National
Qualifications
2019

X857/76/12

Physics
Paper 1 — Multiple choice

WEDNESDAY, 15 MAY
9:00 AM – 9:45 AM

Total marks — 25

Attempt ALL questions.

You may use a calculator.

Instructions for the completion of Paper 1 are given on *page 02* of your answer booklet X857/76/02.

Record your answers on the answer grid on *page 03* of your answer booklet.

Reference may be made to the data sheet on *page 02* of this question paper and to the relationships sheet X857/76/22.

Space for rough work is provided at the end of this booklet.

Before leaving the examination room you must give your 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	$3{\cdot}00 \times 10^{8}\ \text{m s}^{-1}$	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
	10 590 }	
Helium-neon	633	Red

PROPERTIES OF SELECTED MATERIALS

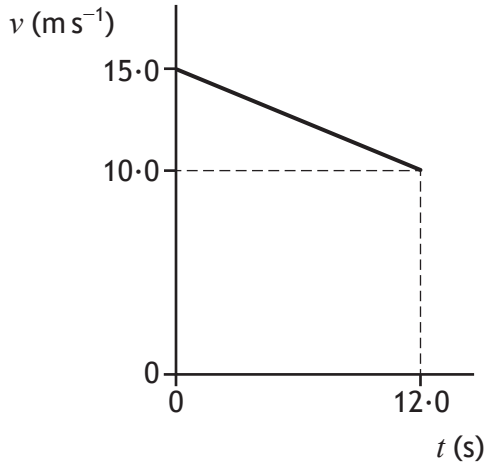
Substance	*Density*/kg m^{-3}	*Melting point*/K	*Boiling point*/K
Aluminium	$2{\cdot}70 \times 10^{3}$	933	2623
Copper	$8{\cdot}96 \times 10^{3}$	1357	2853
Ice	$9{\cdot}20 \times 10^{2}$	273	. . . .
Sea Water	$1{\cdot}02 \times 10^{3}$	264	377
Water	$1{\cdot}00 \times 10^{3}$	273	373
Air	1·29	. . . .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

Total mark — 25

Attempt ALL questions

1. The graph shows how the speed v of a car varies with time t.



The average speed of the car during the 12·0 s is

A $1{\cdot}25\ m\ s^{-1}$

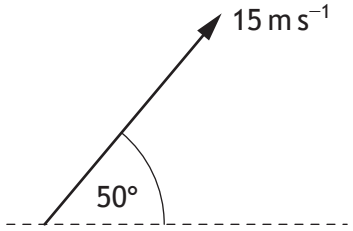
B $2{\cdot}08\ m\ s^{-1}$

C $2{\cdot}50\ m\ s^{-1}$

D $7{\cdot}50\ m\ s^{-1}$

E $12{\cdot}5\ m\ s^{-1}$.

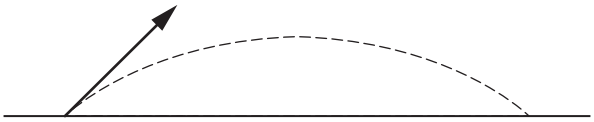
2. A stone is thrown at 50° to the horizontal with a speed of $15\ m\ s^{-1}$.



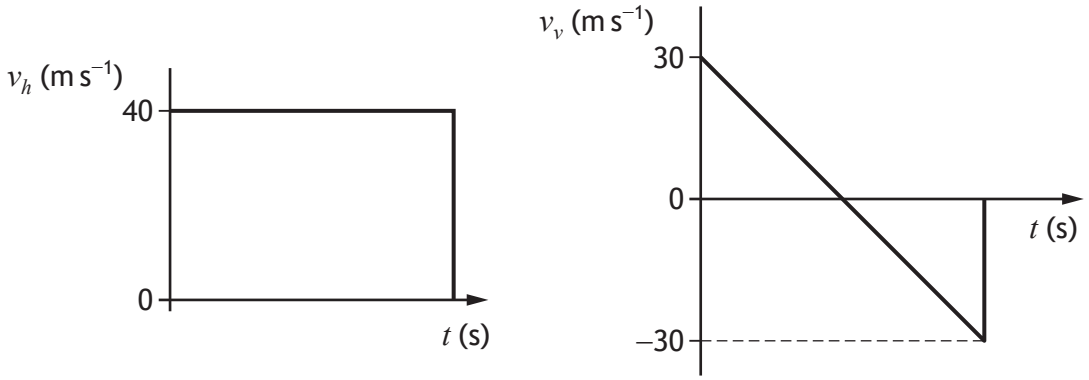
Which row in the table gives the horizontal component and the vertical component of the initial velocity of the stone?

