

SPECIMEN PAPERS

SET 2

Paper 1 SL

Time allowed: 1 hour 30 minutes.

A calculator and the data booklet are required.

The paper consists of Section A with 25 multiple choice questions and Section B with data-based questions.

Section A – Multiple choice questions

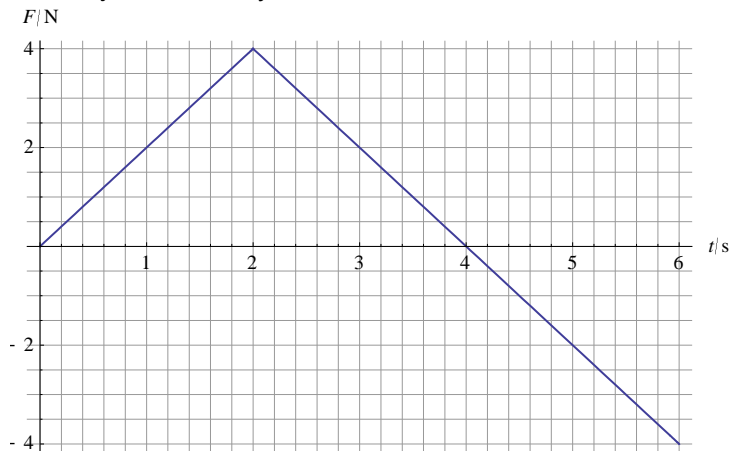
1 A car has an initial velocity of 20 m s^{-1} . It decelerates at 5.0 m s^{-2} . After which distance will the car stop?

- A** 4.0 m **B** 40 m **C** 80 m **D** 100 m

2 A projectile has an initial horizontal velocity of 10 m s^{-1} and an initial vertical velocity of 20 m s^{-1} . The initial kinetic energy is K . What is the kinetic energy after 1 s?

- A** $\frac{K}{5}$ **B** $\frac{2}{5}K$ **C** $\frac{5}{2}K$ **D** $5K$

3 The graph shows the variation with time t of the net force F on an object of mass 2.0 kg . The object is initially at rest.

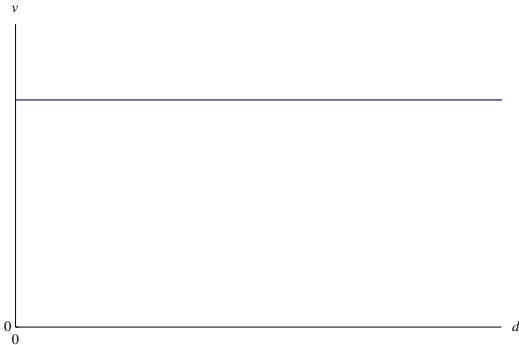


What is the velocity of the object at $t = 6 \text{ s}$?

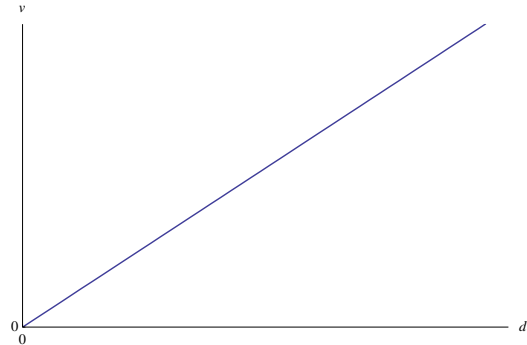
- A** 2.0 m s^{-1} **B** 4.0 m s^{-1} **C** 8.0 m s^{-1} **D** 16 m s^{-1}

- 4 A constant resultant force is applied to a body initially at rest.

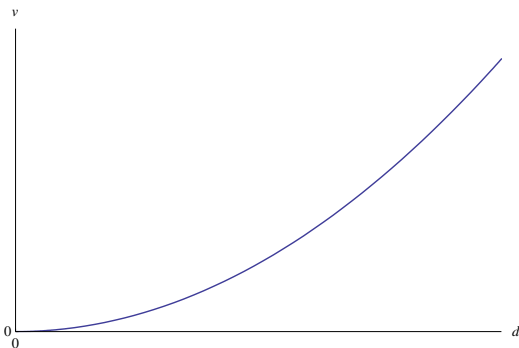
Which graph correctly shows the variation with distance travelled d of the speed v of the body?



