SMJK YU HUA KAJANG
MARKING SCHEME
PHYSICS PAPER 3 FORM 4 PRACTICAL

NO	MARKING CRITERIA	MARKS	
No 1		SUB	TOTAL
1 (a)	Diameter = 2.50 cm (Exactly). Can accept 2.48 – 2.52 cm		2
(b)	By using a mark, blocks, protractor, set square or pin / or Move the rule closer to the pendulum bob Lower the pendulum bob to be very near the ruler by lowering the retort clamp. This action will reduce parallax error while making a measurement. A drawing that show any of the effect above will also suffice		2

(c) (ii)

d / **cm**	t / **s**	T/ **s**	SUB
2.0	13.3 – 13.6	1.33 – 1.36	2
3.0	13.3 – 13.6	1.33 – 1.36	2
4.0	13.3 – 13.6	1.33 – 1.36	2
5.0	13.4 – 13.7	1.34 – 1.37	2
6.0	13.4 – 13.7	1.34 – 1.37	2
6.0	13.4 – 13.7	1.34 – 1.37	2

12

Bonus 2 mks.

NO	MARKING CRITERIA	SUB	TOTAL
(d)	**Description:** By increasing the distance d, there is little or no effect on the value of T **Or** The period of the pendulum T is not influenced by a small increase in the amplitude of the pendulum. **Justification:** From the data of T above, the values of **T are very similar/same** for every value of d. T displays very **little deviation from each other in the table.**	2 2	
(e)	To reduce human reaction time. **Or** T reduce random error in measurement **or** T is too small to be measured for 1 swing. Its too quick and reaction time error will be very large.	2	
(f)			

<table>
<tr><td></td><td><table><tr><th>d / cm</th><th>t/ s</th><th>T /s</th></tr><tr><td>15.0</td><td>13.5 – 14.5</td><td>1.35 – 1.45</td></tr><tr><td>20.0</td><td>13.5 – 14.5</td><td>1.35 – 1.45</td></tr></table></td><td>3
3</td><td></td></tr>
<tr><td>(g)</td><td>By comparing table 1.1 and 1.2, the values of T for a larger swing distance has visible effect on the period of the pendulum. The period become slightly larger.</td><td>3</td><td></td></tr>
<tr><td>(h)</td><td>When the amplitude of oscillation become large, additional observation is

The pendulum oscillation is not in one plane. The pendulum swing begins to recess or rotate in an anticlockwise manner.</td><td>3</td><td></td></tr>
<tr><td colspan="3">TOTAL</td><td>34</td></tr>
</table>

Answers prepared by

Pradeep Kumar Chakrabarty
Guru Cemerlang Fizik
SMJK Yu Hua Kajang
Nov 2014

Some extra notes to ponder about.

The Period of a Pendulum

Our final discussion will pertain to the period of the pendulum. As discussed previously in this lesson, the period is the time it takes for a vibrating object to complete its cycle. In the case of pendulum, it is the time for the pendulum to start at one *extreme*, travel to the opposite *extreme*, and then return to the original location. Here we will be interested in the question *What variables affect the period of a pendulum?* We will concern ourselves with possible variables. The variables are the mass of the pendulum bob, the length of the string on which it hangs, and the *angular displacement*. The angular displacement or *arc angle* is the angle that the string makes with the vertical when released from rest. These three variables and their effect on the period are easily studied and are often the focus of a physics lab in an introductory physics class. The data table below provides representative data for such a study.

Trial	Mass (kg)	Length (m)	Arc Angle (°)	Period (s)
1	0.02-	0.40	15.0	1.25
2	0.050	0.40	15.0	1.29
3	0.100	0.40	15.0	1.28
4	0.200	0.40	15.0	1.24
5	0.500	0.40	15.0	1.26
6	0.200	0.60	15.0	1.56
7	0.200	0.80	15.0	1.79
8	0.200	1.00	15.0	2.01
9	0.200	1.20	15.0	2.19
10	0.200	0.40	10.0	1.27
11	0.200	0.40	20.0	1.29
12	0.200	0.40	25.0	1.25
13	0.200	0.40	30.0	1.26