	Horizontal component ($m\ s^{-1}$)	**Vertical component ($m\ s^{-1}$)**
A	15 sin 50	15 cos 50
B	15 cos 50	15 sin 50
C	15 cos 50	15 sin 40
D	15 cos 40	15 sin 50
E	15 sin 50	15 cos 40

3. A golfer strikes a golf ball, which then moves off at an angle to the ground. The ball follows the path shown.



The graphs show how the horizontal component of the velocity v_h and the vertical component of the velocity v_v of the ball vary with time t.



The speed of the ball just before it hits the ground is

A 10 m s^{-1}

B 30 m s^{-1}

C 40 m s^{-1}

D 50 m s^{-1}

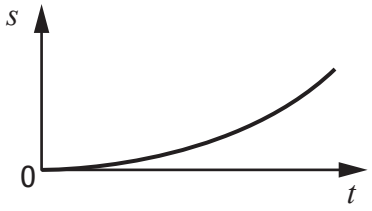
E 70 m s^{-1}.

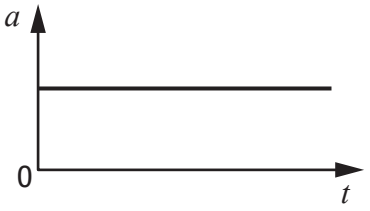
4. A car accelerates from rest along a straight level road.

The acceleration of the car is constant.

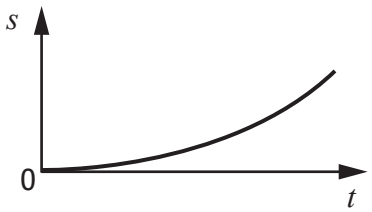
Which pair of displacement-time (s-t) and acceleration-time (a-t) graphs represent the motion of the car?

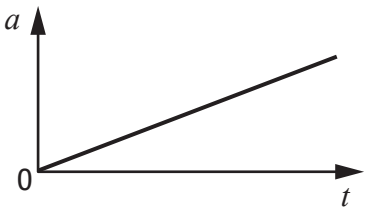
A



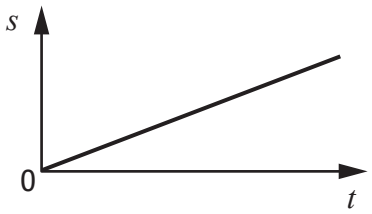


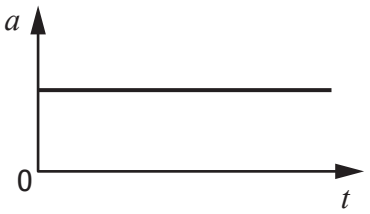
B



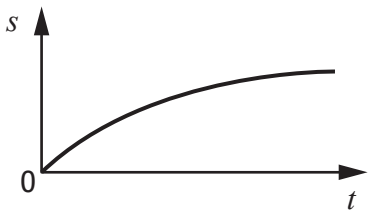


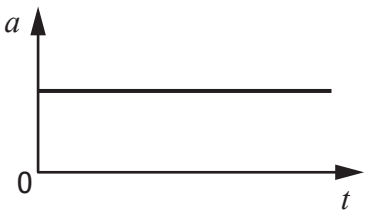
C



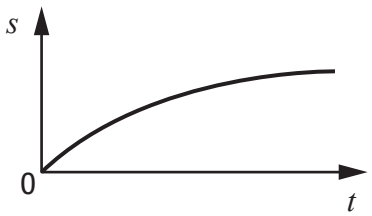


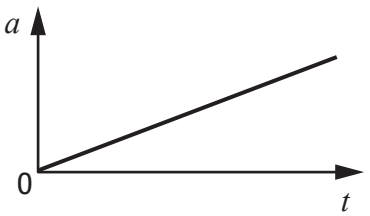
D





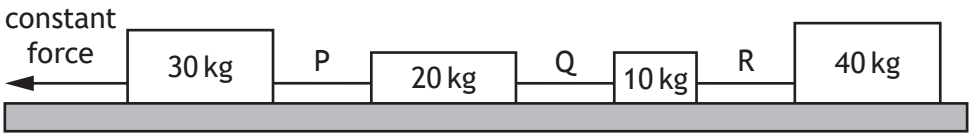
E





[Turn over

5. Four masses on a horizontal, frictionless surface are linked together by strings P, Q and R. A constant force is applied as shown.



