Name _____ Date _____ Period _____

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Simple Pendulum Virtual Lab

Physics

Open **activities.zornscience.org/pendulum-lab/** and follow each step. Select **Free exploration** first. Show your work with units.

Objective

Find which variables (mass, length, release angle, gravity) change the **period** of a pendulum, and track how **energy** transfers as it swings.

NGSS alignment: HS-PS3-1. Use a model to calculate the change in energy of one part of a system when the change in energy of the other parts is known. HS-PS3-2. Develop and use models to show that energy at the macroscopic scale is a combination of energy of motion (kinetic) and energy stored by position (potential).
Practices and concepts: Planning and carrying out investigations; Analyzing and interpreting data; Using mathematics; Energy and matter; Cause and effect.

Meet the simulation

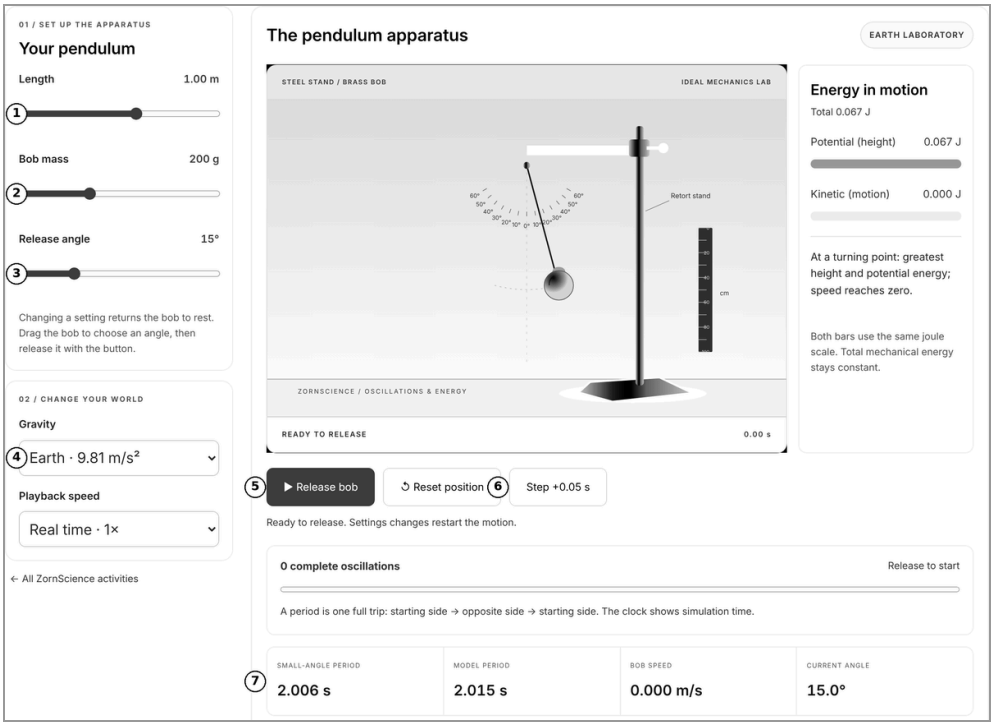


Figure 1. The Simple Pendulum lab. The dark scene is shown inverted for printing.

(1) Length: pivot to the center of the bob (0.05 m steps).
(2) Bob mass (50 g steps).
(3) Release angle in degrees.
(4) Gravity: Earth, Moon, Jupiter, or zero.
(5) Releases (and pauses) the bob.
(6) Moves a paused swing forward 0.05 s.
(7) Readouts: small-angle period, model period, bob speed, current angle.

Click a slider, then use the arrow keys for exact values.

Pre-lab

1. What is the **period** of a pendulum? Does a swing from the left side to the right side count as one period? Explain.

2. For small angles, $T = 2\pi\sqrt{(L/g)}$. Calculate the period of a 0.60 m pendulum on Earth ($g = 9.81\ m/s^2$).

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3. Predict: which change will make the period longer? (a) double the mass, (b) double the length, (c) move to the Moon. Circle all that apply.

Part A. Does mass change the period?

1. Select **Free exploration**. Set Gravity to **Earth**, Length to **1.00 m**, and Release angle to **10°**.
2. Set each bob mass below. Record the **model period** and the **Total** energy shown under "Energy in motion".

