



National  
Qualifications  
2016

**X757/76/02**

**Physics**  
**Section 1 — Questions**

TUESDAY, 24 MAY

9:00 AM – 11:30 AM

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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               | $c$    | $3.00 \times 10^8 \text{ m s}^{-1}$                               | Planck's constant | $h$    | $6.63 \times 10^{-34} \text{ J s}$ |
| Magnitude of the charge on an electron | $e$    | $1.60 \times 10^{-19} \text{ C}$                                  | Mass of electron  | $m_e$  | $9.11 \times 10^{-31} \text{ kg}$  |
| Universal Constant of Gravitation      | $G$    | $6.67 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$ | Mass of neutron   | $m_n$  | $1.675 \times 10^{-27} \text{ kg}$ |
| Gravitational acceleration on Earth    | $g$    | $9.8 \text{ m s}^{-2}$                                            | Mass of proton    | $m_p$  | $1.673 \times 10^{-27} \text{ kg}$ |
| Hubble's constant                      | $H_0$  | $2.3 \times 10^{-18} \text{ s}^{-1}$                              |                   |        |                                    |

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

### PROPERTIES OF SELECTED MATERIALS

| Substance | Density/kg m <sup>-3</sup> | Melting Point/K | Boiling Point/K |
|-----------|----------------------------|-----------------|-----------------|
| Aluminium | $2.70 \times 10^3$         | 933             | 2623            |
| Copper    | $8.96 \times 10^3$         | 1357            | 2853            |
| Ice       | $9.20 \times 10^2$         | 273             | ....            |
| Sea Water | $1.02 \times 10^3$         | 264             | 377             |
| Water     | $1.00 \times 10^3$         | 273             | 373             |
| Air       | 1.29                       | ....            | ....            |
| Hydrogen  | $9.0 \times 10^{-2}$       | 14              | 20              |

The gas densities refer to a temperature of 273 K and a pressure of  $1.01 \times 10^5 \text{ Pa}$ .

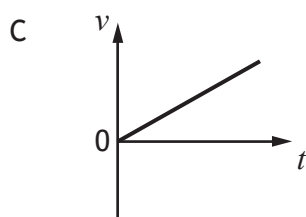
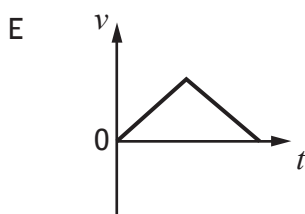
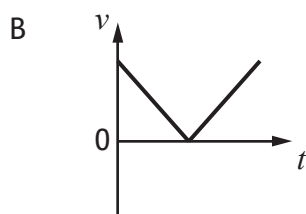
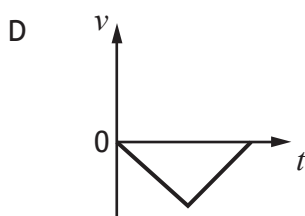
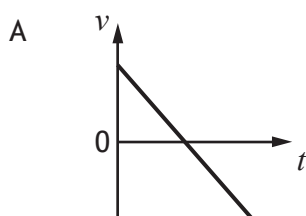
SECTION 1 — 20 marks

Attempt ALL questions

1. A car accelerates uniformly from rest. The car travels a distance of 60 m in 6.0 s. The acceleration of the car is

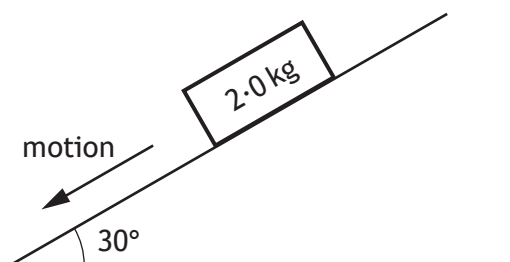
- A  $0.83 \text{ m s}^{-2}$
- B  $3.3 \text{ m s}^{-2}$
- C  $5.0 \text{ m s}^{-2}$
- D  $10 \text{ m s}^{-2}$
- E  $20 \text{ m s}^{-2}$ .

2. A ball is thrown vertically upwards and falls back to Earth.  
Neglecting air resistance, which velocity-time graph represents its motion?



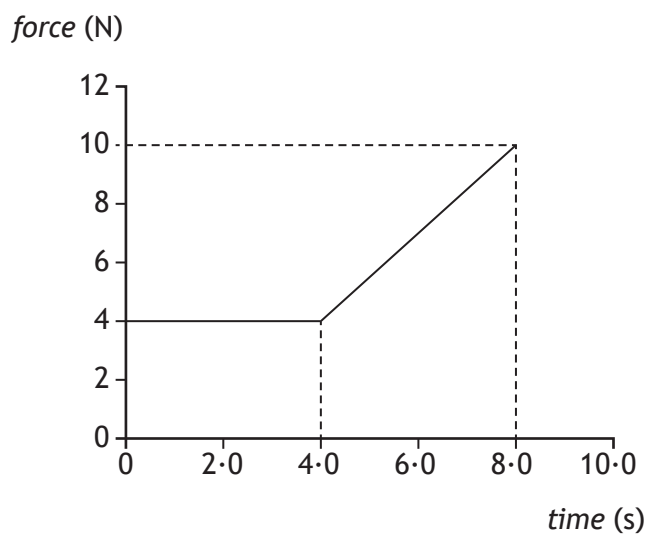
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3. A block of wood slides with a constant velocity down a slope. The slope makes an angle of  $30^\circ$  with the horizontal as shown. The mass of the block is  $2.0 \text{ kg}$ .