The tension in the strings is

A greatest in P and least in Q
B greatest in P and least in R
C greatest in R and least in Q
D greatest in R and least in P
E the same in P, Q and R.

6. A student makes the following statements about an elastic collision.

I Total momentum is conserved.
II Total kinetic energy is conserved.
III Total energy is conserved.

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

7. The terminal velocity v_t of a skydiver is given by the relationship

$$v_t = \sqrt{\frac{2mg}{\rho A C_d}}$$

where

m is the mass of the skydiver in kg

g is the gravitational field strength in N kg^{-1}

C_d is the drag coefficient

ρ is the density of air in kg m^{-3}

A is the area of the skydiver in m^2.

When in freefall, a skydiver of mass 95 kg has a drag coefficient of 1·0 and a terminal velocity of 44 m s^{-1}.

The gravitational field strength is 9·8 N kg^{-1} and the density of air is 1·21 kg m^{-3}.

The area of the skydiver is

A 0·59 m^2

B 0·79 m^2

C 0·89 m^2

D 4·2 m^2

E 35 m^2.

8. A spacecraft is travelling at a constant speed relative to a nearby planet.

A technician on the spacecraft measures the length of the spacecraft as 275 m.

An observer on the planet measures the length of the spacecraft as 125 m.

The speed of the spacecraft relative to the observer on the nearby planet is

A $1{\cdot}54 \times 10^4$ m s^{-1}

B $2{\cdot}22 \times 10^8$ m s^{-1}

C $2{\cdot}67 \times 10^8$ m s^{-1}

D $3{\cdot}00 \times 10^8$ m s^{-1}

E $7{\cdot}14 \times 10^{16}$ m s^{-1}.

[Turn over

9. The redshift of a distant galaxy is 0·014.

According to Hubble's law, the distance of the galaxy from Earth is

A $9{\cdot}66 \times 10^{-12}$ m

B $1{\cdot}83 \times 10^{24}$ m

C $1{\cdot}30 \times 10^{26}$ m

D $9{\cdot}32 \times 10^{27}$ m

E $6{\cdot}33 \times 10^{39}$ m.

10. A student makes the following statements about the Universe.

I The force due to gravity acts against the expansion of the Universe.

II Measurements show the rate of expansion of the Universe is increasing.

III The mass of a galaxy can be estimated by the orbital speed of the stars within the galaxy.

Which of these statements is/are correct?

A I only

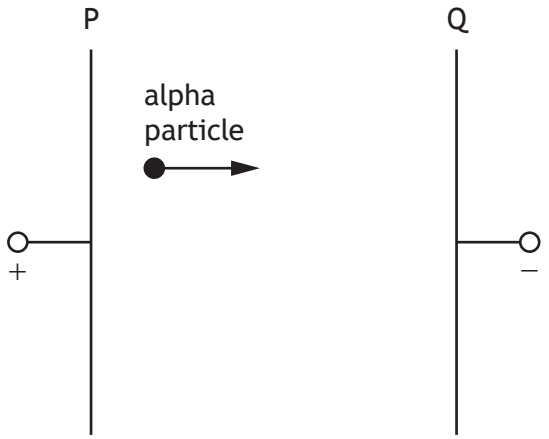
B II only

C III only

D I and II only

E I, II and III

11. An alpha particle is accelerated in an electric field between metal plates P and Q.



The charge on the alpha particle is $3{\cdot}2 \times 10^{-19}$ C.

The kinetic energy gained by the alpha particle while travelling from plate P to plate Q is $8{\cdot}0 \times 10^{-16}$ J.

