# 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

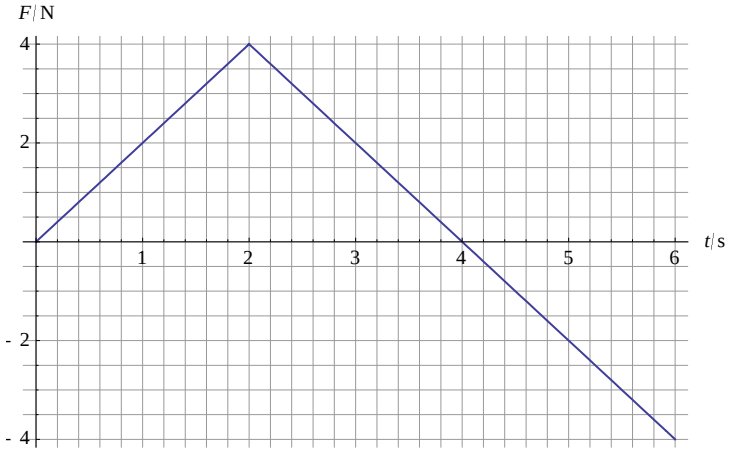
**1** A car has an initial velocity of 20 m $s^{-1}$. It decelerates at 5.0 m $s^{-2}$. After which distance will the car stop?

**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.

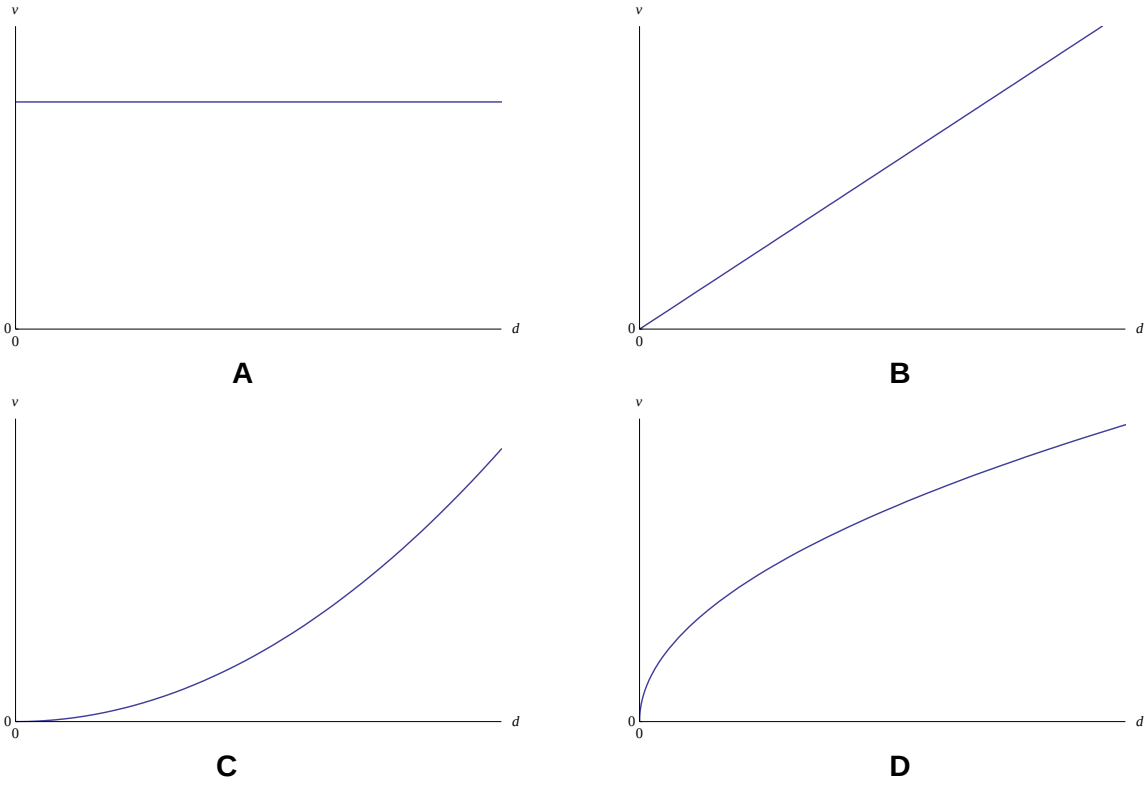



What is the velocity of the object at *t* = 6 s?