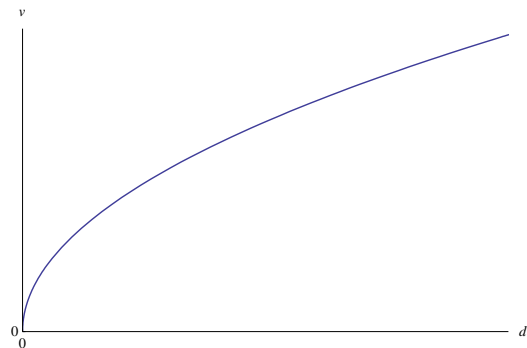
A



B



C



D

- 5 A constant net force of 6.0 N accelerates a body from rest to a speed of 8.0 m s^{-1} . What is the average power developed by the force?

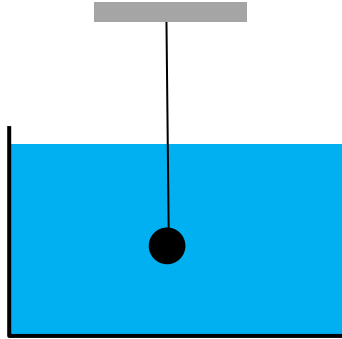
A 12 W

B 24 W

C 48 W

D It is impossible to answer without knowing the mass.

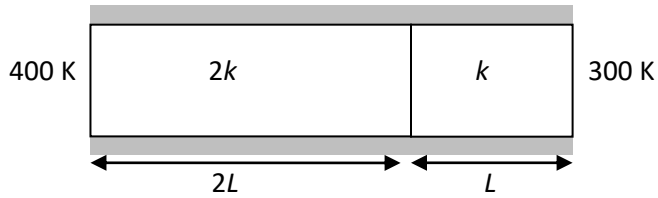
- 6 A small steel ball of density ρ_s is attached to a string and is fully submerged in a container filled with a liquid of density ρ_L .



The string is cut. What is the initial acceleration of the ball?

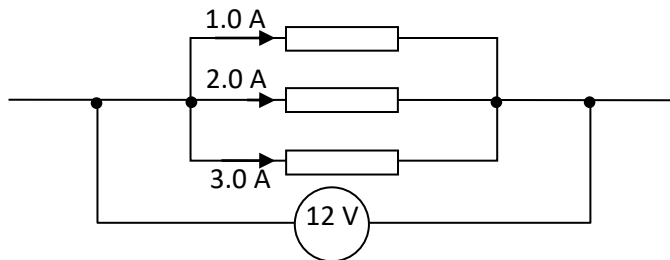
- A $g(1 + \frac{\rho_s}{\rho_L})$
- B $g(1 - \frac{\rho_s}{\rho_L})$
- C $g(1 + \frac{\rho_L}{\rho_s})$
- D $g(1 - \frac{\rho_L}{\rho_s})$
- 7 Two kilograms of water at 10°C are mixed with one kilogram of water at 70°C . What is the equilibrium temperature of the mixture in $^\circ\text{C}$?
- A 20 B 30 C 40 D 50
- 8 The average speed of the molecules of an ideal gas is c . The pressure is doubled, and the density is halved. What is the new average speed of the molecules of the gas?
- A c
- B $c\sqrt{2}$
- C $2c$
- D $4c$

- 9 Two insulated rods of the same cross-sectional area are joined. The lengths, thermal conductivities and the constant endpoint temperatures are indicated on the diagram.



What is the temperature where the rods join?

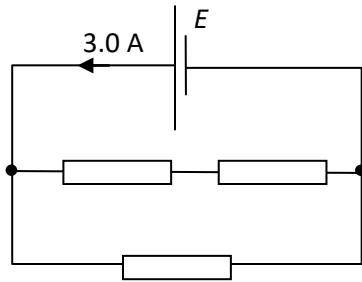
- A 325 K B 350 K C 367 K D 375 K
- 10 The diagram shows part of a circuit. The ideal voltmeter reads 12 V.



