Topic 2 – Guidance for Practical 1

Experimental determination of the acceleration of free fall

Safety

Although great care has been taken in checking the accuracy of the information provided in this guidance, Cambridge University Press shall not be responsible for any errors, omissions or inaccuracies.

Teachers and technicians should always follow their school and departmental safety policies. You must ensure that you consult your employer's model risk assessments and modify them as appropriate to meet local circumstances before starting any practical work. Risk assessments will depend on your own skills and experience, the skills and experience of your students, and the facilities available to you. Everyone has a responsibility for his or her own safety and for the safety of others. The notes below should not be regarded as a risk assessment.

You should carry out the practical yourself before presenting it to students. Make sure you are comfortable with the procedures, and can anticipate any difficulties your students may encounter.

Guidance

Students will practice video analysis, estimating and calculating uncertainties, recording measurements in appropriate tables, processing data to linearise graphs and using graphical method to determine experimental values.

This practical usually takes place at the beginning of the course and most students require a lot of guidance in tabulating data as well as estimating and processing uncertainties.

Apparatus and materials

Each group will need:

- ball
- metre rule (or tape measure)
- digital camera
- laptop

Setting up the practical

If available, an electromagnet and a trap door connected to a switch and timer could be used.

Answers to questions

1 The equipment uncertainty of height measurements is equal to half the smallest division of the metre rule, since it is an analogue instrument.
The equipment uncertainty of time measurements is equal to the smallest division of the digital clock on the video reproducing software, since it is digital a measuring instrument.

2 Shape of ball, resolution of video, estimation of when ball has reached the ground, etc.

3 Students should determine the region ($g - \delta g$, $g + \delta g$), where δg is the uncertainty of g, and check whether the theoretical value of $9.81\,\mathrm{m\,s^{-2}}$ falls within this region. If yes, then the experiment agrees with the theory.

4 Sources of errors might include the angle that the video is captured, the position of the ruler and whether it is vertical, the video resolution, student estimation of the time the ball is released and has touched the ground.

5 Addressing as many of the above points as possible.

Topic 2 – Guidance for Practical 2

Determination of mass using balanced forces

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You should carry out the practical yourself before presenting it to students. Make sure you are comfortable with the procedures, and can anticipate any difficulties your students may encounter.

Guidance

Students will practice calculations of balanced forces on separate axes and calculating force components.

Apparatus and materials

Each group will need:

- two stands and clamps (one tall and one short)
- free-run pulley wheel with rod
- strings (one long piece of string and one shorter with a loop at one end)
- mass hanger (100g) and slot masses (several different masses)
- 'unknown' mass, labelled *X*
- protractor (or printout of protractor)
- top-pan balance

Answers to questions

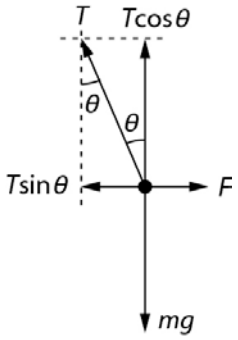
1 A second angle would have to be measured: the one between the horizontal and the string from point O to the pulley. The *mg* force would have to be resolved to its *x*- and *y*-components and new equations for the equilibrium for each axis written.

x-axis: $T\cos\theta = mg\cos\varphi \Rightarrow T = \frac{mg\cos\varphi}{\cos\theta}$

y-axis: $T\sin\theta = Xg\sin\varphi \Rightarrow X = \frac{T\sin\theta}{g\sin\varphi}$

$$\Rightarrow X = \frac{mg\cos\varphi\sin\theta}{g\sin\varphi\cos\theta} = m\frac{\tan\theta}{\tan\varphi}$$

2



x-axis: $T\sin\theta = F$

y-axis: $T\cos\theta = mg \Rightarrow T = \frac{mg}{\cos\theta}$

$$\Rightarrow F = \frac{mg\sin\theta}{\cos\theta} = mg\tan\theta$$