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

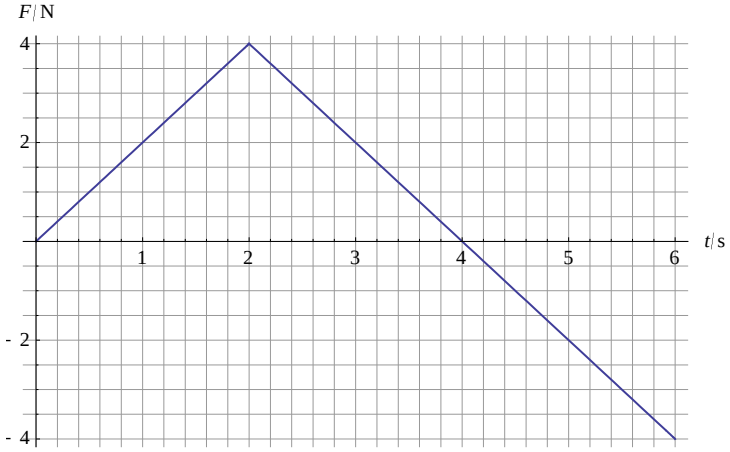
1 A car has an initial velocity of 20 m s^{-1}. It decelerates at 5.0 m s^{-2}. After which distance will the car stop?

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.

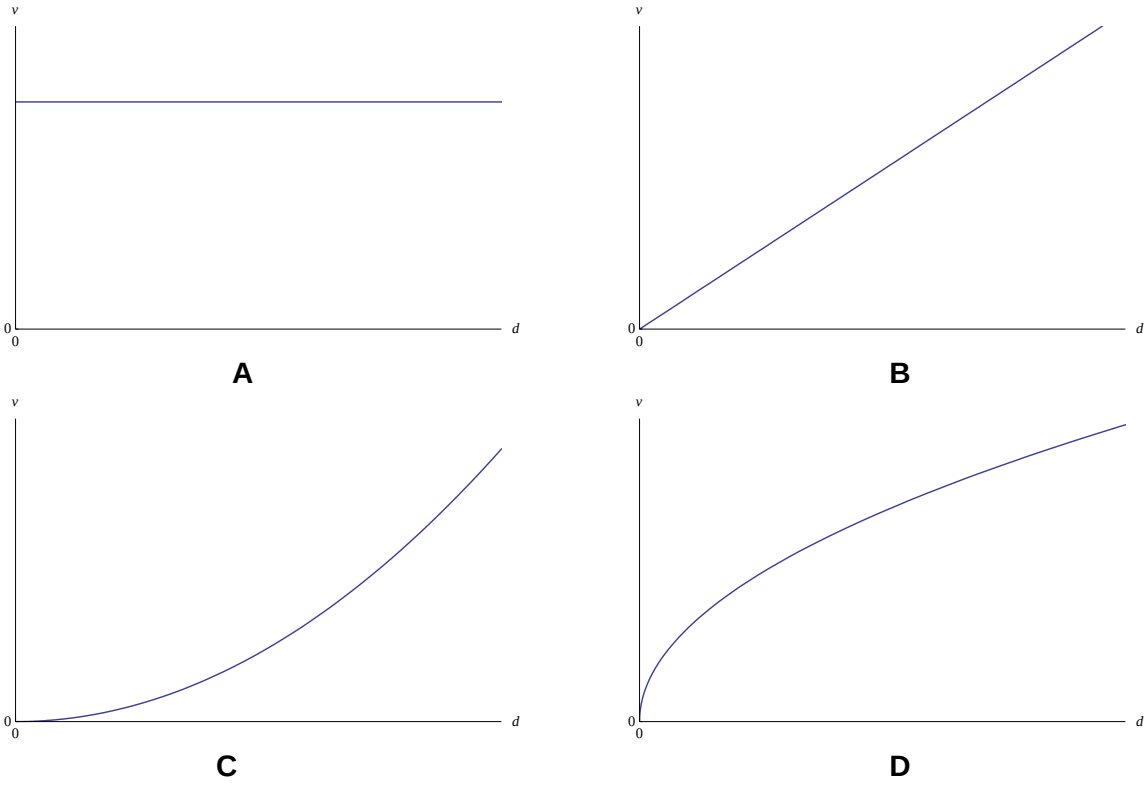


What is the velocity of the object at t = 6 s?

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?



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?