What is the total resistance of the three resistors?

- A $2.0\ \Omega$ B $4.0\ \Omega$ C $6.0\ \Omega$ D $20\ \Omega$

- 11 The cell has emf E and no internal resistance. It is connected to three identical resistors, each of resistance R . The current leaving the cell is 3.0 A.

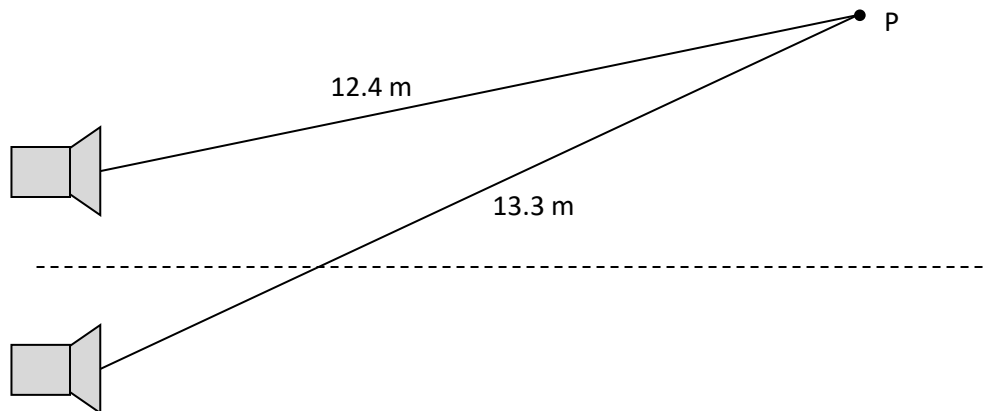


The total power dissipated in the circuit is 36 W. What is the emf of the cell and what is R ?

	Emf /V	R/Ω
A	12	6.0
B	12	4.0
C	4.0	6.0
D	4.0	4.0

- 12 Two speakers emit sound of the same wavelength in phase.

Point P is at distances of 12.4 m and 13.3 m from the speakers. No sound is observed at P.



What is the shortest possible wavelength of the sound?

- A** 0.45 m **B** 0.60 m **C** 0.90 m **D** 1.8 m
- 13 A string has both ends fixed. Two **consecutive** harmonics on the string have frequencies 240 Hz and 300 Hz. What is the frequency of the first harmonic on this string?

- A** 30 Hz **B** 60 Hz **C** 120 Hz **D** 150 Hz

14 A lightly damped oscillating system has natural frequency f . An external periodic force F of frequency $1.5f$ acts on the system. The frequency of F is increased. What happens to the amplitude of oscillations?

- A** It is unchanged.
B It decreases.
C It increases.
D It is impossible to answer with the data given.

15 Light from a spectral line in the lab has wavelength 480 nm. The same line emitted from a galaxy has wavelength 460 nm. What is correct about the velocity of this galaxy? (The speed of light is c .)

	Speed	Direction
A	$\frac{c}{24}$	Away from earth
B	$\frac{c}{24}$	Towards earth
C	$\frac{c}{23}$	Away from earth
D	$\frac{c}{23}$	Towards earth

16 An oil drop has electric charge 8.0×10^{-19} C. The oil drop splits into two smaller drops of the same radius. What could be the charges on the two smaller oil drops?

