**Answers for Homework 10**

**By SJ**

1. KK9.2

Answer: a) (attractive), , The effective potential looks like:

b), 



c) Use harmonic approx close to equilibrium (of course you can directly solve it use exact from of effective potential):



1. KK9.4

Answer: 

To have circular stable orbit is equivalent asking,  has a local minimum. .







1. KK9.5

Answer: a) 



Circular motion 









b) 

L will stay same, Etot increases.

Before blow: 

After blow: 

c)  can be calculated by see that 



1. Answer:
2. The relation between deflection and b

The trajectory will be hyperbola, and the asymptotes of the hyperbola will be angle , and the deflection angle is:



For Hyperbola , we have:



For the given condition, we know the E and l (energy and angular momentum which are conserved) and from that we can find the theta:

, 



For hyperbola:









1. let the  be the small angle spanned by the detector, the number of electrons collected will be , these electrons coming from within a interval of impact parameter , so that:



, 



1. In 3-D, the only change is the relation between density per steradian, and that relation was given (derived in lecture) by:  and , so , and all the relations have been worked above:

From , we have:



And , so the final result is:



**KK9.7** (not in this set, but I give answer anyway)

Answer: Largest at perigee,



At smallest r,



Since the E’-E is some fixed value for escape. So the largest v is at perigee and delta v should be parallel with v. The above used assumption delta v is small, so neglect its squared term. If we take the squared delta v into consideration, the result will be same.

1. **KK9.8**

Answer: 











 ( is you shoot downward, the minimum distance to the center of earth).

The TA originally provide the answer to the wrong problem, here is the KK’s 9.9”

This kind of problem is where you get a pair parameters to figure out what the orbit looks alike or what are the energy and angular momentum. In this problem, the pair of parameter provided are eccentricity and period. The eccentricity is directly related to the orbit function, while the T is related to long axis by Kepler’s 3 rd law:



Perihelion and aphelion are just minimum and maximum r:



Then: 

(b) Knowing the orbit is equivalent to know the energy and momentum of the object and thus we can calculate the velocity. There are many ways I shall choose the angular momentum since I think this one is easier. At perihelion, the L is related to v with simple relation:

, knowing the A and eccentricity will give us L:



1. KK9.12

Answer:

1. 







1. Two orbit change.

Orbit a:  circular,

Orbit Q: elliptical 

Orbit b: 

Orbit Q: 



 

 











At A, 

At B, change orbit Q to B,

Orbit B, , 



the m along orbit Q at B,









1. KK10.3

Answer: Undamped  

Damped  







1. KK10.5

Answer:



 Double degeneracy root

From 2nd Homogeneous ODE

Initial condition: 







Given an initial blow, the oscillator will move under damping and its displacement will decrease when dx/dt (velocity =0), but we have derived the velocity form given the initial velocity and displacement:





1. KK10.11

Answer:

1. 





 (1)

 (2)

1. (1)+(2) 



(1)- (2) 



y1, y2 can be solved.

1. 

At long time  will kill , i.e. 













1. KK10.12
2. satisfies homogeneous i.e. ,

 satisfies , input which is the equation(10-25).

1. 



 (1)



 (2)

,  is determined knowing the,and.

,need to be determined, if the is small 

(2) 

(1) 



1. Answer: (a) As , .

Along the x axis, 

i.e. 

θ1

θ2

Along the y axis, 

i.e. 

(b) 

(c) 

The initial state, .

Then,  and .

1. Answer:
2. 
3. , then 
4. 
5. 
6. Answer:
7. The wave is in form of 



1. 
2. Answer:
3. 
4. (I shall answer part c too here) Here the simple harmonic wave can be:

0.2 which is a wave travelling towards right. In this case at x=0:

 compare with condition given (of course you may add integer n times 2 pi to it)

At x=1m:





Why k is negative? Well this is actually because the condition given in can be equally written as: , then:





This is the wave travelling towards right. (Of course there are can be other k’s corresponding to , I only consider the m=1 case above)

However we should consider  again, this just tells us it could be a wave with minus k, |k|=, that is a wave travelling towards left! For this left traveling wave: 

Of course this left travelling can also be derived is we assume at beginning that the wave form is travelling towards left as: .

Indeed the conditions provided in the problem cannot determine a unique wave.

1. The superposition of the two packet when they overlap will make displacement smaller. Considering one particular moment when they exactly overlap and the cancellation is complete. The displacement is zero at that particular moment, but not the velocities! The transverse velocity of parts on rope is not zero. You may expect during the cancellation of displacement, the velocity will increase (potential energy to kinetic) which is true:



For a qualitative description, consider a wave packet travelling towards right as shown. The leading edge (the head or the right side of the packet) part of the rope has velocity up, while the trailing edge has velocity down. Now imagine another reversed wave packet (I did not draw it) not only on shape but also on direction of travel, towards left: The leading edge will be the left side and they have velocity “up” in the sense for the packet, but since the packet is reversed (comparing to the one shown in the figure)so this ‘up’ is ‘down’ for the packet shown in the figure. You see that the velocities add up constructively.

This can also be argued like following: for the right traveling packet, the displacement can be written as: y=f(k(x-vt)), for the reversed packet traveling towards left: y=-f(k(x+vt)), take time derivative you will see the dy/dt adds up constructively.