



National  
Qualifications  
2019

**X857/75/02**

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

WEDNESDAY, 15 MAY

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**INSTRUCTIONS TO CANDIDATES**

Candidates should enter their surname, forename(s), date of birth, Scottish candidate number and the name and Level of the subject at the top of their first answer sheet.

Record your answers by writing the letter at the end of each question.

Reference may be made to the Data sheet and to the Relationships sheet.

Questions marked with an asterisk differ in some respects from those in the printed paper.

An OW in the margin indicates a new question.

## DATA SHEET

### Speed of light in materials

Material	Speed in $\text{m s}^{-1}$
Air	$3.0 \times 10^8$
Diamond	$1.2 \times 10^8$
Glass	$2.0 \times 10^8$
Water	$2.3 \times 10^8$

### Speed of sound in materials

Material	Speed in $\text{m s}^{-1}$
Air	340
Carbon dioxide	270
Tissue	1500
Water	1500

### Gravitational field strengths

	Gravitational field strength on the surface in $\text{N kg}^{-1}$
Earth	9.8
Mars	3.7
Moon	1.6
Sun	270

### Specific heat capacity of materials

Material	Specific heat capacity in $\text{J kg}^{-1} \text{ }^\circ\text{C}^{-1}$
Aluminium	902
Copper	386
Ice	2100
Water	4180

### Specific latent heat of fusion of materials

Material	Specific latent heat of fusion in $\text{J kg}^{-1}$
Aluminium	$3.95 \times 10^5$
Copper	$2.05 \times 10^5$
Water	$3.34 \times 10^5$

### Radiation weighting factors

Type of radiation	Radiation weighting factor
alpha	20
beta	1
gamma	1
X-rays	1

### Specific latent heat of vaporisation of materials

Material	Specific latent heat of vaporisation in $\text{J kg}^{-1}$
Carbon Dioxide	$3.77 \times 10^5$
Glycerol	$8.30 \times 10^5$
Water	$22.6 \times 10^5$

SECTION 1

Attempt ALL questions

1. Which of the following are **both** vectors?

- A weight and acceleration
- B kinetic energy and acceleration
- C mass and acceleration
- D force and speed
- E speed and acceleration

2. A car is travelling at  $6.0 \text{ m s}^{-1}$  along a straight level road.  
The car then accelerates uniformly at  $2.0 \text{ m s}^{-2}$  for  $4.0 \text{ s}$ .  
The final speed of the car is

- A  $8.0 \text{ m s}^{-1}$
- B  $14 \text{ m s}^{-1}$
- C  $22 \text{ m s}^{-1}$
- D  $26 \text{ m s}^{-1}$
- E  $48 \text{ m s}^{-1}$ .

\* 3. Refer to the diagram for Question 3. The graph shows how the speed  $v$  of a car varies with time  $t$ .

During which part of the journey does the car have the greatest acceleration?

- A OP
- B PQ
- C QR
- D RS
- E ST

- \* 4. Refer to the diagram for Question 4. A ball is kicked horizontally with a speed of  $8.0 \text{ m s}^{-1}$  off a high river bank as shown.

The ball lands on the lower river bank at X,  $2.0 \text{ s}$  after the ball is kicked.

The river is  $3.0 \text{ m}$  wide.

The effect of air resistance on the ball is negligible.

The distance  $d$  between the edge of the lower river bank and X is

- A  $1.0 \text{ m}$
- B  $4.0 \text{ m}$
- C  $13 \text{ m}$
- D  $16 \text{ m}$
- E  $19 \text{ m}$ .

- \* 5. The table gives the distance from Earth, the approximate surface temperature and the age of five stars.

Star	Distance from Earth (light-years)	Approximate surface temperature (K)	Age (years)
Sirius A	8.6	9900	$2.4 \times 10^8$
Polaris	430	6000	$7.0 \times 10^7$
Betelgeuse	640	3600	$7.9 \times 10^6$
Rigel	860	11 000	$8.0 \times 10^6$
VY Canis Majoris	3900	3500	$1.0 \times 10^7$

A student makes the following statements based on this information.

- I As the distance from Earth increases, the age of a star decreases.
- II As the age of a star increases, the approximate surface temperature of the star increases.
- III There is no apparent relationship between the distance from Earth and the approximate surface temperature of a star.

Which of these statements is/are correct?

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

- \* 6. A geostationary satellite orbits the Earth.

Which row in the table shows the altitude above the surface of the Earth and orbital period of the geostationary satellite?

	Altitude above the surface of the Earth (km)	Orbital period (hours)
A	36 000	12
B	36 000	24
C	36 000	48
D	18 000	12
E	18 000	24

7. The weight of a robot on Earth is 240 N.

The weight of the robot on Mars is

- A 3.7 N
  - B 65 N
  - C 91 N
  - D 240 N
  - E 890 N.
8. A hairdryer is connected to a 230 V supply.

The current in the hairdryer is 2.0 A.

The electrical charge that passes through the hairdryer in 5 minutes is

- A 10 C
- B 460 C
- C 600 C
- D 1150 C
- E 69 000 C.

- \* 9. Refer to the diagram for Question 9. The graph shows how the resistance  $R$  of a thermistor varies with temperature  $T$ .

The thermistor is connected in a circuit.

At a temperature of  $50^{\circ}\text{C}$  the current in the thermistor is  $0.004\text{ A}$ .

