

Simple harmonic motion and the physical pendulum

AP Physics C (Mechanics and E&M, calculus-based) · Test

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

This test covers simple harmonic motion and physical pendulums in the style of AP Physics C: Mechanics. Show every step, give units and state assumptions such as small angles. You may use a calculator and $g = 9.81 \text{ m/s}^2$. The total is 20 marks.

Level: AP Physics C (Mechanics and E&M, calculus-based) · **Curriculum:** AP PC:M Unit 7

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

Question 1 Spring oscillator (2 marks)

A 0.25 kg mass is attached to a spring with $k = 100 \text{ N/m}$. Calculate ω and the period.

Question 2 Calculus on $x(t)$ (3 marks)

A particle moves with $x = 0.060 \cos(10t)$ (SI units).

- Calculate the maximum speed. (1 mark)
- Calculate the maximum acceleration. (1 mark)
- Calculate x at $t = 0.10 \text{ s}$. (1 mark)

Question 3 Amplitude and period (2 marks)

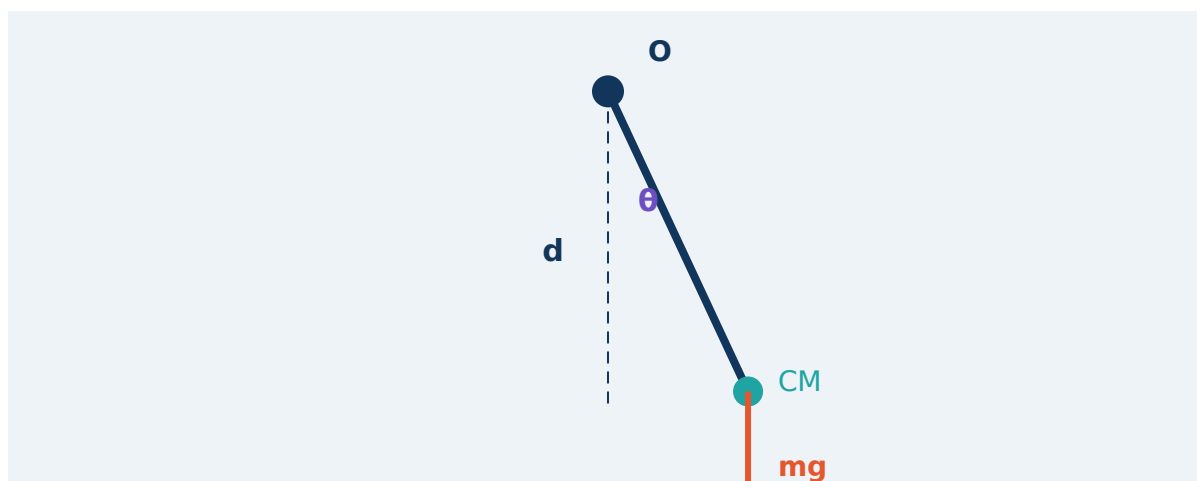
Explain why the period of a mass on a spring does not depend on the amplitude of the oscillation.

Question 4 Energy and speed (3 marks)

A 0.40 kg block on a spring ($k = 250 \text{ N/m}$) oscillates with amplitude 0.080 m.

- Calculate the total energy. (1 mark)
- Calculate the potential energy at $x = 0.040 \text{ m}$. (1 mark)
- Calculate the speed at $x = 0.040 \text{ m}$. (1 mark)

Question 5 Physical pendulum (3 marks)



Question 5: a physical pendulum.

Show that for small angles the body in the figure undergoes SHM with $\omega = \sqrt{(mgd / I)}$, where I is the moment of inertia about the pivot O.

Question 6 Swinging rod (3 marks)

A uniform rod of length 0.60 m is pivoted at one end and swings in a vertical plane through small angles. Calculate its period.

Question 7 Doubling the period (2 marks)

A simple pendulum 1.0 m long has a period of 2.0 s. Calculate the length needed to double the period.

Question 8 Verify a solution (2 marks)

Show that $x = A \sin(\omega t)$ satisfies $d^2x/dt^2 = -\omega^2 x$.