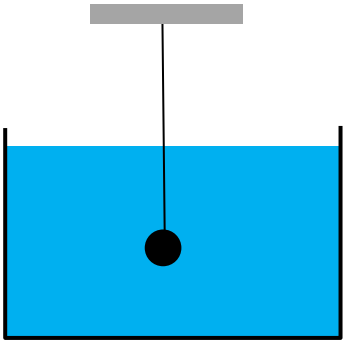
A 12 W

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 $g(1-\frac{\rho_L}{\rho_S})$

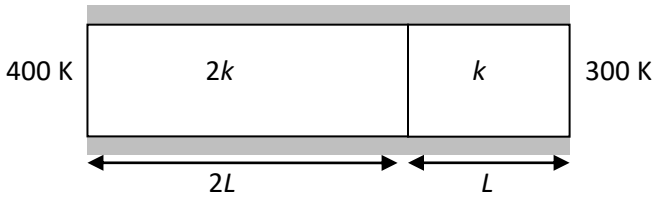
7 Two kilograms of water at $10\,^{\circ}\mathrm{C}$ are mixed with one kilogram of water at $70\,^{\circ}\mathrm{C}$. What is the equilibrium temperature of the mixture in $^{\circ}\mathrm{C}$?

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 $4c$

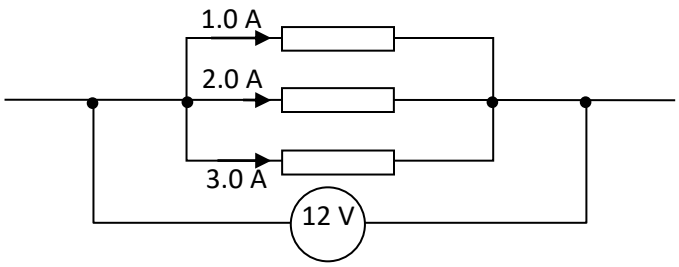
9 Two insulated rods of the same cross-sectional area are joined. The lengths, thermal conductivities and the constant endpoint temperatures are indicated on the diagram.



What is the temperature where the rods join?

A 325 K **B** 350 K **C** 367 K **D** 375 K

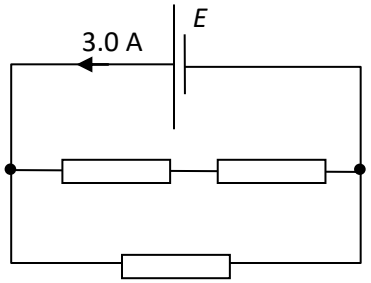
10 The diagram shows part of a circuit. The ideal voltmeter reads 12 V.



What is the total resistance of the three resistors?

A 2.0 Ω **B** 4.0 Ω **C** 6.0 Ω **D** 20 Ω

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.

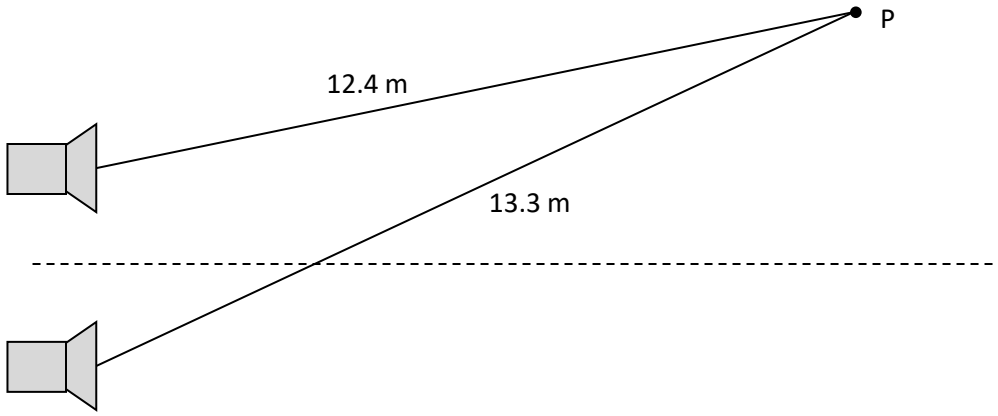


The total power dissipated in the circuit is 36 W. What is the emf of the cell and what is *R*?

	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 1.5*f* 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?

