

National Qualifications 2016

X757/76/02

Physics Section 1 — Questions

TUESDAY, 24 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	С	$3.00 imes 10^8 { m m s^{-1}}$	Planck's constant	h	$6.63 imes10^{-34}\mathrm{Js}$
Magnitude of the charge on an electron	е	$1.60 imes 10^{-19} \mathrm{C}$	Mass of electron	m _e	9∙11 × 10 ⁻³¹ kg
Universal Constant of Gravitation	G	$6.67 imes 10^{-11} \text{m}^3 \text{kg}^{-1} \text{s}^{-2}$	Mass of neutron	<i>m</i> _n	$1.675 imes 10^{-27} \mathrm{kg}$
Gravitational acceleration on Earth	g	$9.8\mathrm{ms^{-2}}$	Mass of proton	m _p	$1\cdot 673 imes 10^{-27}\mathrm{kg}$
Hubble's constant	H_0	$2.3 imes 10^{-18} s^{-1}$			

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	<i>Wavelength</i> /nm	Colour	Element	<i>Wavelength</i> /nm	Colour
Hydrogen	656	Red	Cadmium	644	Red
	486	Blue-green		509	Green
434 Blue-violet			480	Blue	
	410 Violet	Violet			
	397	Ultraviolet		Lasers	
	389 Ultraviolet	Ultraviolet	Element	<i>Wavelength</i> /nm	Colour
			Carbon dioxide	9550 7	Infrared
Sodium	589	Yellow		10590 🖌	
			Helium-neon	633	Red

PROPERTIES OF SELECTED MATERIALS

Substance	Density/kg m ⁻³	Melting Point/K	Boiling Point/K
Aluminium	2.70×10^{3}	933	2623
Copper	8.96×10^{3}	1357	2853
Ice	9.20×10^{2}	273	
Sea Water	1.02×10^3	264	377
Water	1.00×10^3	273	373
Air	1.29		• • • •
Hydrogen	9∙0 × 10 ^{−2}	14	20

The gas densities refer to a temperature of 273 K and a pressure of $1\cdot01\times10^5\,Pa.$

SECTION 1 — 20 marks Attempt ALL questions

- 1. A car accelerates uniformly from rest. The car travels a distance of 60 m in $6 \cdot 0 \text{ s}$. The acceleration of the car is
 - A 0.83 m s^{-2}
 - B 3.3 m s^{-2}
 - C $5 \cdot 0 \text{ m s}^{-2}$
 - D 10 m s^{-2}
 - E $20 \,\mathrm{m\,s^{-2}}$.
- A ball is thrown vertically upwards and falls back to Earth.
 Neglecting air resistance, which velocity-time graph represents its motion?



3. A block of wood slides with a constant velocity down a slope. The slope makes an angle of 30° with the horizontal as shown. The mass of the block is 2.0 kg.



The magnitude of the force of friction acting on the block is

- A 1.0 N
- B 1.7 Ν
- C 9.8 N
- D 17.0 N
- E 19.6 N.
- 4. The graph shows the force which acts on an object over a time interval of 8.0 seconds.



The momentum gained by the object during this 8.0 seconds is

- A 12 kg m s⁻¹
- B 32 kg m s⁻¹
- C 44 kg m s⁻¹
- D 52 kg m s⁻¹
- E 72 kg m s⁻¹.

5. A planet orbits a star at a distance of $3 \cdot 0 \times 10^9$ m.

The star exerts a gravitational force of 1.6×10^{27} N on the planet. The mass of the star is 6.0×10^{30} kg. The mass of the planet is

- $A \qquad 2{\boldsymbol \cdot} 4\times 10^{14}\,kg$
- $B \qquad 1{\cdot}2\times 10^{16}\,kg$
- $C \qquad 3{\cdot}6\times 10^{25}\,kg$
- $D \qquad 1{\cdot}6\times 10^{26}\,kg$
- $E \qquad 2{\boldsymbol{\cdot}}4\times 10^{37}\,\text{kg.}$
- 6. A car horn emits a sound with a constant frequency of 405 Hz.

The car is travelling away from a student at $28 \cdot 0 \text{ m s}^{-1}$.

The speed of sound in air is 335 m s^{-1} .

The frequency of the sound from the horn heard by the student is

- A 371 Hz
- B 374 Hz
- C 405 Hz
- D 439 Hz
- E 442 Hz.

7. The graphs show how the radiation per unit surface area, R, varies with the wavelength, λ , of the emitted radiation for two stars, P and Q.



A student makes the following conclusions based on the information in the graph.

- I Star P is hotter than star Q.
- II Star P emits more radiation per unit surface area than star Q.
- III The peak intensity of the radiation from star Q is at a shorter wavelength than that from star P.

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
- 8. One type of hadron consists of two down quarks and one up quark.

The charge on a down quark is $-\frac{1}{3}$.

The charge on an up quark is $+\frac{2}{3}$.

