This print-out should have 15 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

AP M 1998 MC 9

13:01, calculus, multiple choice, < 1 min, fixed.

001

The equation of motion of a simple harmonic oscillator is

$$\frac{d^2x}{dt^2} = -9x,$$

where x is displacement and t is time.

What is the period of oscillation?

1. $T = 6\pi$

2. $T = \dfrac{9}{2\pi}$

3. $T = \dfrac{3}{2\pi}$

4. $T = \dfrac{2\pi}{3}$

5. $T = \dfrac{2\pi}{9}$

Simple Harmonic Motion 03

13:01, trigonometry, multiple choice, > 1 min, wording-variable.

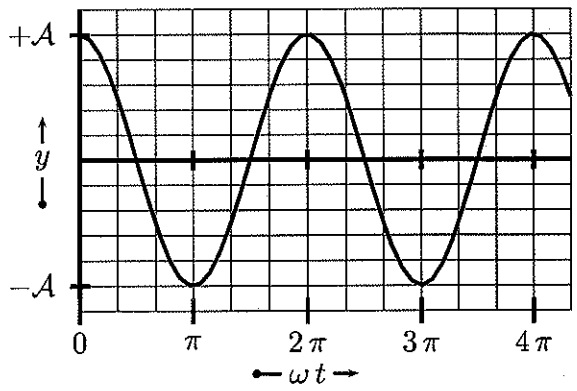
002

Simple harmonic motion can be described using the equation

$$y = A\sin(kx - \omega t - \phi).$$

Consider the simple harmonic motion given by the figure.

At position $x = 0$, we have



What equation describes the motion? $\sin(-\theta) = -\sin\theta$.

1. $y = A\sin\left(-\omega t + \dfrac{\pi}{2}\right)$

2. $y = A\sin\left(-\omega t - \dfrac{\pi}{2}\right)$

3. $y = A\sin\left(-\omega t + \dfrac{3\pi}{2}\right)$

4. $y = A\cos\left(-\omega t + \dfrac{\pi}{2}\right)$

5. $y = A\cos\left(-\omega t - \dfrac{\pi}{2}\right)$

6. $y = A\cos\left(-\omega t + \dfrac{3\pi}{2}\right)$

7. $y = A\tan\left(-\omega t + \dfrac{\pi}{2}\right)$

8. $y = A\tan\left(-\omega t - \dfrac{\pi}{2}\right)$

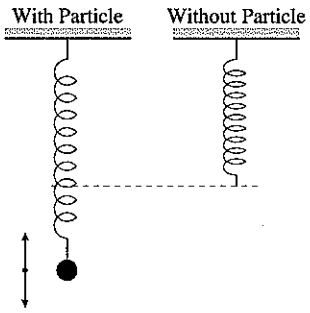
9. $y = A\tan\left(-\omega t + \dfrac{3\pi}{2}\right)$

Free Spring

13:02, trigonometry, multiple choice, > 1 min, normal.

003

A particle hangs from a spring and oscillates with a period of 0.26 s.



If the mass-spring system remained at rest, by how much would the mass stretch it from its normal equilibrium position? The acceleration of gravity is 9.8 m/s^2.

1. 0.0167808 m

2. 0.0335616 m

3. 0.0527185 m

4. 0.0671233 m

5. 0.268493 m

6. 0.134247 m

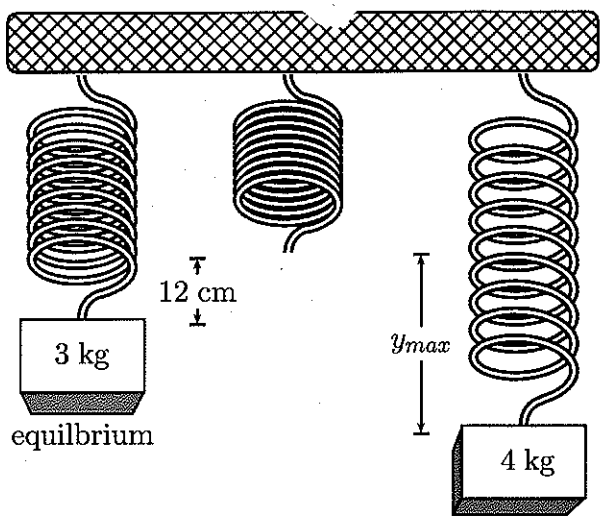
AP B 1998 MC 38

13:04, trigonometry, multiple choice, < 1 min, normal.

004

A block of mass 3 kg is hung from a spring, causing it to stretch 12 cm at equilibrium, as shown below.

The 3 kg block is then replaced by a 4 kg block, and the new block is released from the position shown below, at which point the spring is unstretched.



How far will the 4 kg block fall before its direction is reversed? *Hint:* For the new block case, the total distance of fall is twice the amplitude of the oscillation. The acceleration of gravity is 9.8 m/s^2. Answer in units of cm.