**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?

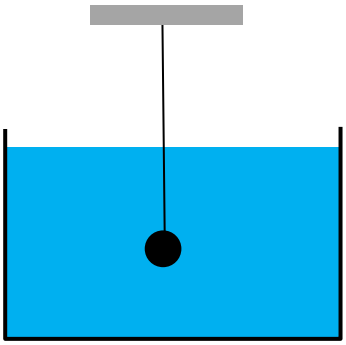
**A** 12 W

**B** 24 W

**C** 48 W

**D** It is impossible to answer without knowing the mass.

**6** A small steel ball of density $\rho_S$ is attached to a string and is fully submerged in a container filled with a liquid of density $\rho_L$.



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

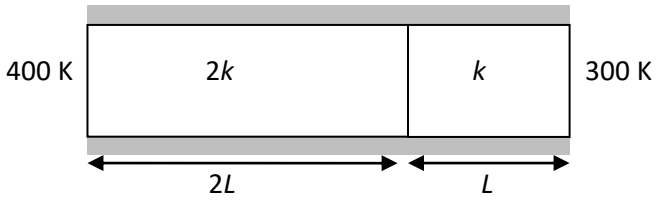
**7** Two kilograms of water at $10\,^{\circ}\mathrm{C}$ are mixed with one kilogram of water at $70\,^{\circ}\mathrm{C}$. What is the equilibrium temperature of the mixture in $^{\circ}\mathrm{C}$?

**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** $4c$

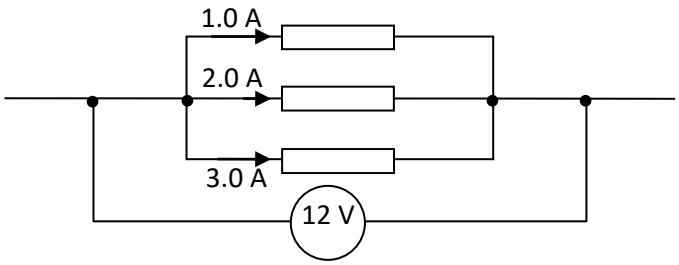
**9** Two insulated rods of the same cross-sectional area are joined. The lengths, thermal conductivities and the constant endpoint temperatures are indicated on the diagram.




What is the temperature where the rods join?

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

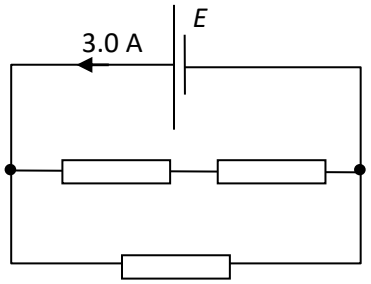
**10** The diagram shows part of a circuit. The ideal voltmeter reads 12 V.




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.

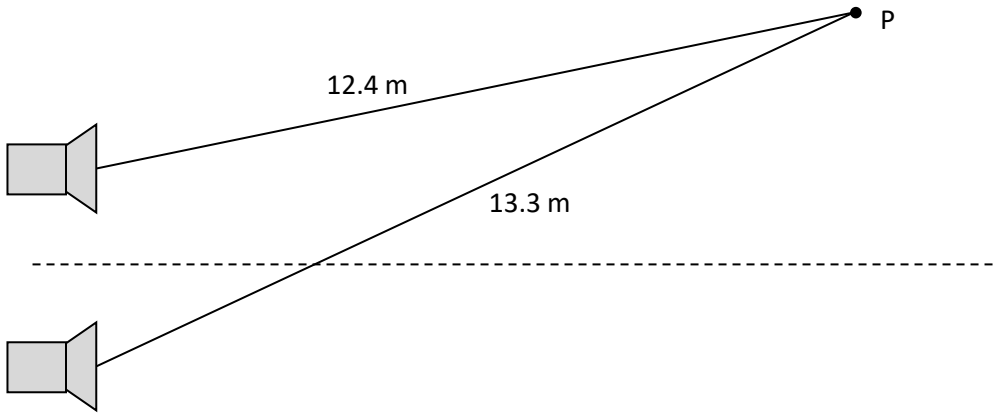



The total power dissipated in the circuit is 36 W. What is the emf of the cell and what is *R*?

| | **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 $8.0\times10^{-19}$ C. The oil drop splits into two smaller drops of the same radius. What could be the charges on the two smaller oil drops?

