Kinetic energy and a pendulum model

Student activity • observation and reasoning

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The question

What ideal speed does an energy model predict at the bottom of a pendulum's swing?

Measure a small pendulum's vertical drop and compare an ideal energy prediction with its real motion.

Equipment

- Small bob, string, secured stand and tray
- Balance, ruler, booklet and calculator

Use a small securely attached bob and low release height. Keep faces and hands out of the swing path, secure stands and do not swing towards people. Never release from beside your face.

Course coverage: Shared Physics / Double Award: 4.14–4.15. Kinetic energy and gravitational energy.

Plan, model or apparatus sketch

Draw a labelled setup or force diagram; include the measured quantities.

Method and reasoning

Read the whole sequence before starting

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1. Use a staff-secured small pendulum above a tray. Measure the bob's mass and identify its lowest position while it is stationary.

2. Raise the bob a small amount to one side. Measure the vertical rise of its centre, not the arc length or string length. Keep the release below the staff-marked position.

3. Release without pushing, stand clear and observe its return height on the opposite side. Repeat three times at the same release height.

4. Calculate the decrease in gravitational energy mgh for the initial descent, using g = 9.8 N kg^{-1}.

5. Assuming no dissipation and no initial speed, set mgh = ½mv^2 and calculate the ideal speed at the bottom. Label this as a prediction, not a measured speed.

6. Discuss why return height is usually lower and why doubling speed would quadruple kinetic energy for the same mass. Identify what extra measurement would test the predicted speed.

Cleanup

- Bring each bob to rest before returning equipment; remove it before carrying the stand.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Kinetic energy $E_k = \frac{1}{2}mv^2$. Practice example: a 0.10 kg bob drops vertically by 0.05 m; its gravitational energy decreases by 0.049 J and ideal bottom speed is about 0.99 m s^{-1}. Real motion includes drag and pivot losses. A height-based prediction is not an independent speed measurement.

Trial	Vertical drop / m	Return height / m	Ideal energy / J
1			
2			
3			

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. What distance belongs in mgh?

2. Find KE of 0.20 kg at 2.0 m s^{-1}.

3. How does doubling speed change KE?

4. Does the ideal predicted speed depend on bob mass?

5. Why is return height lower?

6. How could the speed prediction be tested independently?