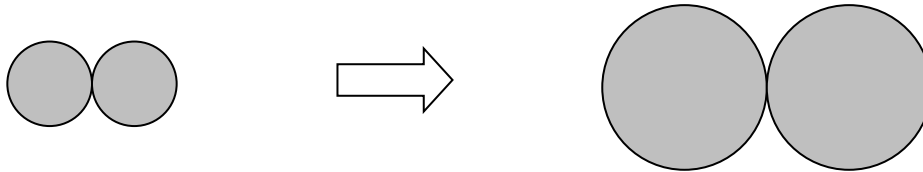
	One drop	The other drop
A	4.0×10^{-19} C	4.0×10^{-19} C
B	1.6×10^{-19} C	4.8×10^{-19} C
C	2.0×10^{-19} C	6.0×10^{-19} C
D	4.8×10^{-19} C	3.2×10^{-19} C

17 A potential difference is established between two parallel plates. A proton is placed on the positive plate and released. The proton reaches the negative plate with kinetic

energy K . The potential difference and the separation of the plates are both doubled, and the experiment is repeated. What is the kinetic energy of the proton now?

- A** K **B** $2K$ **C** $4K$ **D** $8K$

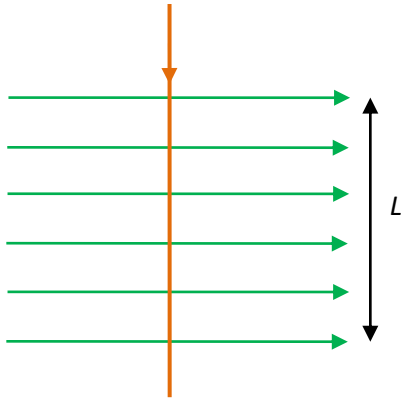
- 18** Two identical steel spheres touch. The gravitational force between them is F . The spheres are replaced by two steel spheres of double the radius.



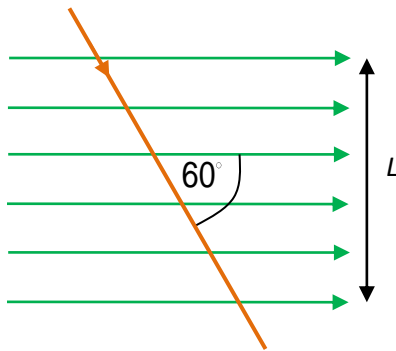
The new spheres touch. What is the force between them?

- A** $\frac{F}{4}$ **B** $\frac{F}{2}$ **C** $4F$ **D** $16F$

- 19** A current carrying wire experiences a magnetic force F when placed in a uniform magnetic field as shown.



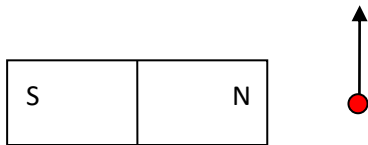
The wire is rotated so it makes an angle of 60° with the magnetic field.



What is the force on the wire now? ($\cos 60^\circ = \frac{1}{2}$, $\sin 60^\circ = \frac{\sqrt{3}}{2}$, $\tan 60^\circ = \sqrt{3}$)

- A** F
 B $\frac{F}{2}$
 C $\frac{F\sqrt{3}}{2}$
 D $F\sqrt{3}$

20 An electron moves past a bar magnet.



What is the direction of the magnetic force on the electron at the position shown?

- A** Out of the page.
B Into the page.
C To the right.
D To the left.

21 What was Bohr's objection to the Rutherford model of the atom?

- A The electrons would radiate energy and plunge into the nucleus.
- B The electrons did not follow elliptical orbits like planets around the Sun.
- C The space between the nucleus and the electrons was empty space.
- D In multi-electron atoms the electrons would collide with each other.

22 A nucleus X with nucleon number A decays by a series of alpha and beta minus decays. The end nucleus is an isotope of X with nucleon number $A - 8$. How many α and β^- decays took place?

	Number of α decays	Number of β^- decays
A	2	2
B	2	4
C	4	2
D	4	4

23 The initial activity of a radioactive sample X is the same as that of a sample Y. The half-life of X is T and that of Y is $2T$. What is the ratio $\frac{A_x}{A_y}$ of the activity of X to that of Y after a time of $4T$?

- A** $\frac{1}{2}$ **B** $\frac{1}{4}$ **C** 2 **D** 4

24 An unstable nucleus has too many neutrons. What is the likely decay mode of this nucleus?

- A Alpha decay.
- B Beta minus decay.
- C Beta plus decay.
- D Gamma decay.