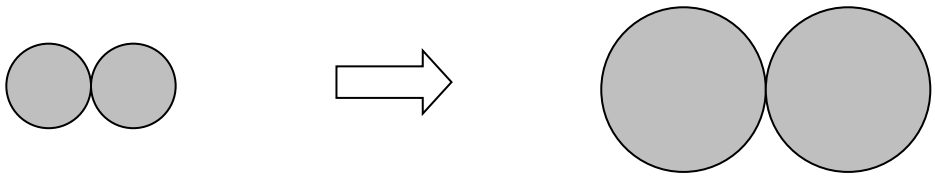
| | One drop | The other drop |
|---|---|---|
| **A** | $4.0\times10^{-19}$ C | $4.0\times10^{-19}$ C |
| **B** | $1.6\times10^{-19}$ C | $4.8\times10^{-19}$ C |
| **C** | $2.0\times10^{-19}$ C | $6.0\times10^{-19}$ C |
| **D** | $4.8\times10^{-19}$ C | $3.2\times10^{-19}$ C |

**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** $8K$

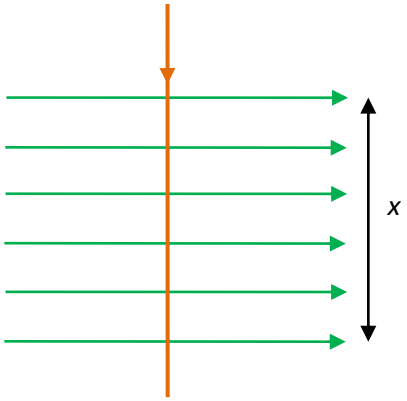
**18** Two identical steel spheres touch. The gravitational force between them is $F$. The spheres are replaced by two steel spheres of double the radius.



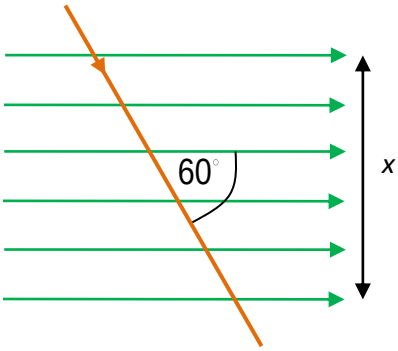
The new spheres touch. What is the force between them?

**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.



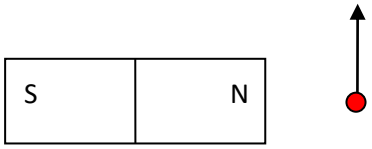

The wire is rotated so it makes an angle of $60^\circ$ with the magnetic field.




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 $\alpha$ and $\beta^-$ decays took place?

| | Number of $\alpha$ decays | Number of $\beta^-$ 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 $\pm 0.01$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]

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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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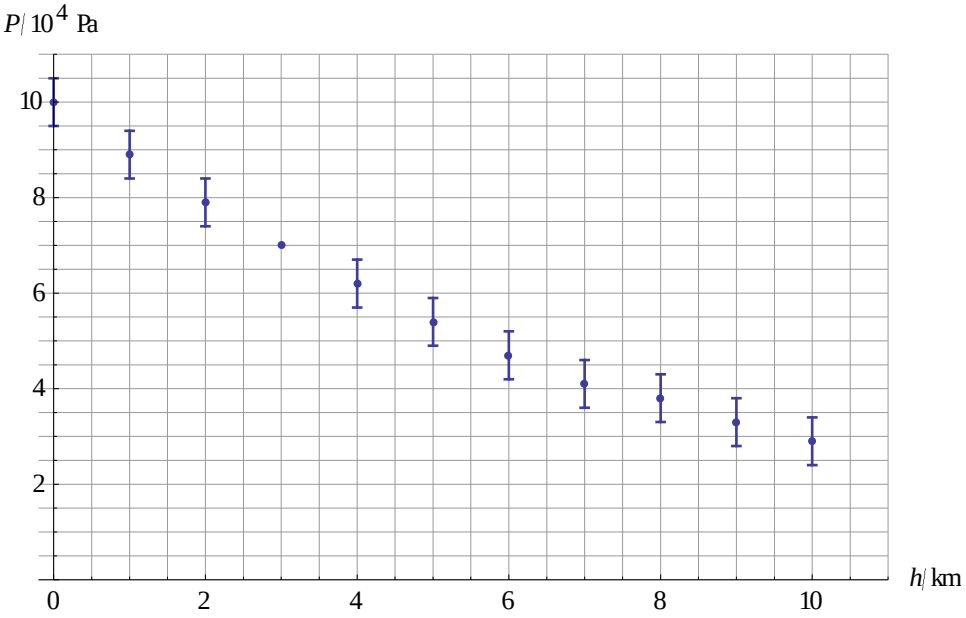
**2.**