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

- A  $1.0 \text{ N}$
  - B  $1.7 \text{ N}$
  - C  $9.8 \text{ N}$
  - D  $17.0 \text{ N}$
  - E  $19.6 \text{ N}$ .
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  $12 \text{ kg m s}^{-1}$
- B  $32 \text{ kg m s}^{-1}$
- C  $44 \text{ kg m s}^{-1}$
- D  $52 \text{ kg m s}^{-1}$
- E  $72 \text{ kg m s}^{-1}$ .

5. A planet orbits a star at a distance of  $3.0 \times 10^9$  m.

The star exerts a gravitational force of  $1.6 \times 10^{27}$  N on the planet.

The mass of the star is  $6.0 \times 10^{30}$  kg.

The mass of the planet is

- A  $2.4 \times 10^{14}$  kg
- B  $1.2 \times 10^{16}$  kg
- C  $3.6 \times 10^{25}$  kg
- D  $1.6 \times 10^{26}$  kg
- E  $2.4 \times 10^{37}$  kg.

6. A car horn emits a sound with a constant frequency of 405 Hz.

The car is travelling away from a student at  $28.0 \text{ m s}^{-1}$ .

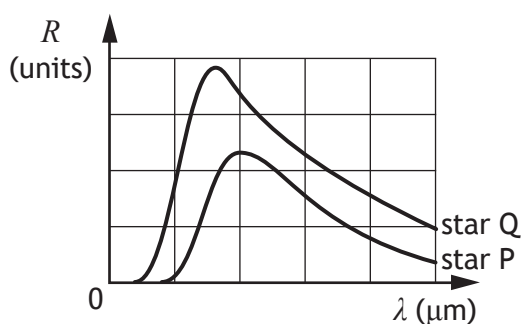
The speed of sound in air is  $335 \text{ m s}^{-1}$ .

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.

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7. The graphs show how the radiation per unit surface area,  $R$ , varies with the wavelength,  $\lambda$ , 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?

|   | <i>charge</i> | <i>type of hadron</i> |
|---|---------------|-----------------------|
| A | 0             | baryon                |
| B | +1            | baryon                |
| C | -1            | meson                 |
| D | 0             | meson                 |
| E | +1            | meson                 |

9. A student makes the following statements about sub-nuclear particles.

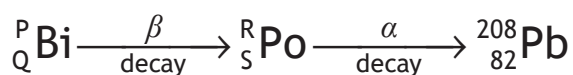
- I The force mediating particles are bosons.
- II Gluons are the mediating particles of the strong force.
- III Photons are the mediating particles of the electromagnetic force.

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

10. 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.



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

|   | P   | Q  | R   | S  |
|---|-----|----|-----|----|
| A | 210 | 83 | 208 | 81 |
| B | 210 | 83 | 210 | 84 |
| C | 211 | 85 | 207 | 86 |
| D | 212 | 83 | 212 | 84 |
| E | 212 | 85 | 212 | 84 |

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

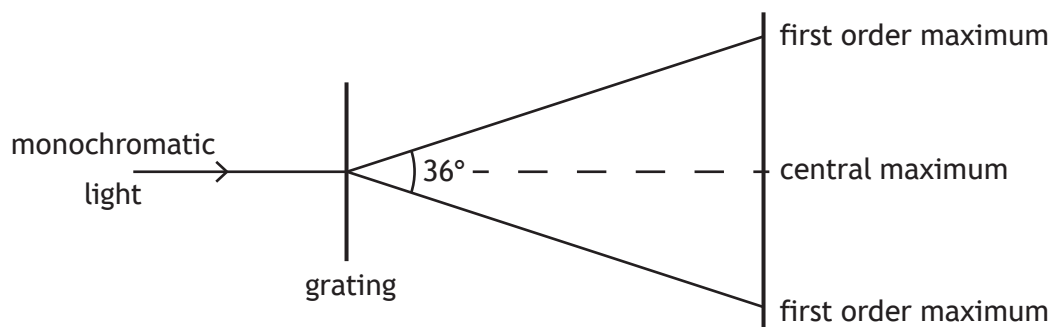
| <i>Metal</i> | <i>Threshold frequency<br/>(Hz)</i> |
|--------------|-------------------------------------|
| sodium       | $4.4 \times 10^{14}$                |
| potassium    | $5.4 \times 10^{14}$                |
| zinc         | $6.9 \times 10^{14}$                |

