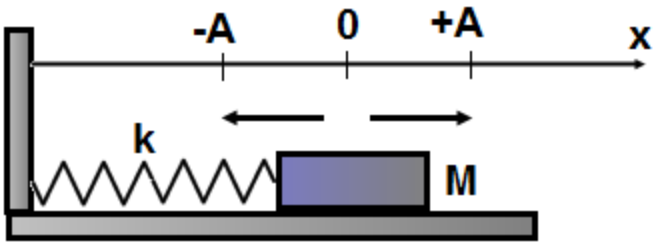
Name _____ # _____ AP Physics 1

Simple Harmonic Motion (SHM)

I. Vibrating Mass on a Spring



$$KE_1 + PE_1 = KE_2 + PE_2$$

Where is the acceleration the greatest? Why?

Smallest? Why?

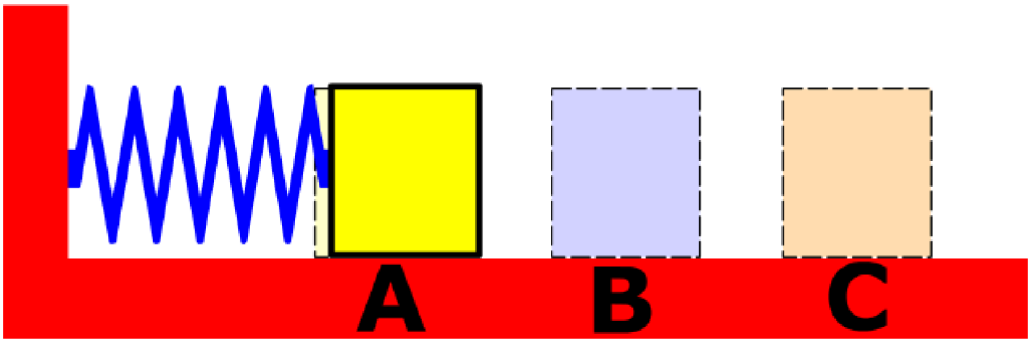
II. Period

- time for one full _____

- determined by .... _____ and _____

T = _____

III. Energy Changes – Conservation of Energy



PE at C equals .....

Ex) Mass M is attached to a spring with a spring constant **k**

If the **maximum displacement** of a mass **M** from its equilibrium position is **A**, find the **velocity** of the mass at B is

Position as a function of time

$$X = A\cos\theta$$

Since we can replace θ with ωt.

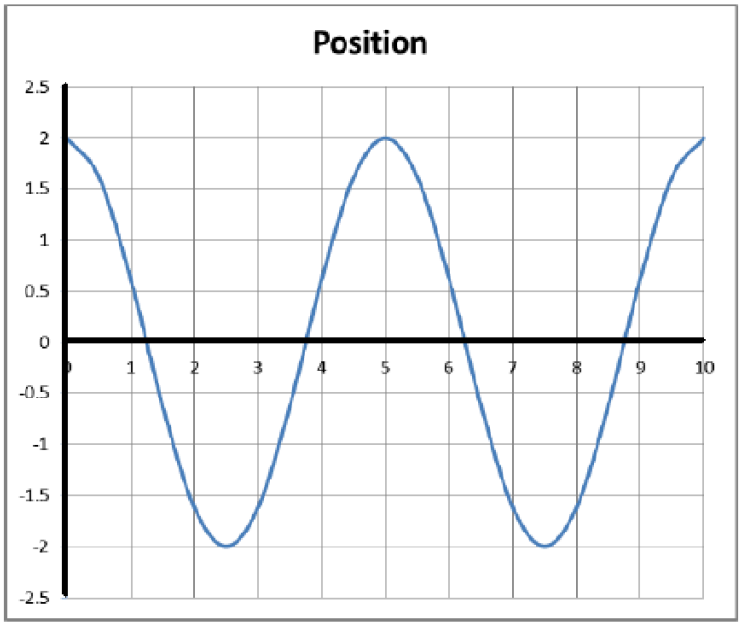
$$X = A\cos(\omega t)$$

Where A is amplitude, T is period, and t is time.

$$X = A\cos([\_\_\_\_\_]t)$$

$$X = A\cos([\_\_\_\_\_]t)$$

What is the amplitude? Period?



$$x = A\cos\left(\frac{2\pi}{T}t\right)$$

Velocity as a function of time

We can also derive the equation for velocity as a function of time.

$$v = -v_0 \sin\theta$$

Since v=ωr can replace v with ωA as well as θ with ωt.

$$v = -A\omega\sin(\omega t)$$

And again we can also replace ω with 2πf or 2π/T.

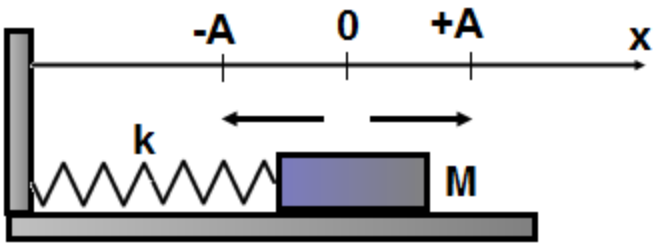
$$v = -A\left(\frac{2\pi}{T}\right)\sin\left(\frac{2\pi}{T}t\right)$$

Where A is amplitude, T is period, and t is time.

Sample Problems

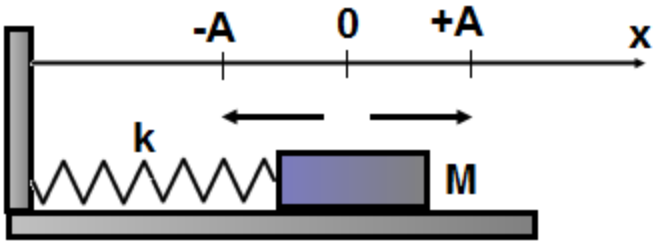
1. A block with a mass M is attached to a spring with a spring constant k. The block undergoes SHM. Where is the block located when its velocity is a maximum in magnitude?