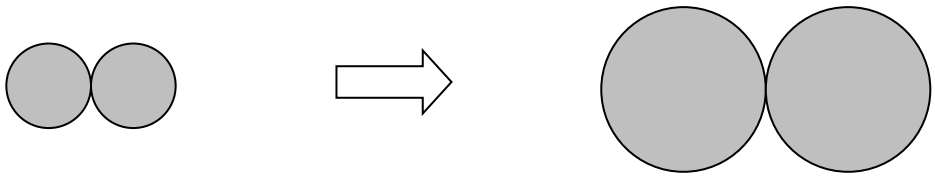
	One drop	The other drop
A	4.0×10^{-19} C	4.0×10^{-19} C
B	1.6×10^{-19} C	4.8×10^{-19} C
C	2.0×10^{-19} C	6.0×10^{-19} C
D	4.8×10^{-19} C	3.2×10^{-19} C

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** $8K$

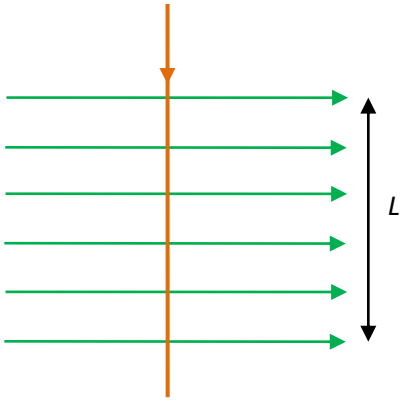
18 Two identical steel spheres touch. The gravitational force between them is F. The spheres are replaced by two steel spheres of double the radius.



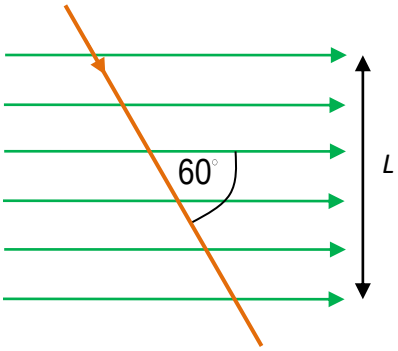
The new spheres touch. What is the force between them?

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.



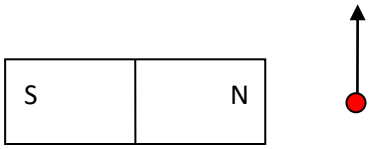
The wire is rotated so it makes an angle of 60° with the magnetic field.



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 2*T*. What is the ratio $\frac{A_X}{A_Y}$ of the activity of X to that of Y after a time of 4*T*?

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]

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(b) One group measured the time for a single oscillation with a stopwatch whose precision was ± 0.01s 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]

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(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]

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(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]

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(ii) For your answer in (i), state the gradient of the straight line. [1]

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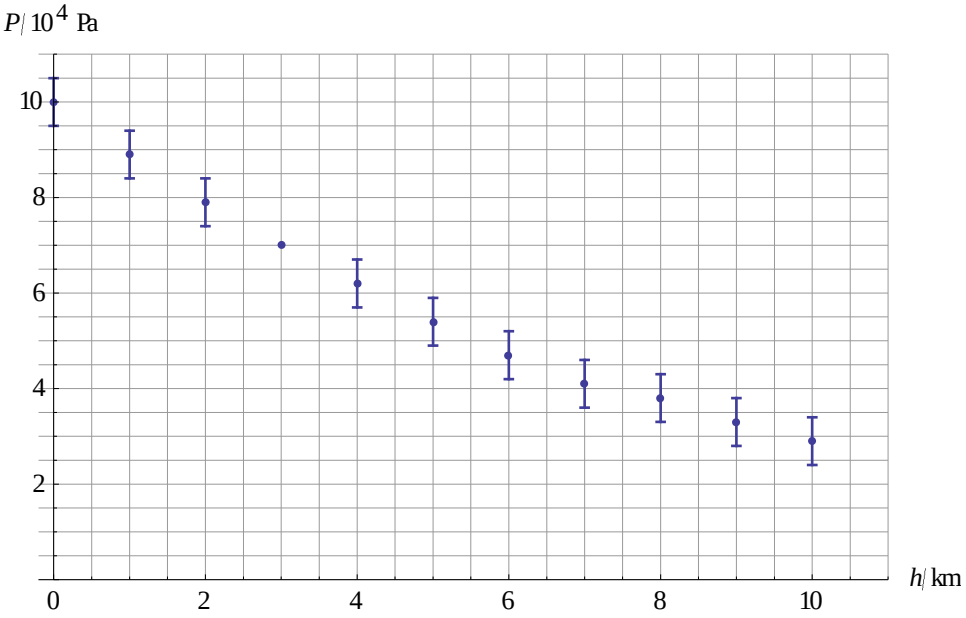
2.

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 km is not shown.