The potential difference across plates P and Q is

A $2{\cdot}6 \times 10^{-34}$ V

B $2{\cdot}0 \times 10^{-4}$ V

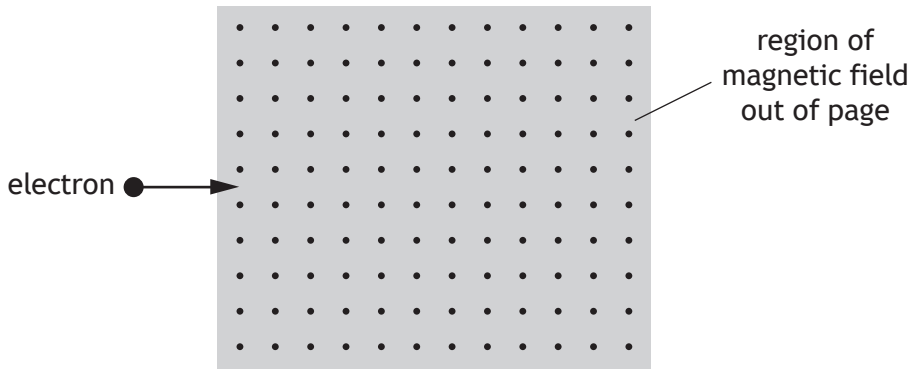
C $4{\cdot}0 \times 10^{-4}$ V

D $2{\cdot}5 \times 10^{3}$ V

E $5{\cdot}0 \times 10^{3}$ V.

[Turn over

12. An electron enters a region of uniform magnetic field as shown.



The direction of the magnetic force on the electron immediately after entering the field is

A towards the top of the page

B towards the bottom of the page

C towards the right of the page

D into the page

E out of the page.

13. A student makes the following statements about the Standard Model.

I Every particle has an antiparticle.

II Alpha decay is evidence for the existence of the neutrino.

III The W-boson is associated with the strong nuclear force.

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

14. A nucleus represented by $^{223}_{87}Fr$ decays by beta emission.

The symbol representing the nucleus formed as a result of this decay is

A $^{224}_{87}Fr$

B $^{222}_{87}Fr$

C $^{223}_{88}Ra$

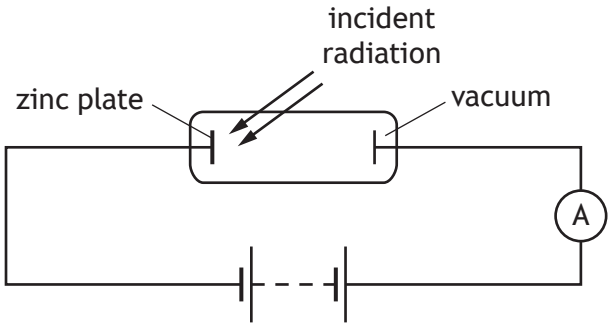
D $^{223}_{86}Rn$

E $^{224}_{88}Ra$.

[Turn over

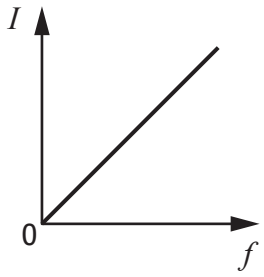
15. The diagram shows an experiment set up to investigate the photoelectric effect.

The frequency of the incident radiation is varied and the current in the circuit is measured.

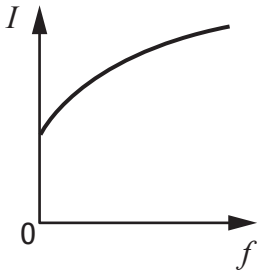


Which graph shows the relationship between the current I in the circuit and the frequency f of the incident radiation?

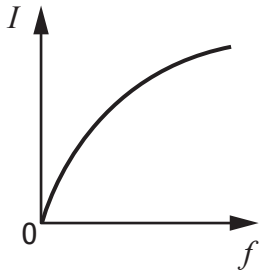
A



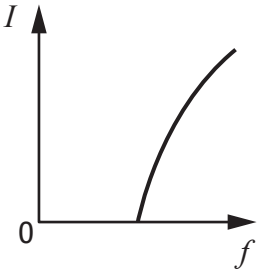
D



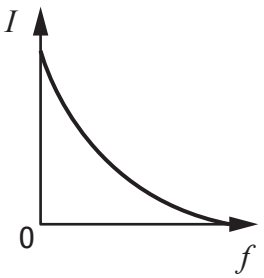
B



E



C



16. A photon of energy $6{\cdot}40 \times 10^{-19}$ J is incident on a metal plate.

This causes photoemission to take place.

The work function of the metal is $4{\cdot}20 \times 10^{-19}$ J.

