Paper 3

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1 a) $c = Td\sqrt{g}$ $\quad s\,m\,m^{\frac{1}{2}}s^{-1}$

$= m^{3/2}$

b) Absolute uncertainty in measurement of 20 oscillations is same as for one. This is divided by 20 so % uncertainty is less.

c) i [Straight line touching as many points as possible]

ii. [Should now attempt to extrapolate line to vertical axis]

Since $T = \frac{c}{d\sqrt{g}}$, $T \propto \frac{1}{d}$ so the data should show a proportional relation. This is consistent as line is straight and through the origin.

d) [Find gradient using a large triangle]

Gradient $0.51 \le m \le 0.57$ $\quad$ Gradient $= \frac{c}{\sqrt{g}}$

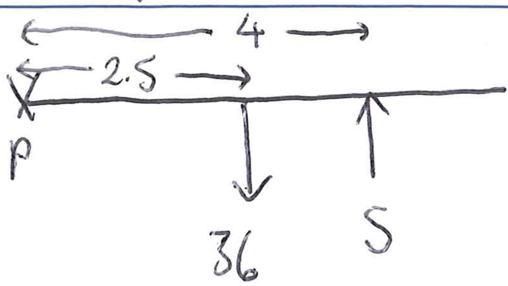
$g = \left(\frac{c}{\text{gradient}}\right)^2$

$8.6 \le g \le 10.7\ ms^{-2}$

2\. a) Rearranging: $m = \frac{VIt}{L_v}$ If V and I are constant then m is proportional to t. ($\checkmark$) Constant power provided ($\checkmark$)

b) Heat will be lost so energy provided will be larger than expected (VIt). This gives a larger value of L_v.

c) Heat loss is a systematic error for each experiment. Finding the difference will cancel this systematic error.

6 a) 

$\circlearrowleft P = P \circlearrowright$

$4S = 2.5 \times 36$

$S = 22.5\,N$

b) i. $\Gamma = I\alpha$

$36 \times 2.5 = 30.6\,\alpha$

$\alpha = 2.94 \text{ rad s}^{-2}$

ii. The angular acceleration is not constant as the component of the weight acting perpendicular to the rod is changing and so torque is not constant.

c) i. [Knowing that motion equations will not work!]

Conservation of energy: $\Delta GPE = \Delta KE_{rot}$

$mg \rightarrow W\frac{L}{2} = \frac{1}{2} I \omega^2$

vertical height drop by centre of mass

$\omega = \sqrt{\frac{WL}{I}} = \sqrt{\frac{36 \times 5}{30.6}}$

$= 2.43 \text{ rad s}^{-1}$

ii. $L = I\omega = 30.6 \times 2.43$ using show that

$= 74.4 \text{ kg m}^2 \text{ s}^{-1}$

7\. a) i. $C \rightarrow A$ is adiabatic

$$P_C V_C^{5/3} = P_A V_A^{5/3}$$

$$P_c = 2.8\times10^6 \times \left(\frac{1\times10^{-4}}{1.85\times10^{-4}}\right)^{5/3}$$

$$= 1.00\times10^6\ Pa$$

ii. $A \rightarrow B$ is isothermal so $T_B = T_A$

$$\frac{T_c}{V_c} = \frac{T_B}{V_B}$$

$$T_c = \frac{T_B}{V_B} V_c = \frac{385 \times 1.85\times10^{-4}}{2.8\times10^{-4}} = 254.4K$$

b) Thermal energy transferred = work done + ΔU

first law

$$p\Delta V = 1.00\times10^6 (2.8\times10^{-4} - 1.85\times10^{-4})$$

$$= 95\ J$$ [Negative since W on gas]

$$\Delta U = \frac{3}{2} p\Delta V = \frac{3}{2} \times 95 = 142.5$$ [Negative since cooling]

$$Q = \Delta U + p\Delta V$$

$$= -142.5 - 95 = -238\ J$$

c) i. $\text{efficiency} = \dfrac{288-238}{288}$ ← net work done [enclosed area]

$= 0.17$

ii. $S = \dfrac{\Delta Q}{T}$ ← decreases from B → C

[constant C → A since adiabatic and increases from A → B]