25 Stars X and Y have the same luminosity. X has parallax $0.02''$ and Y has parallax $0.04''$.

What is the ratio $\frac{b_x}{b_y}$ of the apparent brightness of X to that of Y?

- A** $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

SECTION B – Data based questions

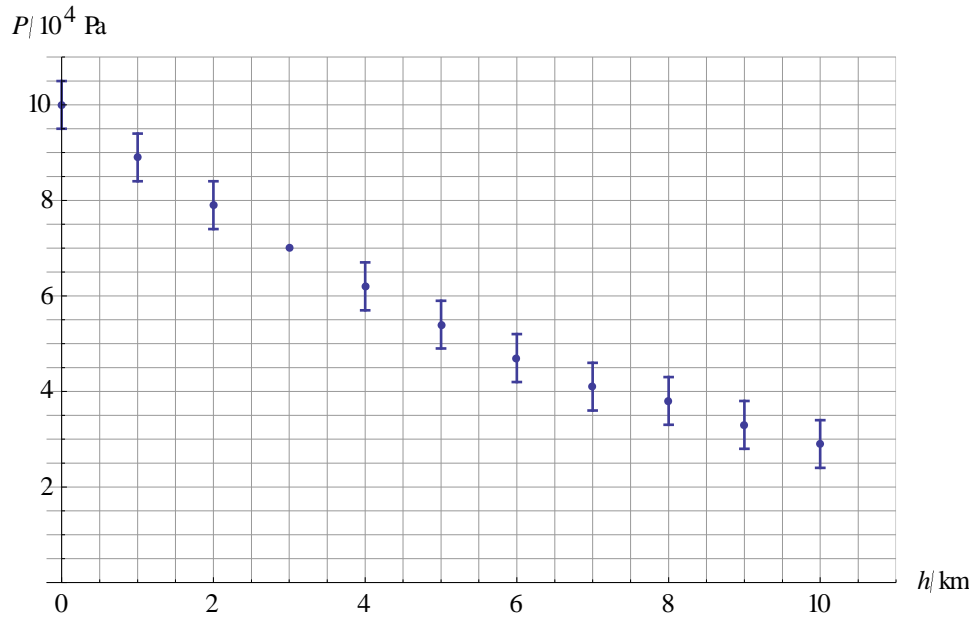
1.

Groups of students investigated the dependence of the period of a simple pendulum on the length of the pendulum.

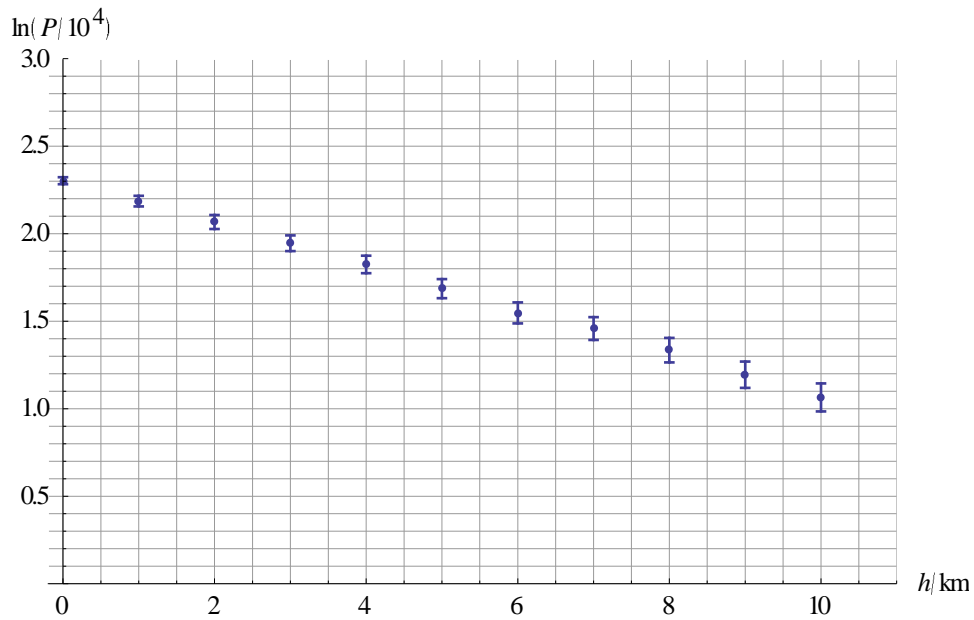
- (a) All groups used pendulum bobs of the same mass and radius under the same ambient conditions. State one other variable that must be controlled during the experiment. [1]
- (b) One group measured the time for a single oscillation with a stopwatch whose precision was $\pm 0.01\text{s}$ and quoted this as the uncertainty in the period. State and explain whether this is a realistic estimate of the uncertainty in the period. [2]
- (c) Another group used the stopwatch to measure the time T for 10 oscillations and then divided T by 10. State and explain an advantage for doing this. [2]
- (d) The theoretical prediction for the dependence of period on length is $T = 2\pi\sqrt{\frac{L}{g}}$.
- (i) Suggest how the data for period and length must be plotted to get a straight-line graph. [1]
- (ii) For your answer in (i), state the gradient of the straight line. [1]

