

Springs, pendulums and simple harmonic motion

AP Physics 1 (algebra-based) · Test

Name: _____ Date: _____ Class: _____ Mark: ____ / 20

This test has 8 questions worth 20 marks. It mixes calculations, graph reading, an experimental design and a paragraph argument, as in AP Physics 1 free-response questions. Use $g = 9.81$ N/kg and give answers with units.

Level: AP Physics 1 (algebra-based) · **Curriculum:** AP P1 Unit 7

Time: 45 minutes · 8 questions · Total: 20 marks · Calculator allowed

Question 1 Define SHM (2 marks)

State the two conditions that the net force must satisfy for an object to perform simple harmonic motion.

- State the relationship between the force and the displacement. (1 mark)
- State the direction of the force. (1 mark)

Question 2 Spring period (2 marks)

A 0.18 kg mass oscillates on a spring with $k = 72$ N/m.

- Calculate the period. (1 mark)
- Calculate the frequency. (1 mark)

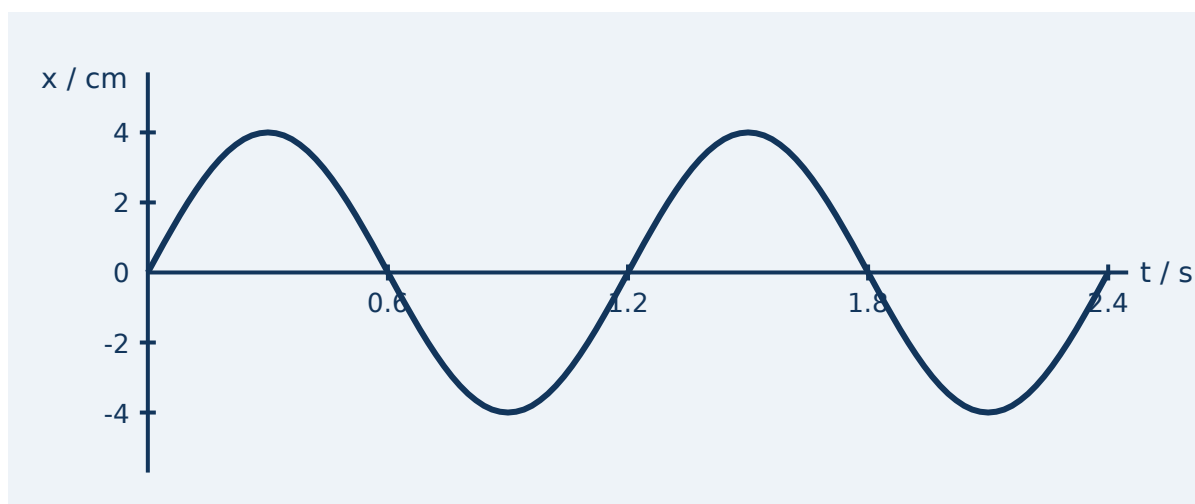
Question 3 Pendulum design (2 marks)

A pendulum has a length of 1.60 m, measured from the pivot to the centre of the bob, and swings through a small angle. Use $g = 9.81$ N/kg.

- Calculate its period. (1 mark)
- Calculate the length needed for a period of 1.00 s. (1 mark)

Question 4 Graph analysis (3 marks)

The graph shows a mass on a spring in Kofi's lab.



Displacement of a mass on a spring in Kofi's lab.

- Read the amplitude and the period. (1 mark)
- State one time at which the kinetic energy is greatest and explain your choice. (1 mark)
- Calculate the greatest speed using $v = 2\pi A/T$. (1 mark)

Question 5 Changing amplitude (2 marks)

A student doubles the amplitude of a spring oscillator without changing the mass or the spring.

- State what happens to the period and to the greatest speed. (1 mark)
- State by what factor the total energy changes and justify it with an equation. (1 mark)

Question 6 Energy at a point (3 marks)

A 0.50 kg block on a smooth table oscillates on a horizontal spring with $k = 80 \text{ N/m}$ and amplitude 0.10 m.

- Calculate the total energy. (1 mark)
- Calculate the kinetic energy when $x = 0.060 \text{ m}$. (1 mark)
- Calculate the speed at that position. (1 mark)

Question 7 Experimental design (3 marks)

Design an experiment to test whether the period of a hanging mass-spring system depends on the amplitude.

- Name the independent and dependent variables. (1 mark)
- Describe how you would measure the period accurately and name two controlled variables. (1 mark)
- State the result you would expect and how the data would show it. (1 mark)

Question 8 Heavier bob claim (3 marks)

Aarav claims that a heavier pendulum bob swings with a shorter period because gravity pulls harder on it. Write a short paragraph that evaluates this claim, using forces and the equation for the period.