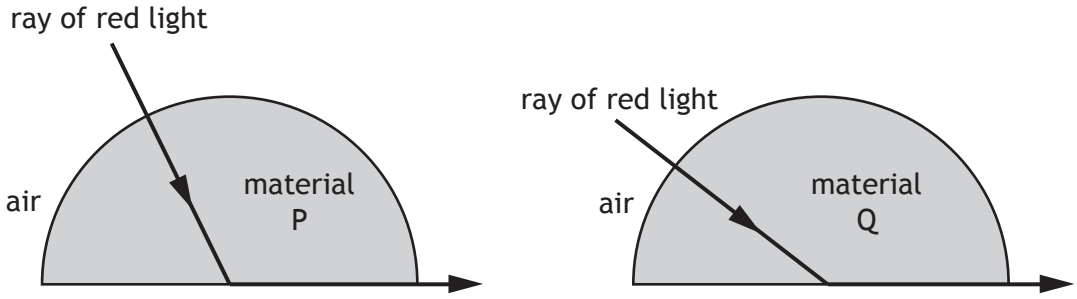
B (645 ± 4) nm

C (646 ± 1) nm

D (646 ± 4) nm

E (3228 ± 20) nm.

15. Red light is used to investigate the critical angle of two materials P and Q.



A student makes the following statements.

I Material P has a higher refractive index than material Q.

II The wavelength of the red light is longer inside material P than inside material Q.

III The red light travels at the same speed inside materials P and Q.

Which of these statements is/are correct?

A I only

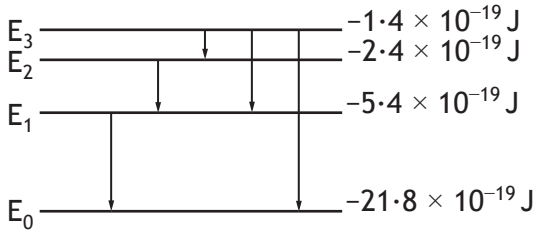
B II only

C III only

D I and II only

E I, II and III

16. The diagram represents some electron transitions between energy levels in an atom.



The radiation emitted with the shortest wavelength is produced by an electron making transition

A E_1 to E_0

B E_2 to E_1

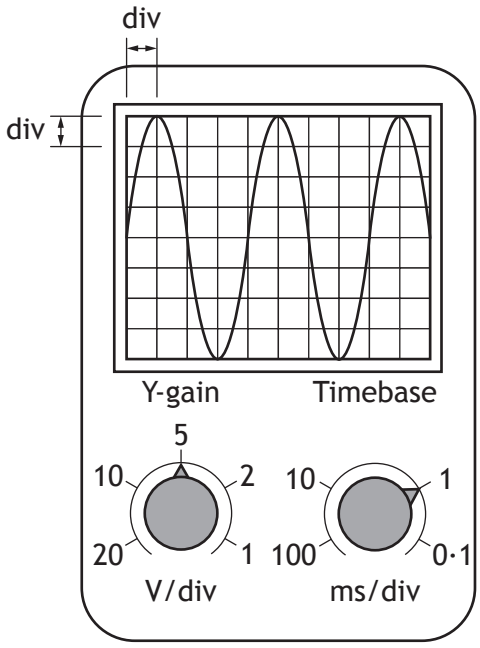
C E_3 to E_2

D E_3 to E_1

E E_3 to E_0.

[Turn over

17. The output from a signal generator is connected to the input terminals of an oscilloscope. The trace observed on the oscilloscope screen, the Y-gain setting and the timebase setting are shown.



The frequency of the signal shown is calculated using the

A timebase setting and the vertical height of the trace

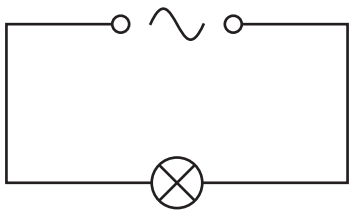
B timebase setting and the horizontal distance between the peaks of the trace

C Y-gain setting and the vertical height of the trace

D Y-gain setting and the horizontal distance between the peaks of the trace

E Y-gain setting and the timebase setting.

18. A circuit is set up as shown.



The r.m.s voltage across the lamp is 12 V.

The power produced by the lamp is 24 W.

The peak current in the lamp is

A 0·71 A

B 1·4 A

C 2·0 A

D 2·8 A

E 17 A.

19. A student makes the following statements about energy bands in different materials.

I In metals the highest occupied energy band is not completely full.

II In insulators the highest occupied energy band is full.

III The gap between the valence band and conduction band is smaller in semiconductors than in insulators.

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

20. The upward lift force L on the wings of an aircraft is calculated using the relationship

$$L = \tfrac{1}{2}\rho v^2 A C_L$$

where:

ρ is the density of air
v is the speed of the wings through the air
A is the area of the wings
C_L is the coefficient of lift.

The weight of a model aircraft is 80·0 N.
The area of the wings on the model aircraft is 3·0 m^2.
The coefficient of lift for these wings is 1·6.
The density of air is 1·29 $kg\,m^{-3}$

The speed required for the model aircraft to maintain a level flight is

A 2·5 $m\,s^{-1}$

B 3·6 $m\,s^{-1}$

C 5·1 $m\,s^{-1}$

D 12·9 $m\,s^{-1}$

E 25·8 $m\,s^{-1}$.

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

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