2.

The graph shows the variation of the atmospheric pressure P with height h above the earth's surface. The error bar for $h = 3.0\text{ km}$ is not shown.



- (a) State the atmospheric pressure at the surface, in the form $P \pm \Delta P$. [1]
- (b) It is suggested that P is inversely proportional to h . State and explain whether this is a reasonable suggestion. [2]
- (c)
- Draw the error bar for the data point with $h = 3.0$ km. [1]
 - Determine the percentage uncertainty in P for $h = 3.0$ km. [2]
- (d) The graph shows the variation of the natural logarithm of P with h .



- (i) Draw the line of best fit. [1]
- (ii) Estimate the slope of the line of best fit, including its unit. [2]
- (iii) Predict the pressure at a height of 20 km. [3]
- (iv) Suggest why the estimate in (iii) may not be reliable. [1]

Markscheme

1	B		11	A		21	A	
2	B		12	B		22	B	
3	A		13	B		23	B	
4	D		14	B		24	B	
5	B		15	B		25	A	
6	D		16	D				
7	B		17	B				
8	C		18	D				
9	B		19	A				
10	A		20	A				

1				
a		The angle by which the pendulum is displaced✓		[1]
b		It is not✓ The reaction time is much greater than the precision of the stopwatch✓		[2]
c		It reduces the random uncertainty✓ If the uncertainty in the measurement of the 10 oscillations is ΔT , the uncertainty in the period is $\frac{\Delta T}{10}$ ✓		[2]
d	i	T vs \sqrt{L} or T^2 vs L ✓ $\frac{2\pi}{\sqrt{g}}$ or $\frac{4\pi^2}{g}$ ✓	Accept other (correct but unlikely) possibilities	[2]

2				
a		$(1.00 \pm 0.05) \times 10^5$ Pa ✓		[1]
b		It is not✓ If it were, the pressure at the surface would be infinite✓ OR $P \times h$ would be constant which it is not		[2]
c	i	Vertical error bar drawn at correct place $\pm 0.5 \times 10^4$ Pa ✓		[1]

c	ii	$\frac{0.5 \times 10^4}{7.0 \times 10^4} \times 100 \checkmark$ $7\% \checkmark$		[2]
d	i	<p>Any reasonable straight line through all error bars \checkmark</p>		[1]
d	ii	$\frac{(1.1 - 2.3)}{10} = -0.12 \checkmark$ $\text{km}^{-1} \checkmark$	Accept range 0.10 to 0.14	[2]
d	iii	$\ln\left(\frac{P}{10^4}\right) = 2.3 - 0.12 \times 20 = -0.10 \checkmark$ $\frac{P}{10^4} = e^{-0.10} \checkmark$ $P = 9.0 \times 10^3 \text{ Pa} \checkmark$		[3]
d	iv	The model is extrapolated very far from the data set \checkmark		[1]