1) Two vectors are defined analytically as follows, $\vec{A} = 5\vec{\imath} - 2\vec{\jmath}$ şi $\vec{B} = \vec{\imath} + 4\vec{\jmath}$.

a) Graphically represent the two vectors.
b) Calculate and plot the sum, $\vec{A} + \vec{B}$, and the difference, $\vec{A} - \vec{B}$, of the two.
c) Calculate the scalar product of vectors $\vec{A}$ and $\vec{B}$.
d) Calculate and plot the projection of vector $\vec{B}$ on the direction of vector $\vec{A}$.
e) If vector $\vec{C}$ is given by $\vec{\imath} + a\vec{\jmath}$, find the value of a so that $\vec{C}$ is perpendicular to $\vec{A}$.
f) Plot the two vectors $\vec{A}$ and $\vec{C}$.
g) What is the projection of $\vec{C}$ along the direction of $\vec{A}$?

2) The position vector of a particle has the following time dependence:

$$\vec{r}(t) = 2t^2\vec{i} - 6t\vec{j} + 5t^2\vec{k}$$

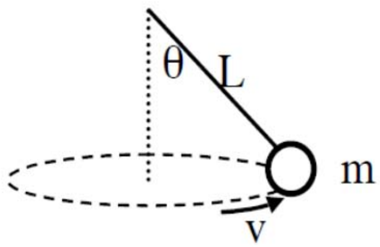
Determine:

(a) The velocity and the acceleration vectors time dependence laws.
(b) The position of the particle after t=4s.
(c) The particle's average velocity in the time range t_1=3s and t_2=5s.

3) An object's velocity is measured to be $v_x(t)=\alpha+\beta t$, where α=4m/s and $\beta=-2m/s^2$. At t=0 the object is at x=0. (a) Calculate the object's position and acceleration as a function of time. (b) Graphically represent x(t), $v_x(t)$, $a_x(t)$. (c) What is the object's maximum positive displacement from the origin?

4) A body of mass m hangs on a rope of length L. It swings in a circular path, in a flat plane, with a constant angular velocity ω.

a) What's the tension T in the cord?
b) Given the angle of the cord, θ , what is the speed v?



5) A 1.0 m long board has one end raised to a height of 50 cm to form an incline. A 1.0 kg mass is allowed to slide with friction down the entire length of the inclined plane (the friction coefficient is μ=0.1. (a) What is the final speed of the mass when it reaches the bottom? (b) If the mass is replaced with a 2.0 kg mass, what would be the new speed when it reaches the bottom? Answer to the questions using kinematics and using work- energy considerations: $\Delta E=\Delta(K+U) = W_{Friction}$.

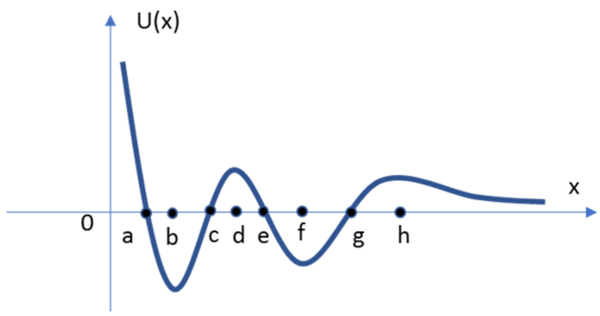
6) A force acting on a body varies with the position following the law: $\mathbf{F(x) = -2x^2 +3}$ N. Calculate the work of this force when moving the body between the positions $x_1=-0.1$m and $x_2=0.1$m.

7) A ball is thrown straight up with initial speed v_0. If air resistance cannot be ignored, when the ball returns to its initial position its speed is different with respect to v_0. Explain this and calculate the final velocity, using energy concepts. (You may assume that the air resistance is proportional to $-bv$, where b is a constant and v the ball's velocity.

8) An object is released from rest at the top of a ramp. (a) If the ramp is frictionless, does the object's speed at the bottom of the ramp depend on the shape of the ramp or just on its height? Explain. (b) What if the ramp is not frictionless? (c) Is the friction force a conservative force? Explain your answer.

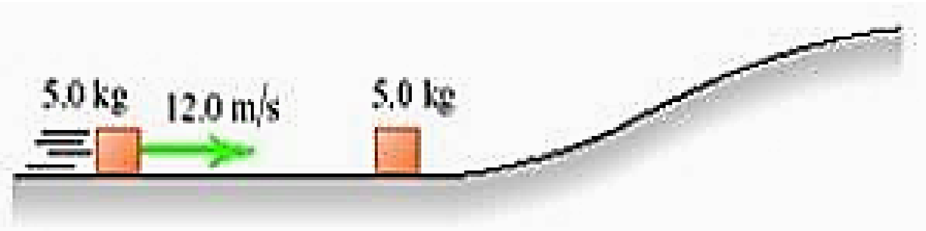
9) A slingshot consists of a light leather cup, containing a stone that is pulled back against 2 rubber bands. It takes a force of 30 N to stretch the bands 1.0 cm (a) What is the potential energy stored in the bands when a 50.0 g stone is placed in the cup and pulled back 0.20 m from the equilibrium position? (b) With what speed does it leave the slingshot?