Trial	Bob mass (g)	Model period (s)	Total energy (J)
1	50		
2	200		
3	500		

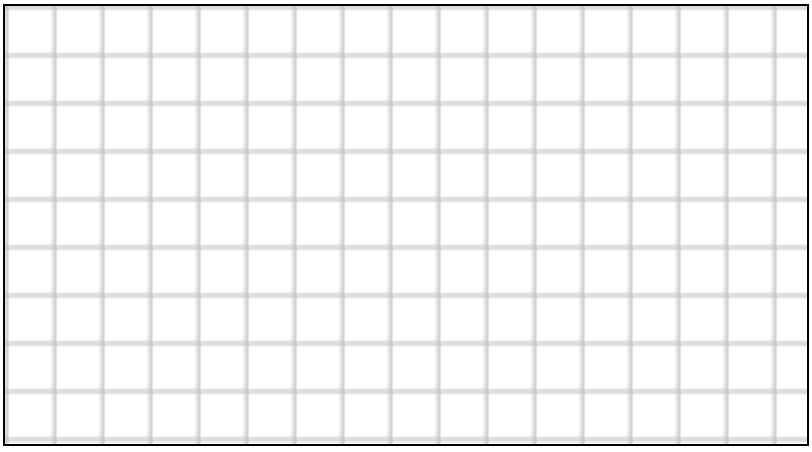
4. How does mass affect the period? How does mass affect the energy? Explain why a heavier bob does not swing faster.

Part B. Does length change the period?

1. Keep Earth, **200 g**, and **10°**. Set each length below and record the **model period**.
2. Calculate T^2 (period squared) for each trial. Round to 3 decimal places.

Trial	Length L (m)	Model period T (s)	T^2 (s^2)
4	0.30		
5	0.60		
6	0.90		
7	1.20		
8	1.50		

5. Graph T^2 (y-axis) against length (x-axis). Label both axes with units and draw a line of best fit. Find the slope.



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6. Squaring $T = 2\pi\sqrt{(L/g)}$ gives $T^2 = (4\pi^2/g)L$, so the slope equals $4\pi^2/g$. Use your slope to calculate g. Why is your answer slightly lower than 9.81 m/s^2?

7. Compare trials 5 and 7. The length doubled. By what factor did the period change? Does doubling the length double the period?

Part C. Does the release angle change the period?

1. Set Earth, **1.00 m**, **200 g**. Set each release angle below and record both periods.
2. Percent difference = (model − small-angle) / small-angle × 100. Round to 2 decimal places.

Release angle (°)	5	10	20	30	45	60
Small-angle period (s)						
Model period (s)						
Percent difference (%)						

8. Show your percent difference calculation for 60°. When is $T = 2\pi\sqrt{(L/g)}$ a good approximation?

Part D. Does gravity change the period?

1. Set **1.00 m**, **200 g**, **10°**. Choose each Gravity setting and record the model period.

Location	Earth (9.81 m/s^2)	Moon (1.62 m/s^2)	Jupiter (24.79 m/s^2)	Zero gravity
Model period (s)				

9. Divide the Moon period by the Earth period. Show that this matches $\sqrt{(g_{Earth}/g_{Moon})}$. Why does the bob not swing at all in zero gravity?

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Part E. Energy during one swing

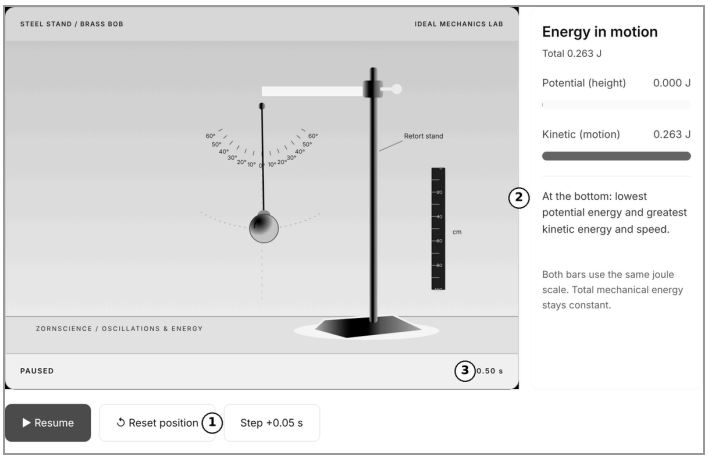


Figure 2. Paused at 0.50 s. (1) Step button. (2) Energy readouts. (3) Clock.

1. Set Earth, **1.00 m**, **200 g**, **30°**. Do not release.
2. Record the readouts at 0.00 s.
3. Select **Step +0.05 s** five times (clock reads 0.25 s). Record.
4. Step five more times (0.50 s). Record.

Clock (s)	Current angle (°)	Potential energy (J)	Kinetic energy (J)	PE + KE (J)	Bob speed (m/s)
0.00					
0.25					
0.50					

10. The bob starts 0.134 m above its lowest point. Calculate its starting potential energy with PE = mgh. Then use KE = ½mv^2 and your kinetic energy at 0.50 s to calculate the speed at the bottom. Compare both answers to the readouts.

11. Describe the energy transfer from the release point to the bottom. What happens to the total mechanical energy, and why?

12. A real pendulum slowly stops swinging. Name two differences between the ideal model and a real lab that explain this. Where does the energy go?

Conclusion

13. Write a claim that answers the objective: which variables change the period? Support it with evidence from Parts A to D (specific numbers), then explain your reasoning with T = 2π√(L/g) and energy.

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