   A) x = 0 B) x = ±A C) x = +A/2 D) x = -A/2 E) None of the above



2. A block with a mass M is attached to a spring with a spring constant k. The block undergoes SHM. Where is the block located when its potential energy is a maximum?

   A) x = 0 B) x = ±A C) x = +A/2 D) x = -A/2 E) None of the above



3. A block with a mass M is attached to a spring with a spring constant k. The block undergoes SHM. Where is the block located when its acceleration is a minimum in magnitude?

   A) x = 0 B) x = ±A C) x = +A/2 D) x = -A/2 E) None of the above

4. A mass-spring oscillating system undergoes SHM with a period T. What is the period of the system if the amplitude is doubled?

   A) 2T B) 4T C) T D) 1/2T E) 1/4T

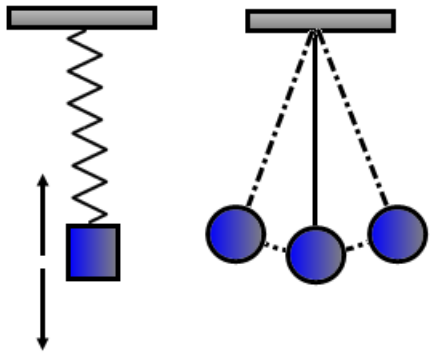
5. A mass-spring oscillating system undergoes SHM with a period T when it is located on Earth. What is the period of the system when it is located on Moon?

   A) 6T B) T/6 C) $\frac{T}{\sqrt{6}}$ D) $\sqrt{6}$ T E) T

Pendulum Notes

6. A block with a mass M is attached to a vertical spring with a spring constant k. When the block is displaced from equilibrium and released its period is T. A second identical spring k is added to the first spring in parallel. What is the period of oscillations when the block is suspended from two springs?

A) 2T B) 4T C) T D) $\frac{T}{\sqrt{2}}$ E) $\sqrt{2}$ T



7. Two oscillating systems: spring-mass and simple pendulum undergo SHM with an identical period T. If the mass in each system is doubled which of the following is true about the new period?

	Mass-spring	Simple pendulum
A)	T T	$\frac{T}{\sqrt{2}}$ $\frac{T}{\sqrt{2}}$
B)	$\frac{T}{\sqrt{2}}$ $\frac{T}{\sqrt{2}}$	T T
C)	T T	T T
D)	$\sqrt{2}T$ $\sqrt{2}T$	T T
E)	T T	$\sqrt{2}T$ $\sqrt{2}T$

8. An object undergoes SHM and position as a function of time is presented by the following formula: x= (0.1 m)Sin(4πt). What is the period of oscillations?

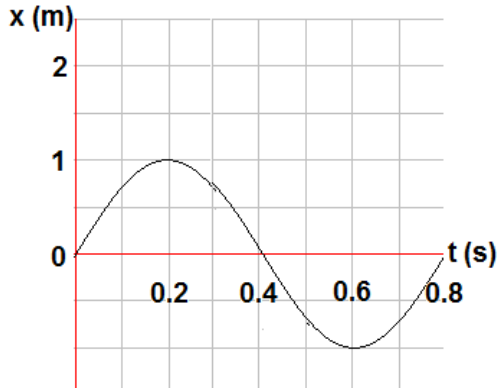
A) 2 s B) 1 s C) 0.5 s D) 0.1 s E) 4 s

9. An object undergoes SHM and position as a function of time is presented by the following formula: x= (0.5 m) Cos (πt). What is the amplitude of oscillations?

A) 2 m B) 1 m C) 0.5 m D) 0.1 m E) 4 m

10. The position as a function of time of a mass-spring oscillating system is presented by the graph. Which of the following is true about velocity and acceleration at the time 1.5 s?

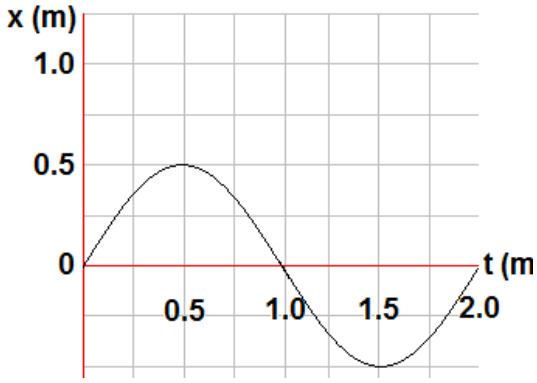
Velocity	**Acceleration**
A) v >0	a < 0
B) v = 0	a = 0
C) v =0	a > 0
D) v >0	a = 0
E) v < 0	a = 0



11. A particle undergoes SHM represented by the graph. Which of the following is true about the amplitude and period of oscillations?

Amplitude	Period
A) 1 m	0.1 s
B) 2 m	0.5 s
C) 1 m	0.6 s
D) 1 m	0.8 s

E) 2 m 0.4 s



12. An object oscillates at the end of a spring. The position as a function of time is presented by the graph. Which of the following formulas represent the position and velocity of the object?

	Position	**Velocity**
A)	x = (0.5) Sin(πt)	v = (0.5π) Sin(πt)
B)	x = (0.5) Sin(πt)	v = (0.5π) Cos(πt)
C)	x = (0.5) Cos(πt)	v = (0.5π) Sin(πt)
D)	x = (0.5π) Sin(πt)	v = (0.5) Sin(πt)
E)	x = (0.5) Cos(πt)	v = (0.5π) Cos(πt)