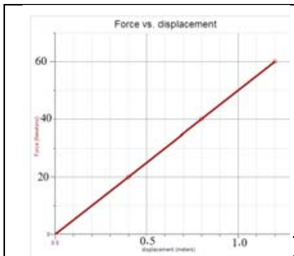
Ayman Ghannam **Chapter 15** **Simple Harmonic Motion** http://ssc.kfupm.edu.sa/index.php?mp=hs_dtl&ac=1447	

$$x(t) = A\cos(\omega t+\varphi)$$

$$v(t) = -A\omega\sin(\omega t+\varphi) \quad\Rightarrow\quad v_{max} = A\omega$$

$$a(t) = -A\omega^2\cos(\omega t+\varphi) \quad\Rightarrow\quad a_{max} = A\omega^2$$

$\mathbf{F}_s = -k\mathbf{x}$ $PE_{elastic} = \frac{1}{2}kx^2$ $x = A\cos\omega t$ $\omega = \frac{2\pi}{T} = 2\pi f$	$T_S = 2\pi\sqrt{\frac{m}{k}}$ $T_P = 2\pi\sqrt{\frac{l}{g}}$ $T = \frac{1}{f}$	F_S = the restoring force of the spring k = spring constant x = displacement from equilibrium position $PE_{elastic}$ = elastic (spring) potential energy A = *amplitude* ω = angular frequency	T = period f = frequency m = mass T_P = period of a pendulum T_S = period of a mass on a spring g = acceleration due to gravity



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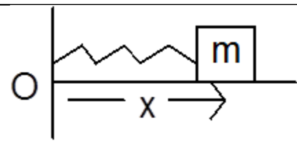

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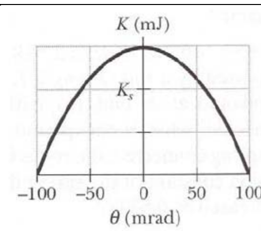

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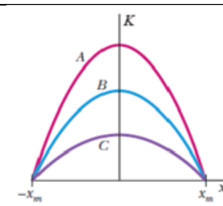

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Q.1 A mass $m = 5.0$ kg oscillates on the end of a spring on a horizontal surface with negligible friction according to the equation $x = A\cos(\omega t)$. The graph of F *vs.* x for this motion is shown below. The last data point corresponds to the maximum displacement of the mass. Determine the

(a) Angular frequency ω of the oscillation.(10rad/s)

(b) Frequency f of oscillation.(1.6Hz)

(c) Amplitude A of oscillation.(1.2m)

(d) Displacement from equilibrium position ($x = 0$) at time of 2s.(0.5m)

Q.2 A block of mass 0.02 kg is attached to a horizontal spring with spring constant of 25 N/m. The other end of the spring is fixed. The block is pulled a distance 10 cm from its equilibrium position (x = 0) on a frictionless horizontal table and released. The frequency of the resulting simple harmonic motion is☹5.6Hz)

Q.3 The maximum speed of a 3.00-kg object executing simple harmonic motion is 6.00 m/s. The maximum acceleration of the object is 5.00 m/s^2. What is its period of oscillations?(7.45s)

Q.4 A 0.500 kg mass attached to a spring of force constant 8.00 N/m vibrates in simple harmonic motion with an amplitude of 10.0 cm. Calculate the time it takes the mass to move from $x = 0$ to $x = 10.0$ cm.(0.393s)

Q.5 A block attached to an ideal horizontal spring undergoes a simple harmonic motion about the equilibrium position (x = 0) with an amplitude A = 10 cm. The mechanical energy of the system is 16 J. What is the kinetic energy of the block when x = 5.0 cm(12J)

Q.6 A block of mass 2.0 kg attached to a spring oscillates in simple harmonic motion along the x axis. The limits of its motion are x = −20 cm and x = + 20 cm and it goes from one of these extremes to the other in 0.25 s. The mechanical energy of the block-spring system is:(6.3J)

Q.7 A 2.0-kg mass connected to a spring of force constant 8.0 N/m is displaced 5.0 cm from its equilibrium position and released. It oscillates on a horizontal, frictionless surface. Find the speed of the mass when it is at 3.0 cm from its equilibrium position.(0.08m/s)

Q.8 A block is in SHM on the end of a spring, with position given by:

$$x = x_m \cos(\omega t + \pi / 6 \text{ rad}),$$

where t is in seconds. At t = 0, calculate the ratio of the potential energy U to the total mechanical energy E, i.e. U/E of the system.(0.75)

Q.9 A simple pendulum consists of a mass m = 6.00 kg at the end of a light cord of length L. The angle θ between the cord and the vertical is given by $\theta = 0.08 \cos\left[\left(4.43\,t + \pi\right)\right]$, where t is in second and θ is in radian. Find the length L.(0.5m)

Q.10 A 3-kg block, attached to a spring, executes simple harmonic motion according to x = 2 cos (50 t) where x is in meters and t is in seconds. The mechanical energy of the block-spring system is(14000J)

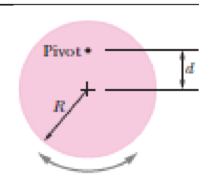
Q.11 A particle executes simple harmonic motion on a horizontal frictionless surface, with the equilibrium position at x = 0. At t = 0, it is released from rest at a displacement x = 0.5 m. If the frequency of oscillation is 5 Hz, find the displacement x at t = 0.02 s.(0.4m)

Q.12 Figure shows the kinetic energy K of a simple pendulum versus its angle θ from the vertical. The vertical axis scale is set by Ks = 20.0 mJ. The pendulum bob has mass 0.30 kg. What is the length of the pendulum?(2.04m)

Q.13 Figure shows plots of the kinetic energy K versus position x for three linear simple harmonic oscillators that have the **same** mass. Rank the plots according to the corresponding **period** of the oscillator, greatest first.(C,B,A)

Q.14 A thin rod, of length 1.00 m, is pivoted from one end and is allowed to oscillate in a vertical plane like a pendulum. What is the period of oscillation of this system? Ignore air resistance and the friction at the pivot.(1.64s)

Q.15 In Fig. a physical pendulum consists of a uniform solid disk (of radius R = 2.35 cm) supported in a vertical plane by a pivot located a distance d = 1.75 cm from the center of the disk. The disk is displaced by a small angle and released. What is the period of the resulting simple harmonic motion?(0.366s)



Q.16 In Fig. below, a physical pendulum consists of a uniform solid disk (of radius R = 2.27 cm) supported in a vertical plane by a pivot located at the rim of the disk. The disk is displaced by a small angle and released. What is the period of the resulting simple harmonic motion?(0.370s)