NAME

PRACTICE PROBLEMS EXAM 2 CHECKPOINTS

1. What are the basic plotting/graphing building blocks for these kinds of problems with constant (nonzero or zero) acceleration, and what are the formulas for them?

\[ x(t) = x_0 + v_0(t-t_0) + \frac{1}{2} a_0(t-t_0)^2 \]

BTW When merged (e.g. ___ origin use only for given \( \alpha_0 \) segments also free to choose)

2. What is a common mistake made in
   a) (the same mistake made often in every problem)?
      Don't read carefully (e.g. "frictionless")
   c) F not applied to \( m_1 \) < BTW draw FBD's even if not asked for
   d) Not using drag force on \( m_2 \) due to \( m_1 \) <

3. This problem is straightforward so let's use the opportunity to answer our visitor's question (Dimitri Offengenden): Take the density of the probe and the black hole each to be unchanged but reduce the length scale of everything (size and distances) by a factor of ten (1/10). What happens?

2nd law: \[ \frac{\frac{G m_1 m_2}{r^2}}{r} = \frac{v^2}{r} \quad \frac{\frac{v^2}{r}}{m_2} = \frac{1}{r} \quad \frac{v^2}{r^2} \quad \text{also} = \omega^2 \]

\[ \Rightarrow \frac{G m_1 m_2}{r^3} = \omega^2 \quad \text{if} \quad r = \frac{1}{10} r, \quad m_2 \rightarrow \left(\frac{1}{10}\right)^3 m_2 \quad \omega \rightarrow \omega \text{ is same, } \]

\[ \left(\frac{v}{v_0} \text{ so is } v \right) \]

4. What are three different formulas we've seen involving the work \( W \) and what are the conditions under which we can use them?

\[ W = F \cdot d \cos \theta \text{ for } F, d \text{ const.} \]

\[ W = -\Delta U \text{ for } F \text{ conservative} \]

\[ W = \Delta K \text{ for } W_{\text{net}} \]

5. What are three ways we have approached the ELASTIC collision in 1D between two masses in order to predict their outcome?

\[ v_1' = v_1 \frac{m_2 - m_2}{m_1 + m_2}, \quad v_2' = v_2 \frac{2m_2}{m_1 + m_2} \]

or \( m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2' \), \( v_1 - v_2 = -(v_1' - v_2') \) and solve \{ might be simple \}

or use different reference frames for special cases \( m_1 \ll m_2, m_2 \gg m_1 \), \( m_1 = m_2 \)

where we "know" answers

6. What are the unknowns at some time after the small ball leaves the bottom and moves around the loop-the-loop and how do we determine them?

\[ N, v, \Theta \]

2nd law radially \( (N + mg \cos \theta) = m \frac{v^2}{r} \) \{

energy conservation \( (U_i + K_i) = U_f + K_f) \} \{ only 2 cons. \}

+ contact information? (\( \alpha \approx 0 \) at pt. of falling off)
7. What are three equations we could use to find the tension and the force due to the pivot (vertical and horizontal components)?

\[
\begin{align*}
F_{\text{net}}^\text{vert} &= 0 \\
F_{\text{net}}^\text{horiz} &= 0 \\
\tau_{\text{net}} &= 0 \\
\text{OR, we get 3 torques each.}
\end{align*}
\]

8. Knowing the angular acceleration \( \alpha \) of the pulley is related to \( a_0 \) through \( a_0 = \alpha R \) (no slipping, CCW), what are the unknowns and how can we determine them? (Note that Amy is not moving — i.e., she’s not being lifted.)

9. What are two ways you might think about this problem?

i) \( \vec{V}_{B/q} = \vec{V}_{B/C} + \vec{V}_{C/q} = \vec{V}_q + \vec{V}_r \rightarrow \text{resultant must be } \vec{V}_{B/q} \)

ii) Component of \( \vec{V}_{B/q} \) is \( \vec{V}_{C/q} \) must match \( \vec{V}_q \):

10. a) What is the “FBD” for the astronaut walking inside the spaceship relative to her rotating reference frame?

\[
F_\text{net} = m \frac{v^2}{R} \Rightarrow N > 0 \quad \text{so?}
\]

b) What is the “FBD” for the “falling” light fixture relative to the rotating reference frame?

11. Sketch the position \( x(t) \) as a function of time (note that it starts at rest).

12. a) What is the solution of this differential equation?

\[
\frac{dy}{dt} = t + C \Rightarrow y = \frac{t^2}{2} + C
\]

b) Why doesn’t the idea of a strange attractor contradict the sensitivity to initial conditions we expect for these nonlinear systems?

Many trajectories attracted to limited region but different even close

I can go to many different places in region.

c) Recall your harmonic oscillator parameter plots. What would they look like if they were instead plots of a period-two nonlinear oscillator?

[Diagrams of elliptical and circular trajectories labeled with "period one" and "period two"]