10) A particle moves along the x-axis. The potential-energy function is shown in Fig. below. (a) At which of the labeled x-coordinates is the force on the marble zero? (b) Which of the labeled x-coordinates is a position of stable equilibrium? (c) Which of the labeled x-coordinates is a position of unstable equilibrium? (d) Graphically, qualitatively represent the F(x) deduced from U(x).



11) The potential-energy function for a force $\vec{F}$ is $\mathbf{U=\alpha x^3}$ where α is a negative constant. What is the direction of $\vec{F}$?

12) A 5.00-kg chunk of ice is sliding at 12.0 m/s on the floor of an ice-covered valley when it collides with and sticks to another 5.00-kg chunk of ice that is initially at rest. Since the valley is icy, there is no friction. After the collision, how high above the valley floor will the combined chunks go?



13) / A 1.50-kg mass on a spring has displacement as a function of time given by the equation: $x(t) = 10cm\cos[(2s^{-1})t - 1.57]$. Find (a) the time for one complete vibration; (b) the force constant of the spring; (c) the maximum speed of the mass; (d) the maximum force on the mass; (e) the position, speed, and acceleration of the mass at t=1s (f) the force on the mass at that time. (f) Calculate the kinetic, the potential and the total energy of the oscillator. Discuss the result.

14) The equation of movement for a damped oscillator is: $y(t) = 2e^{-2t}\sin\left(4t + \frac{\pi}{2}\right)$cm. Write/ calculate: the damping parameter, the initial amplitude A_0, the angular velocity ω, the initial phase φ, the period T and the frequency f, the quality factor Q.

15) Define the phenomenon of resonance and indicate/explain some applications.

16) Based on electro-mechanic oscillator analogy, indicate the electric equivalent of the: (a) mechanical damping, (b) mass (c) elastic constant of the spring. (d) What happens in time with the electric energy, initially stored in the capacitor in the two situations (i) R=0 and (ii) R>0?

17) A certain transverse wave is described by:

$$y(x,t) = (12mm)\cos 2\pi\left(\frac{x}{14.0cm} + \frac{t}{0.05s}\right)$$

Determine the wave's (a) Amplitude; (b) wavelength (c) frequency (d) speed of propagation (e) direction of propagation.

18) A guitar string with mass 3.00 g and length 70.0 cm is stretched with a tension of 25.0 N. (a) Calculate the frequency of the fundamental sound produced by the string, and the two next harmonics (2nd, 3rd). (b) Graphically represent the string displacement (wave function_ corresponding to the first three harmonics.

19) By measurement, you determine that sound waves are spreading out equally in all directions from a point source and that the intensity is 0.01 W/m^2 at a distance of 3 m from the source. (a) What is the intensity at a distance of 6 m from the source? (b) Calculate the corresponding sound intensity level at 3 meters and at 4 meters distance from the source.

20) The linear density of the A string on a violin is 7.8×10^{-4} kg/m. A wave on the string has a frequency of 440 Hz and a wavelength of 65 cm. What is the tension in the string?

21) Two cars, one behind the other, are traveling in the same direction at the same speed. Does either driver hear the other's horn at a frequency that is different from that heard when both cars are at rest? Explain.

22) The security alarm on a parked car goes off and produces a frequency of 960 Hz. The speed of sound is 343 m/s. As you drive toward this parked car, pass it, and drive away, you observe the frequency to change by 95 Hz. At what speed are you driving?

23) Two out-of-tune flutes play the same note. One produces a tone that has a frequency of 262 Hz, while the other produces 266 Hz. When a tuning fork is sounded together with the 262-Hz tone, a beat frequency of 1 Hz is produced. When the same tuning fork is sounded together with the 266 Hz tone, a beat frequency of 3 Hz is produced. What is the frequency of the tuning fork?

24) A string of length 0.28 m is fixed at both ends. The string is plucked and a standing wave is set up that is vibrating at its second harmonic. The traveling waves that make up the standing waves have a speed of 140 m/s. What is the frequency of vibration?

25) The pressure in a traveling sound wave is given by the equation:

$$\Delta p = (0.50 \text{ Pa}) \sin \pi[(0.58 \text{ m}^{-1})\, x + (200 \text{ s}^{-1})t].$$

Find the (a) pressure amplitude, (b) frequency, (c) wavelength (d) speed of the wave. (e) Indicate the direction of propagation. (f) Write the wave equation y(x,t) corresponding to this wave and estimate the maximum displacement A if the sound propagates in a medium with the given bulk modulus B=1.42 x 10^5 Pa.

26) With one violin playing, the sound level at a certain place is measured as 50 dB. If four violins play equally loudly, what will the sound level most likely be at this place?

27) The sound intensity level at a rock concert is 110 dB, while that at a jazz fest is 100 dB. Determine the ratio of the sound intensity at the rock concert to that at the jazz fest.