At this temperature the voltage across the thermistor is

- A  $0.00002\text{ V}$
- B  $0.002\text{ V}$
- C  $0.008\text{ V}$
- D  $8\text{ V}$
- E  $500\text{ V}$ .

- \*10. Refer to the diagram for Question 10. A student sets up the circuits shown.  
In which circuit will both LEDs be lit?

- \*11. Refer to the diagram for Question 11. A circuit is set up as shown.

The room temperature is  $20^{\circ}\text{C}$ .

The lamp is off.

The lamp will light when

- A the light level is decreased below a certain value
- B the light level is increased above a certain value
- C the resistance of  $R$  is increased above a certain value
- D the battery voltage is reduced to  $5\text{ V}$
- E the temperature is increased above a certain value.

- \*12. Refer to the diagram for Question 12. A circuit is set up as shown.

A student makes the following statements about the readings on the voltmeters.

- I  $V_1 = V_2$
- II  $V_2 = V_3$
- III  $V_S = V_1 + V_2$

Which of these statements must **always** be true?

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

- \*13. Refer to the diagram for Question 13. A solid substance is placed in an insulated container and heated.

The graph shows how the temperature  $T$  of the substance varies with time  $t$ .

To calculate the specific latent heat of fusion of the substance a student would use the time from section

- A PQ
- B QR
- C RS
- D ST
- E TU.

- \*14. The pressure  $p$  due to a liquid at a depth  $h$  is given by the relationship

$$p = \rho gh$$

where  $\rho$  is the density of the liquid and  $g$  is the gravitational field strength.

A liquid has a density of  $990 \text{ kg m}^{-3}$ .

When the pressure due to the liquid is  $1470 \text{ Pa}$ , the depth in the liquid is

- A 0.069 m
  - B 0.15 m
  - C 0.67 m
  - D 1.5 m
  - E 6.6 m.
15. A car is parked in the sun for some time. During this time the air pressure inside the tyres increases.
- The reason for this increase in pressure is
- A the volume occupied by the air particles in the tyres has increased
  - B the force produced by the air particles in the tyres acts over a smaller area
  - C the average spacing between the air particles in the tyres has increased
  - D the increased temperature has made the air particles in the tyres expand
  - E the air particles in the tyres are moving with greater kinetic energy.

16. The temperature of a sample of gas in a container is 20 °C.  
 The volume of the gas is 0.30 m<sup>3</sup>.  
 The container is free to expand in order to maintain a constant pressure.  
 The temperature of the gas is increased to 50 °C.  
 The volume now occupied by the gas is

- A 0.12 m<sup>3</sup>
- B 0.27 m<sup>3</sup>
- C 0.30 m<sup>3</sup>
- D 0.33 m<sup>3</sup>
- E 0.75 m<sup>3</sup>.

\*17. Refer to the diagram for Question 17. The diagram gives information about a wave.  
 Which row in the table shows the amplitude and wavelength of the wave?

	Amplitude (m)	Wavelength (m)
A	3	4
B	3	8
C	6	4
D	6	8
E	8	3

18. A student is studying waves with a period of 80.0 ms and a wavelength of 4.00 m.  
 The frequency of these waves is

- A 0.0125 Hz
- B 0.320 Hz
- C 12.5 Hz
- D 80.0 Hz
- E 320 Hz.

\*19. Refer to diagram 1 and diagram 2 for Question 19. Which of the diagrams shows the diffraction of water waves as they pass between two walls?



- \*20. Refer to the diagram for Question 20. A ray of red light passes through a glass block as shown.

Which row in the table shows the angle of incidence and the corresponding angle of refraction at point X?

	Angle of incidence	Angle of refraction
A	35°	60°
B	30°	55°
C	35°	30°
D	55°	30°
E	60°	35°

- \*21. Refer to diagram 1 and diagram 2 for Question 21. Which row in the table shows the paths taken by alpha particles and gamma radiation as they pass through a uniform electric field between two metal plates?

22. For a particular radioactive source, 1800 atoms decay in a time of 3 minutes.

The activity of the source is

- A 10 Bq  
B 600 Bq  
C 1800 Bq  
D 5400 Bq  
E 324 000 Bq.
23. The crew on an aircraft during a transatlantic flight are exposed to cosmic radiation at an equivalent dose rate of  $5.0 \mu\text{Sv h}^{-1}$ .  
The crew complete 6 transatlantic flights each month. The average duration of a flight is 8 hours.  
The equivalent dose received by the crew due to cosmic radiation during transatlantic flights in **one year** is
- A  $30 \mu\text{Sv}$   
B  $40 \mu\text{Sv}$   
C  $60 \mu\text{Sv}$   
D  $240 \mu\text{Sv}$   
E  $2880 \mu\text{Sv}$ .

- \*24. A radioactive tracer is injected into a patient to enable doctors to check the function of a patient's kidneys.

Radiation from the tracer is monitored outside the patient's body by a detector.

Which row in the table shows the most suitable type of radiation emitted and the half-life for the tracer?

	Type of radiation emitted	Half-life of tracer
A	alpha	6 hours
B	beta	6 hours
C	beta	6 years
D	gamma	6 hours
E	gamma	6 years

25. The activity of a radioactive source is 56 MBq.  
The activity of the source 40 hours later is 3.5 MBq.  
The half-life of this source is

- A 8 hours
- B 10 hours
- C 16 hours
- D 20 hours
- E 28 hours.

[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2]