The maximum speed of the photoelectron is

A $1{\cdot}19 \times 10^{6}\ \text{m s}^{-1}$

B $9{\cdot}60 \times 10^{5}\ \text{m s}^{-1}$

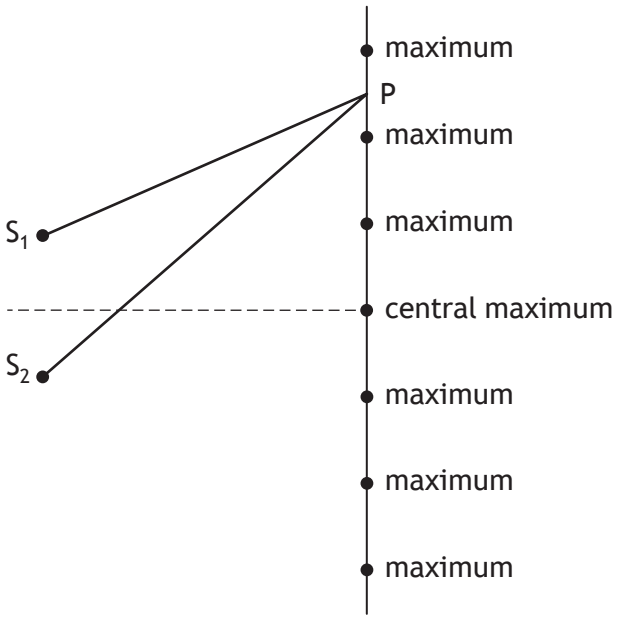
C $6{\cdot}95 \times 10^{5}\ \text{m s}^{-1}$

D $6{\cdot}79 \times 10^{5}\ \text{m s}^{-1}$

E $4{\cdot}91 \times 10^{5}\ \text{m s}^{-1}$.

17. Waves from two coherent sources, S_1 and S_2, produce an interference pattern.

Maxima are detected at the positions shown.



The wavelength of the waves is 28 mm.

For the third **minimum** at P the path difference ($S_2P - S_1P$) is

A 42 mm

B 56 mm

C 70 mm

D 84 mm

E 98 mm.

[Turn over

18. A ray of monochromatic light passes from air into water.

The wavelength of this light in air is 589 nm.

The speed of this light in water is

A $2{\cdot}56 \times 10^2\ m\ s^{-1}$

B $4{\cdot}52 \times 10^2\ m\ s^{-1}$

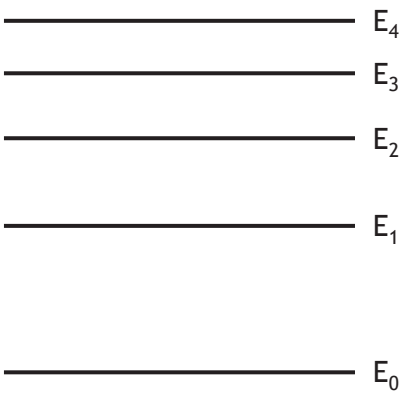
C $2{\cdot}26 \times 10^8\ m\ s^{-1}$

D $3{\cdot}00 \times 10^8\ m\ s^{-1}$

E $3{\cdot}99 \times 10^8\ m\ s^{-1}$.

19. When light passes through the outer layers of the Sun certain frequencies of light are absorbed by hydrogen atoms, producing dark lines in the spectrum.

The diagram represents some of the energy levels for a hydrogen atom.



The number of absorption lines in the spectrum caused by the transition of electrons between these energy levels is

A 4

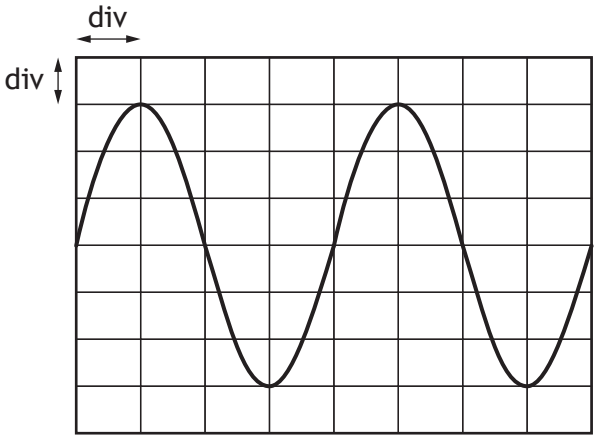
B 6

C 9

D 10

E 20.

20. The output from an AC power supply is connected to an oscilloscope. The trace seen on the oscilloscope screen is shown.



The Y-gain setting on the oscilloscope is 1·0 V/div.

The rms voltage of the power supply is

A 2·1 V

B 3·0 V

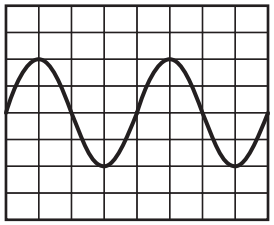
C 4·0 V

D 4·2 V

E 6·0 V.

