Physics/Mathematics Questionnaire

20 mins; closed-everything (not even looking up tables, for this one)

Your name: _____

Below is a set of phys/math questions **not for evaluation** but only for gathering information, which will help my teaching. Provide your quick responses first. Then, if there is time left, your can refine your answers.

1. Expand the following expressions up to the linear term in x, assuming $|x| \ll 1$.

   (a) $\sqrt{1-x}$

   (b) $1/(1+x)^3$

   (c) $\sin x$

   (d) $\exp(1-x)$

   (e) $\ln(1-x)$

2. What is the most general form of $f(t)$ that satisfies the differential equation $df/dt = -2f$?

3. What are the eigenvalues of the matrix $\begin{bmatrix} 0 & -2 \\ -2 & 0 \end{bmatrix}$?

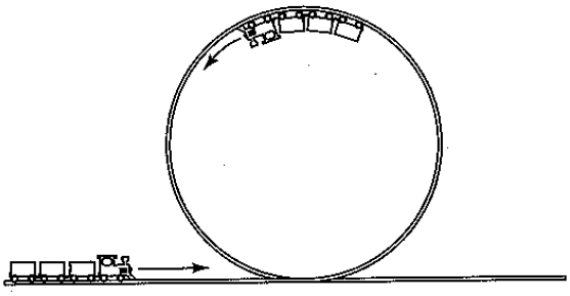
4. Evaluate the following integrals. (First, determine if it is zero or not.)

   (a) $\int_{-\pi}^{\pi} dx \tan x$

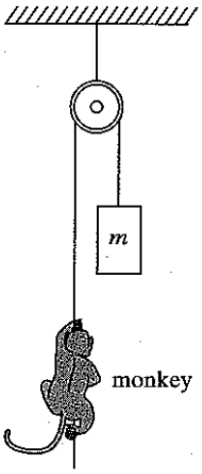
   (b) $\int_{-\pi}^{\pi} dx \cos^2 x$

5. A particle of mass m is undergoing a circular motion at distance r from the center, with angular velocity ω. Express the centripetal acceleration a_c, the angular momentum $L = |\vec{L}|$, and the kinetic energy $T = \frac{1}{2}mv^2$ in terms of m, r and ω.

6. A toy train travels around a loop-the-loop track. Is there a normal force exerted by the track on the train at the instant the train is at the top of the loop? If there is, why? If there is not, why not?



7. A monkey clings to a rope that passes over a pulley. The monkey's weight is balanced by the mass m of a block hanging at the other end of the rope. Both monkey and block are motionless. In order to get to the block, the monkey climbs a distance L (measured along the rope) up the rope. (a) Does the block move as a result of the monkey's climbing? (b) If so, in which direction and by how much?



If you need more space, please use the back-side of the "General Questionnaire" sheet.