Serway CP 13 15

13:04, trigonometry, numeric, > 1 min, wording-variable.

005

A 0.4 kg object connected to a light spring with a spring constant of 19.6 N/m oscillates on a frictionless horizontal surface. The spring is compressed 4 cm and released from rest.

What is the maximum speed of the mass? Answer in units of m/s.

006

What is the speed of the object when the spring is compressed 1.5 cm? Answer in units of m/s.

007

What is the speed when spring is stretched 1.5 cm? Answer in units of m/s.

008

For what value of x does the speed equal one half of the maximum speed? Answer in units of cm.

Spring Oscillation 01

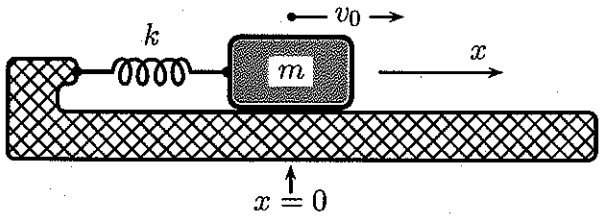
13:07, trigonometry, numeric, > 1 min, normal.

009

Consider the oscillation of a mass-spring system, where

$$x = A\cos(\omega t + \phi)\,.$$

At the time $t = 0$, the mass m is at $x = 0$ (the equilibrium point) and it is moving with a positive velocity v_0.



Find the phase angle ϕ.

(Hint: Consider x as the projection of a counterclockwise uniform circular motion.)

1. $\phi = \pi$

2. $\phi = 0$

3. $\phi = \frac{1}{4}\,\pi$

4. $\phi = \frac{1}{2}\,\pi$

5. $\phi = \frac{3}{4}\,\pi$

6. $\phi = \frac{3}{2}\,\pi$

7. $\phi = \frac{5}{4}\,\pi$

8. $\phi = \frac{7}{4}\,\pi$

9. $\phi = 2\,\pi$

010

Let the mass be $m = 5$ kg, spring constant $k = 600$ N/m and the initial velocity $v_0 = 2$ m/s.

Find the amplitude A. Answer in units of m.

011

Find the total energy of oscillation at $t = \frac{T}{8}$; *i.e.*, at one-eighth of the period.

(Hint: Consider what happens to the total energy during oscillatory motion.)

1. $E = \frac{1}{4}\,m\,v_0^2$

2. $E = \frac{1}{2}\,m\,v_0^2$

3. $E = \frac{3}{4}\,m\,v_0^2$

4. $E = m\,v_0^2$

5. $E = \frac{3}{2}\,m\,v_0^2$

6. $E = \frac{5}{2}\,m\,v_0^2$

7. $E = 2\,m\,v_0^2$

8. $E = \frac{1}{2\sqrt{2}}\,m\,v_0^2$

Holt SF 12C 04

13:02, highSchool, numeric, > 1 min, wording-variable.

012

The body of a 1275 kg car is supported on a frame by four springs. The spring constant of a single spring is 2.00×10^4 N/m. Four people riding in the car have a combined mass of 255 kg. When driven over a pothole in the road, the frame vibrates and for the first few seconds the vibration approximates simple harmonic motion.

What is the period of vibration of the car? Answer in units of s.

Horizontal Spring Oscillation 02

13:02, trigonometry, numeric, > 1 min, wording-variable.

013

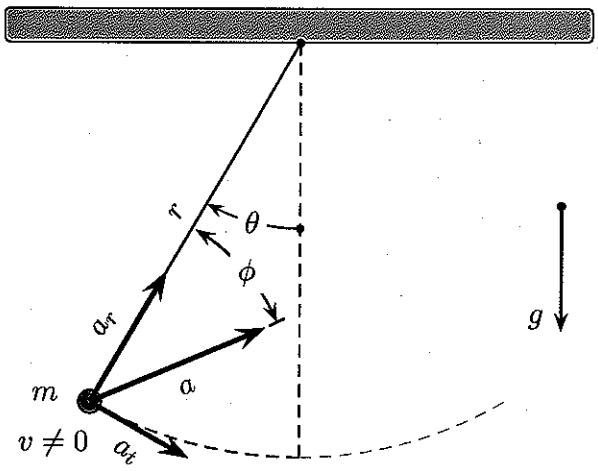
A 50 g mass is attached to a horizontal spring with a spring constant of 10 N/m and released from rest with an amplitude of 25 cm.

What is the velocity of the mass when it is halfway to the equilibrium position if the surface is frictionless? Answer in units of m/s.

Simple Pendulum 03

13:05, trigonometry, numeric, > 1 min, normal.

014



A simple pendulum has a period of 2.5 s.
The acceleration of gravity is 9.8 m/s^2.
What is its length? Answer in units of m.

015

What would its period be on the Moon, where its gravity is 1.67 m/s^2? Answer in units of s.