(a) State the atmospheric pressure at the surface, in the form $P \pm \Delta P$. [1]

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(b) It is suggested that P is inversely proportional to h. State and explain whether this is a reasonable suggestion. [2]

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(c)

(i) Draw the error bar for the data point with h = 3.0 km. [1]

(ii) Determine the percentage uncertainty in P for h = 3.0 km. [2]

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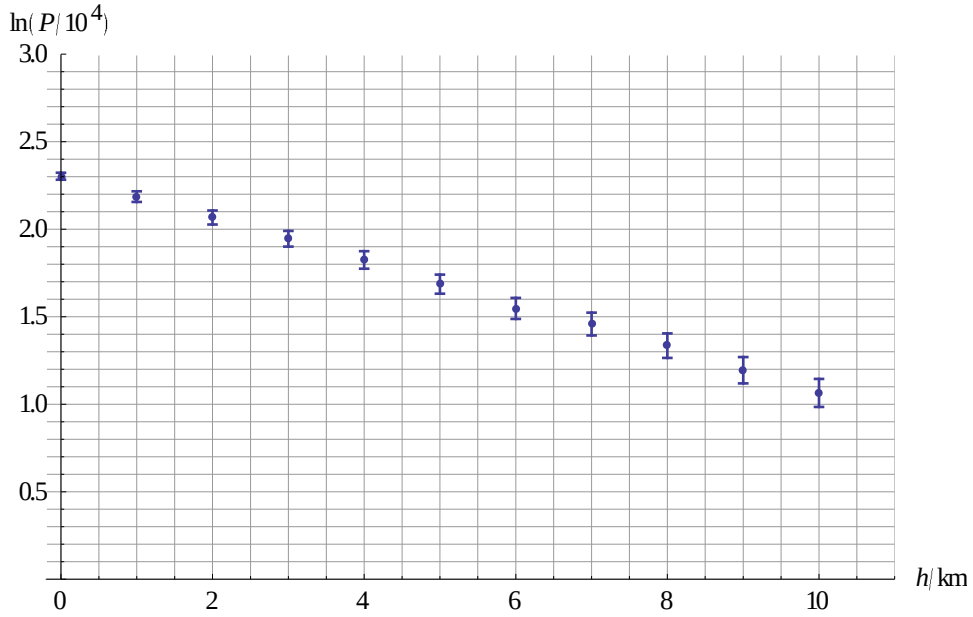
(d) The graph shows the variation of the natural logarithm of P with h.



(i) Draw the line of best fit. [1]

(ii) Estimate the slope of the line of best fit, including its unit. [2]

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(iii) Predict the pressure at a height of 20 km. [3]

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(iv) Suggest why the estimate in (iii) may not be reliable. [1]

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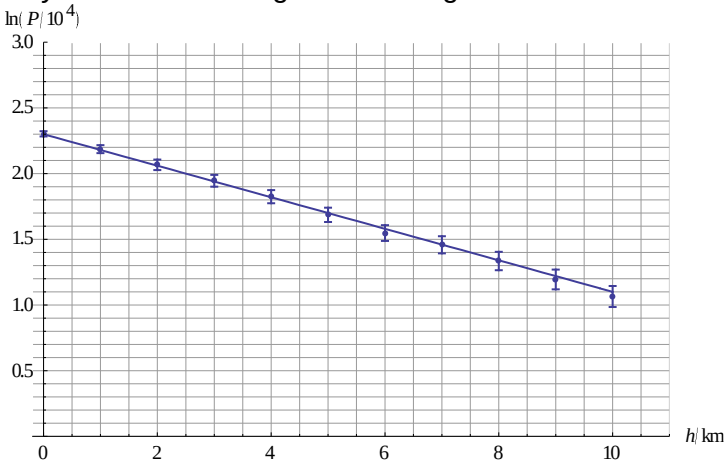
Markscheme

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	$\frac{0.5\times10^4}{7.0\times10^4}\times100$ ✓ 7% ✓		[2]
d	i	Any reasonable straight line through all error bars ✓ 		[1]
d	ii	$\frac{(1.1-2.3)}{10}=-0.12$ ✓ km^{-1} ✓	Accept range 0.10 to 0.14	[2]
d	iii	$\ln(\frac{P}{10^4})=2.3-0.12\times20=-0.10$ ✓ $\frac{P}{10^4}=e^{-0.10}$ ✓ $P=9.0\times10^3$ Pa ✓		[3]
d	iv	The model is extrapolated very far from the data set ✓		[1]