

PHYSICS 180

Problem set #5

Due: 5PM, Wednesday, Oct. 25, 2006

“Talent hits a target no one else can hit; genius hits a target no one else can see”
-----Arthur Schopenhauer (1788-1860)

- 1) A mass, m , is attached to a spring and the resonance frequency of the system is ω_0 . The system is subject to a weak damping force, $F = -bv$ where b is a constant and v is the velocity of the mass. If Catriona also applies a time-dependent force $F = F_0 \cos \omega t$ (*i.e.*, alternately pushing and pulling) on the mass with variable frequency, ω , and the system is underdamped,
- 1) What is the amplitude of the periodic motion as a function of ω once the system reaches steady-state (*i.e.*, oscillates with constant amplitude)? Show a graph.
 - 2) How does the phase constant of the motion depend on ω ? Show a graph.
 - 3) How does the power delivered to the system depend on ω ? Show a graph.

(Hint: assume a solution of the form $x = A(\omega) \cos(\omega t + \phi)$.)

- 2) Dmitri releases a 3 kg block from rest down an incline sloped at 30° with respect to the horizontal and, after traveling 5 m, it hits a spring with spring constant 90 N/m. The coefficient of friction between the block and the incline is 0.2.
- a) How much energy is stored in the spring at maximum compression?
 - b) What is the maximum distance back up the incline that the block travels?
 - c) What is the power delivered to the block when the spring is compressed by half its maximum amount while the block is traveling back up the incline?
- 3) Serway, problem 60, p.177.
- 4) Vidya is standing on the perimeter of a merry-go-round of radius 5 m and which is rotating at a constant rate of one revolution every 5 s. She rolls a ball at a constant speed of 2 m/s directly towards Samantha who is standing at the centre. By how much will the ball miss Samantha? Explain why it misses her.