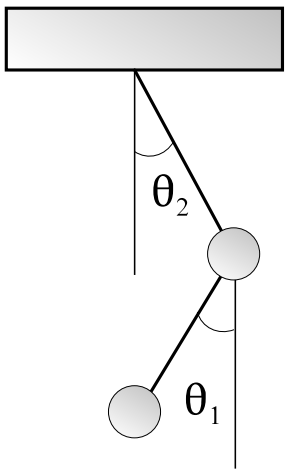
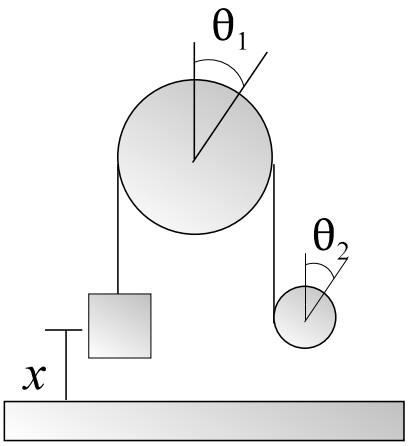
Physics 321
Exam 2 Sample Questions

1. In the following systems, describe each contribution to the kinetic and potential energies. In the Lagrangain formalism, tell what variables will appear in each of these energy terms.



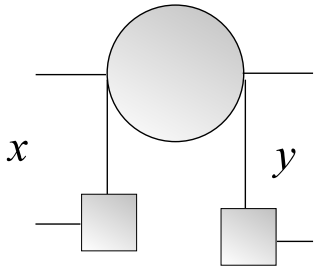


2. Describe how Lagrange's Equations of motion are related to the action integral.

3. Write down Lagrange's equations of motion. Explain the general method that you use to obtain equations of motion.

4. In the usual Lagrangian formalism, how do you deal with equations of constraint (equations that relate one variable to another)?

5. In a simple Atwood's machine (two masses over a pulley), explain how you would solve the problem using Lagrange's multipliers. Take the pulley to be massless. The Lagrangian will be a function of what variables? Why would you use Lagrange multipliers to solve this problem?



6. What is the meaning of "ignorable coordinates"? If a coordinate is ignorable, what important consequence follows from Lagarange's equations of motion?

7. Carefully describe the steps you would use in solving the Atwood's machine problem (with a massive pully of known moment of inertia) using the Hamiltonian formalism.

8. A student suggests that Hamiltonians are just as easy to use a Lagrangians, as all you have to do to get the Hamiltonian is change the sign of U in the Lagrangian. Comment on this remark.

9. You wish to solve the Atwood's machine problem with air drag. How would you include drag in the equations of motion?

10. Explain Fermat's principle. How can it be used to explain why mirages appear?

11. Describe how "artifical gravity" could be created in a space station. Would the surface of a glass of water be flat in the space station?

12. In the expression

$$m\ddot{\vec{r}} = \vec{F}_{real} + m\vec{r} \times \dot{\vec{\Omega}} + 2m\dot{\vec{r}} \times \vec{\Omega} + m(\vec{\Omega} \times \vec{r}) \times \vec{\Omega}$$

give the name of each term.

14. You are sitting in a rotating room. The room is turning so that you face inward and are always moving to your right. In what direction is the centrifugal force? If you lean forward, what is the direction of the Coriolis force? As the room comes to a stop, what is the direction of the transverse force?

15. With your date, you go to a carnival and see a merry-go round, so you decide to take your date on the merry-go-round. The angular velocity of the merry-go-round points downward. You see a tree near the merry-go-round, and you decide to use the equation $\vec{v} = \vec{v}_0 - \vec{\Omega}_0 \times \vec{r}_0$ to calculate the velocity of the tree in your rotating frame. First, you let $\vec{r}_0 = x_0\hat{x}$. Since the velocity of the tree in S_0 is zero, this means that you observe the tree is moving in the $+y$ direction. Explain how this makes sense. Your date leaves you.

16. Does a plumb bob point toward the center of the earth? Explain why or why not. On a still lake, does a plumb bob point in a direction perpendicular to the surface of the water? Explain.

17. Explain why the Coriolis force causes a Foucault pendulum to continue turning in the same direction and why the magnitude of the force is indpendent of the direction of the pendulum's swing.

18. Describe the effect of the Coriolis force on a Foucault pendulum located at the equator.

19. Describe the different types of orbits for an inverse square force problem. What eccentricities are associated with each?

20. A proton scatters from a calcium nucleus via the Coulomb potential. Write a formula for the centrifugal potential in terms of the angular momentum. Explain how the centrifugal potential affects the turning point of the proton.

21. A binary star system consists of one star that is twice as massive as the other star. Describe the motion of the stars. Sketch their orbits.