

Physics 2300: Problem Set #5

Due on Wednesday Sept 26. Remember to begin each problem with a concise problem statement, and to connect the equations in your solution with a few words of explanation.

1. BTM 2.2.10, 2.2.11 (p. 48)
2. Morin 3.57 (Rotating hoop)
3. Morin 3.64 (Car on banked track)
4. Morin 3.65 (Horizontal acceleration) (see Morin 3.21)
5. Morin 3.69 (A force $2m\dot{r}\dot{\theta}$)
6. Morin 4.15 (Amplitude) Find the amplitude of the motion $x(t) = C \cos(\omega t) + D \sin(\omega t)$. Do this in two different ways: (a) by taking a derivative to find the time when $x(t)$ is maximized, using triangle trig IDs to simplify, and (b) by energy conservation.
7. Morin 5.39 (Roller coaster)
8. A mass m slides on a frictionless table, whirling at the end of string of an ever-shortening length $r(t) = r_0 - v_0 t$. Find the angular speed of the mass, $\omega(t) \equiv \dot{\theta}(t)$, given that at $t = 0$, $\omega(0) = \omega_0$. What is the tension in the string $T(t)$? Note: to get $\omega(t)$ you will need to solve the differential equation coming from $F_\theta = ma_\theta$. One method of attack: guess the ansatz $\omega_A(t) = B(1 - \beta t)^n$ and see if you can find a choice of the parameters B , β and n which satisfy the differential equation.
9. (BONUS) Morin 5.52 (Stationary bowl)