Phys 3610, Fall 2009
Problem Set #4, Hint-o-licious Hints

1. *Taylor*, **6.9** Applying the E–L equation for $y(x)$ leads to the (easy) differential equation

$$y'' + y = 0$$

(With the +, the answer isn't sines and cosines!). There will be constants to be determined which you find by using the given endpoints of the curve.

2. *Taylor*, **6.11**

4. *Taylor*, **6.21** The result of Problem 6.20 is that if we are treating y as $y(x)$ and the integrand does not depend on x (the independent variable) then

$$f - y'\frac{\partial f}{\partial y'} = \text{ constant}$$

5. *Taylor*, **6.27** Here you use the E–L equations for several parametrized variables and it is not hard to show that they imply (similar to the 2D case done in the book)

$$x' = C_1 y' \qquad y' = C_2 z' \qquad z' = C_3 x'$$

the only question is how do these relations dictate that the resulting curve is a straight line. Note that you can't just pull out $\frac{dy}{dx}$ as in the 2D case.

The answer is that $(x(u), y(u), z(u))$ gives a curve in space which could possibly be very convoluted. But note that the vector tangent to the curve at any u must be parallel to the vector $d\mathbf{r}/du$, namely

$$(x'(u), y'(u), z'(u))$$

and you can easily show that this vector hsa the same *direction* at all points. A curve with a tangent vector which always points in the same direction is pretty clearly a straight line. And *that* is how you know it's a line.

Note that $x'(u)$ and the rest are not necessarily constants! (If they were, then the curve is clearly a straight line.)

6. *Taylor*, **7.17** You should have

$$\mathcal{L} = \tfrac{1}{2}\left(m_1 + m_2 + \frac{I}{2R^2}\right)\dot{x}^2 + (m_1 - m_2)gx$$

Get $\ddot{x}$ from the Lagrange equation.

7. *Taylor*, **7.22**

8. *Taylor*, **7.29**

9. *Taylor*, **7.34** Showing that the kinetic energy of the spring is

$$T_{\text{spr}} = \tfrac{1}{6}M\dot{x}^2$$

was done in class; fill in the argument or come up with a clearer one! You should get

$$\mathcal{L} = \frac{1}{2}\left(m + \frac{M}{3}\right)\dot{x}^2 - \tfrac{1}{2}kx^2$$

Find the angular frequency of oscillations.

10.