[Turn over

21. The output from a signal generator is connected to an oscilloscope. The trace observed on the oscilloscope screen is as shown in the diagram.



The frequency of the signal from the signal generator is now doubled.

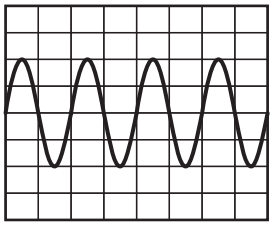
The amplitude of the signal is unchanged.

The Y-gain setting on the oscilloscope is unchanged.

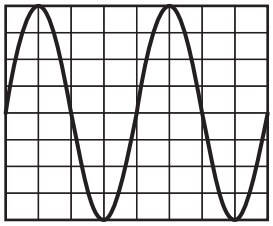
The timebase setting on the oscilloscope is changed from 1·0 ms/division to 0·5 ms/division.

Which of the following diagrams shows the trace that is now observed on the oscilloscope screen?

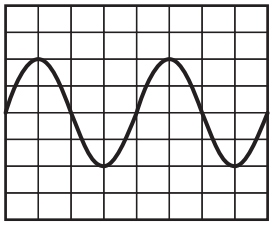
A



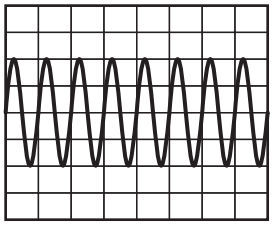
D



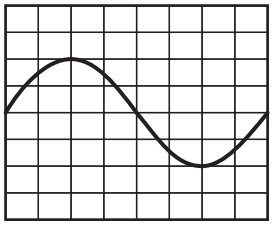
B



E



C



22. A student sets up a circuit and measures the voltage across and the current in a resistor.

The measurements and their uncertainties are

$$\text{voltage} = (10{\cdot}0 \pm 0{\cdot}1)\,\text{V}$$
$$\text{current} = (0{\cdot}50 \pm 0{\cdot}01)\,\text{A}$$

The approximate absolute uncertainty in the calculated value of the resistance of the resistor is

A $\pm 0{\cdot}11\,\Omega$

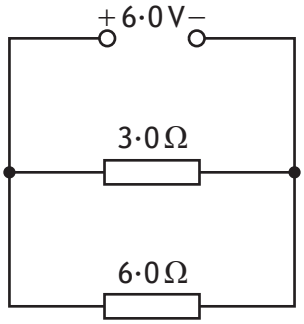
B $\pm 0{\cdot}2\,\Omega$

C $\pm 0{\cdot}4\,\Omega$

D $\pm 1\,\Omega$

E $\pm 2\,\Omega$.

23. A circuit is set up as shown.



The power supply has negligible internal resistance.

The power dissipated in the $3{\cdot}0\,\Omega$ resistor is

A 3·0 W

B 6·0 W

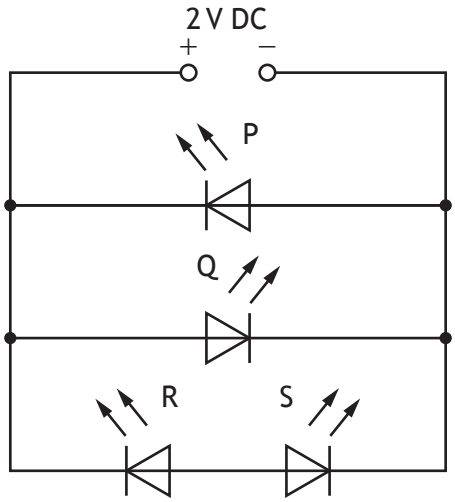
C 9·0 W

D 12 W

E 18 W.

[Turn over

24. A student connects four identical light emitting diodes (LEDs) to a 2 V DC supply as shown.



Which of the LEDs P, Q, R, and S will light?

A P only

B Q only

C P and Q only

D P and R only

E Q and S only.

25. A student makes the following statements about uncertainties.

I All measurements of physical quantities are liable to uncertainties.

II Random uncertainties occur when a measurement is repeated and slight variations occur.

III Systematic uncertainties in a quantity occur when measurements are either all smaller or all larger than the true value of the quantity.

Which of these 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

[END OF QUESTION PAPER]

SPACE FOR ROUGH WORK

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