Which row in the table shows the charge and type for this hadron?

	charge type of had	
A	0	baryon
В	+1	baryon
С	-1	meson
D	0	meson
E	+1	meson

- 9. A student makes the following statements about sub-nuclear particles.
 - I The force mediating particles are bosons.
 - II Gluons are the mediating particles of the strong force.
 - III Photons are the mediating particles of the electromagnetic force.

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
- The last two changes in a radioactive decay series are shown below.
 A Bismuth nucleus emits a beta particle and its product, a Polonium nucleus, emits an alpha particle.

$${}^{\mathsf{P}}_{\mathsf{Q}}\mathsf{Bi} \xrightarrow{\beta} {}^{\mathsf{R}}_{\mathsf{S}}\mathsf{Po} \xrightarrow{\alpha} {}^{208}_{\mathsf{82}}\mathsf{Pb}$$

Which numbers are represented by P, Q, R and S?

	Р	Q	R	S
Α	210	83	208	81
В	210	83	210	84
С	211	85	207	86
D	212	83	212	84
E	212	85	212	84

11. The table below shows the threshold frequency of radiation for photoelectric emission for some metals.

Metal	Threshold frequency (Hz)
sodium	$4 \cdot 4 \times 10^{14}$
potassium	$5\cdot4 imes10^{14}$
zinc	6·9 × 10 ¹⁴

Radiation of frequency 6.3×10^{14} Hz is incident on the surface of each of the metals. Photoelectric emission occurs from

- A sodium only
- B zinc only
- C potassium only
- D sodium and potassium only
- E zinc and potassium only.
- 12. Radiation of frequency 9.00×10^{15} Hz is incident on a clean metal surface.

The maximum kinetic energy of a photoelectron ejected from this surface is 5.70×10^{-18} J. The work function of the metal is

- A $2.67 \times 10^{-19} \, J$
- B $5.97 \times 10^{-18} \text{ J}$
- C $1.17 \times 10^{-17} \, \text{J}$
- $\mathsf{D} \qquad 2 \cdot 07 \times 10^{-2} \,\mathsf{J}$
- $E 9.60 \times 10^{-1} \, J.$

13. A ray of monochromatic light is incident on a grating as shown.



The wavelength of the light is 633 nm.

The separation of the slits on the grating is

- A $1.96 \times 10^{-7} \,\mathrm{m}$
- $B \qquad 1{\cdot}08\times 10^{-6}\,m$
- $C \qquad 2 \cdot 05 \times 10^{-6} \, m$
- D $2.15 \times 10^{-6} \, \text{m}$
- E 4.10×10^{-6} m.
- 14. Light travels from glass into air.

Which row in the table shows what happens to the speed, frequency and wavelength of the light as it travels from glass into air?

	Speed	Frequency	Wavelength
А	decreases	stays constant	decreases
В	decreases	increases	stays constant
С	stays constant	increases	increases
D	increases	increases	stays constant
Е	increases	stays constant	increases

15. The irradiance of light from a point source is 32 Wm^{-2} at a distance of 4.0 m from the source.

The irradiance of the light at a distance of 16 m from the source is

- A 0.125 W m^{-2}
- B 0.50 W m^{-2}
- C $2 \cdot 0 \text{ W m}^{-2}$
- D $8.0 W m^{-2}$
- E 128 W m^{-2} .

16. Part of the energy level diagram for an atom is shown



X and Y represent two possible electron transitions.

A student makes the following statements about transitions X and Y.

- I Transition Y produces photons of higher frequency than transition X
- II Transition X produces photons of longer wavelength than transition Y
- III When an electron is in the energy level E_0 , the atom is ionised.

Which of the statements is/are correct?

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

17. The output of a signal generator is connected to the input of an oscilloscope.The trace produced on the screen of the oscilloscope is shown.



The timebase control of the oscilloscope is set at 2 ms/div.

The Y-gain control of the oscilloscope is set at 4 mV/div.

Which row in the table shows the frequency and peak voltage of the output of the signal generator?

	frequency (Hz)	peak voltage (mV)
Α	0.5	12
В	0.5	6
С	250	6
D	500	12
E	500	24

18. A potential divider circuit is set up as shown.



The potential difference across the 7.0 k Ω resistor is

- A 3.6V
- B 4.0V
- C 5.1 V
- D 8.4V
- E 9.0 V.

19. A circuit is set up as shown.



The resistance of the variable resistor is increased and corresponding readings on the ammeter are recorded.

Resistance (Ω)	2.0	4.0	6.0	8.0
Current (A)	2.0	1.5	1.2	1.0

These results show that as the resistance of the variable resistor increases the power dissipated in the variable resistor

- A increases
- B decreases
- C remains constant
- D decreases and then increases
- E increases and then decreases.
- 20. A 20 μF capacitor is connected to a 12 V d.c. supply.

The maximum charge stored on the capacitor is

- $A \qquad 1{\cdot}4\times 10^{-3}\,C$
- $B \qquad 2 \cdot 4 \times 10^{-4} \, C$
- $C \qquad 1 \cdot 2 \times 10^{-4} \, C$
- $D \qquad 1.7\times 10^{-6}\,C$
- $E = 6.0 \times 10^{-7} C.$

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

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