Radiation of frequency  $6.3 \times 10^{14}$  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  $9.00 \times 10^{15}$  Hz is incident on a clean metal surface.
- The maximum kinetic energy of a photoelectron ejected from this surface is  $5.70 \times 10^{-18}$  J.
- The work function of the metal is
- A  $2.67 \times 10^{-19}$  J
  - B  $5.97 \times 10^{-18}$  J
  - C  $1.17 \times 10^{-17}$  J
  - D  $2.07 \times 10^{-2}$  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

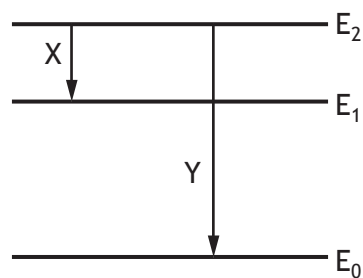
- A  $1.96 \times 10^{-7} \text{ m}$   
 B  $1.08 \times 10^{-6} \text{ m}$   
 C  $2.05 \times 10^{-6} \text{ m}$   
 D  $2.15 \times 10^{-6} \text{ m}$   
 E  $4.10 \times 10^{-6} \text{ m}$ .
14. Light travels from **glass** into **air**.  
 Which row in the table shows what happens to the speed, frequency and wavelength of the light as it travels from glass into air?

|   | <i>Speed</i>   | <i>Frequency</i> | <i>Wavelength</i> |
|---|----------------|------------------|-------------------|
| A | decreases      | stays constant   | decreases         |
| B | decreases      | increases        | stays constant    |
| C | stays constant | increases        | increases         |
| D | increases      | increases        | stays constant    |
| E | increases      | stays constant   | increases         |

15. The irradiance of light from a point source is  $32 \text{ W m}^{-2}$  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  $0.125 \text{ W m}^{-2}$   
 B  $0.50 \text{ W m}^{-2}$   
 C  $2.0 \text{ W m}^{-2}$   
 D  $8.0 \text{ W m}^{-2}$   
 E  $128 \text{ W m}^{-2}$ .

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



X and Y represent two possible electron transitions.

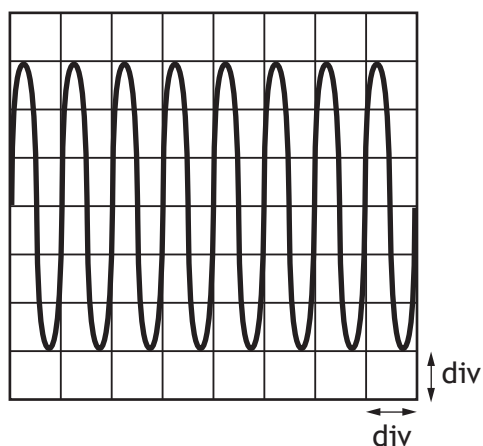
A student makes the following statements about transitions X and Y.

- 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.

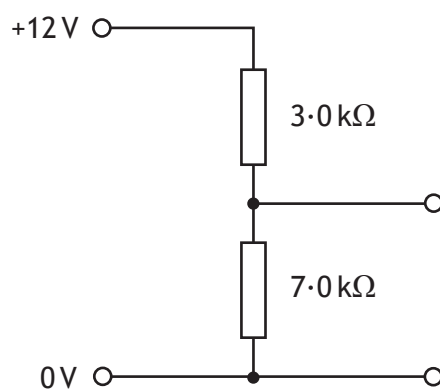
The Y-gain control of the oscilloscope is set at 4 mV/div.

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

|   | <i>frequency (Hz)</i> | <i>peak voltage (mV)</i> |
|---|-----------------------|--------------------------|
| A | 0.5                   | 12                       |
| B | 0.5                   | 6                        |
| C | 250                   | 6                        |
| D | 500                   | 12                       |
| E | 500                   | 24                       |

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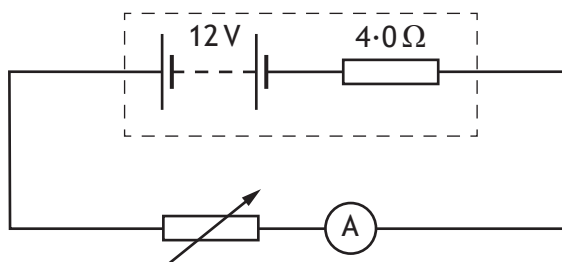
18. A potential divider circuit is set up as shown.



The potential difference across the  $7.0\text{ k}\Omega$  resistor is

- A  $3.6\text{ V}$
- B  $4.0\text{ V}$
- C  $5.1\text{ V}$
- D  $8.4\text{ V}$
- E  $9.0\text{ V}$

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 ( $\Omega$ ) | 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  $20\ \mu\text{F}$  capacitor is connected to a 12 V d.c. supply.  
The maximum charge stored on the capacitor is

- A  $1.4 \times 10^{-3}\ \text{C}$
- B  $2.4 \times 10^{-4}\ \text{C}$
- C  $1.2 \times 10^{-4}\ \text{C}$
- D  $1.7 \times 10^{-6}\ \text{C}$
- E  $6.0 \times 10^{-7}\ \text{C}$ .

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

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