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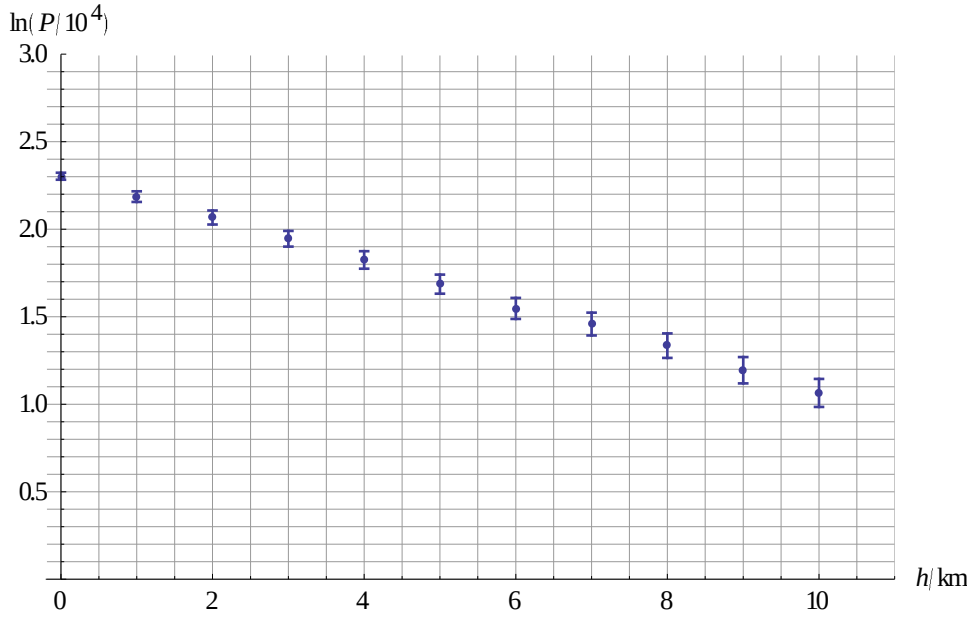
(d) The graph shows the variation of the natural logarithm of $P$ with $h$.



(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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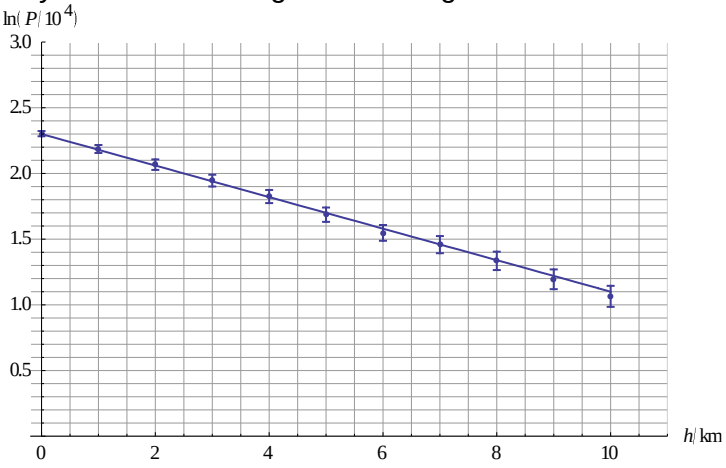
## Markscheme

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **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✓<br>The reaction time is much greater than the precision of the stopwatch✓ | | [2] |
| c | | It reduces the random uncertainty✓<br>If the uncertainty in the measurement of the 10 oscillations is $\Delta T$ , the uncertainty in the period is $\frac{\Delta T}{10}$ ✓ | | [2] |
| d | i | $T$ vs $\sqrt{L}$ or $T^2$ vs $L$ ✓<br>$\frac{2\pi}{\sqrt{g}}$ 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✓<br><br>If it were, the pressure at the surface would be infinite✓<br>*OR*<br>$P \times h$ 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 | $\frac{0.5\times10^4}{7.0\times10^4}\times100$ ✓<br>7% ✓ | | [2] |
| d | i | Any reasonable straight line through all error bars ✓<br>  | | [1] |
| d | ii | $\frac{(1.1-2.3)}{10}=-0.12$ ✓<br>$km^{-1}$ ✓ | Accept range 0.10 to 0.14 | [2] |
| d | iii | $\ln(\frac{P}{10^4})=2.3-0.12\times20=-0.10$ ✓<br>$\frac{P}{10^4}=e^{-0.10}$ ✓<br>$P=9.0\times10^3$ Pa ✓ | | [3] |
| d | iv | The model is extrapolated very far from the data set ✓ | | [1] |