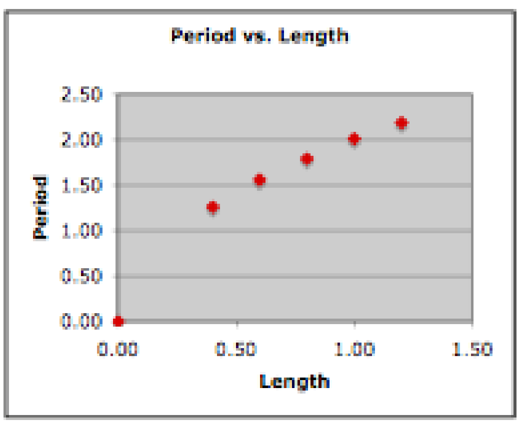
In trials 1 through 5, the mass of the bob was systematically altered while keeping the other quantities constant. By so doing, the experimenters were able to investigate the possible effect of the mass upon the period. As can be seen in these five trials, alterations in mass have little effect upon the period of the pendulum.

In trials 4 and 6-9, the mass is held constant at 0.200 kg and the arc angle is held constant at 15°. However, the length of the pendulum is varied. By so doing, the experimenters were able to investigate the possible effect of the length of the string upon the period. As can be seen in these five trials, alterations in length definitely have an effect upon the period of the pendulum. As the string is lengthened, the period of the pendulum is increased. There is a direct relationship between the period and the length.

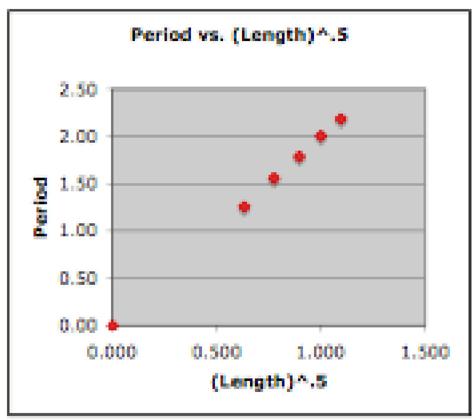
Finally, the experimenters investigated the possible effect of the arc angle upon the period in trials 4 and 10-13. The mass is held constant at 0.200 kg and the string length is held constant at 0.400 m. As can be seen from these five trials, alterations in the arc angle have little to no effect upon the period of the pendulum. If the arc is made very large, then the effect is noticible as the time take for 1 swing is slightly bigger. This has to do with air friction that slows down the pendulum swing.

Anyhow, if air resistance is neglected, then the time of swing T is not influenced by the amplitude of swing.

So the conclusion from such an experiment is that the one variable that effects the period of the pendulum is the length of the string. Increases in the length lead to increases in the period. But the investigation doesn't have to stop there. The quantitative equation relating these variables can be determined if the data is plotted and linear regression analysis is performed. The two plots below represent such an analysis. In each plot, values of period (the dependent variable) are placed on the vertical axis. In the plot on the left, the length of the pendulum is placed on the horizontal axis. The shape of the curve indicates some sort of power relationship between period and length. In the plot on the right, the square root of the length of the pendulum (length to the ½ power) is plotted. The results of the regression analysis are shown.



Slope: 1.7536
Y-intercept: 0.2616
COR: 0.9183



Slope: 2.0045
Y-intercept: 0.0077
COR: 0.9999

The analysis shows that there is a better fit of the data and the regression line for the graph on the right. As such, the plot on the right is the basis for the equation relating the period and the length. For this data, the equation is

$$\textbf{Period} = 2.0045 \bullet \textbf{Length}^{0.5} + 0.0077$$

Using **T** as the symbol for period and **L** as the symbol for length, the equation can be rewritten as

$$T = 2.0045 \bullet L^{0.5} + 0.0077$$

The commonly reported equation based on theoretical development is

$$T = 2 \bullet \Pi \bullet (L/g)^{0.5}$$

where **g** is a constant known as the gravitational field strength or the acceleration of gravity (9.8 N/kg). The value of 2.0045 from the experimental investigation agrees well with what would be expected from this theoretically reported equation. Substituting the value of **g** into this equation, yields a proportionality constant of $2\Pi/g^{0.5}$, which is 2.0071, very similar to the 2.0045 proportionality constant developed in the experiment.