Classical Mechanics I (Spring 2020): Homework #1

Due Apr. 7, 2019

[0.5 pt each, total 6 pts / turn in as a single pdf file to eTL before the class starts]

• By turning in your homework, you acknowledge that you have not received any unpermitted aid, nor have compromised your academic integrity during its preparation. (Remember the SNU College of Natural Sciences Honor Code!)

• Only handwritten answers are accepted except for numerical problems – for which you print out and turn in not just the end results (e.g., plots) but also the source codes.

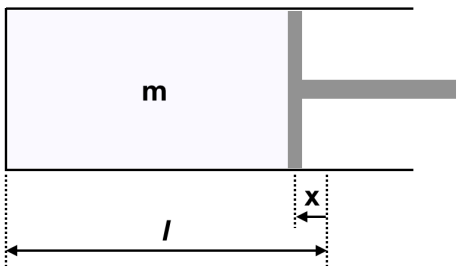
• For some problems you may want to use formulae in Appendices D and E, and/or more extensive references such as Zwillinger.

• Do *not* use the Lagrangian method until we cover it in the class.

1.-8. Thornton & Marion, Problems 2-7, 2-15, 2-22, 2-40, 2-47, 3-10, 3-22, 3-24

(Note: For Problems 2-7, you will need to use Eq.(2.21) with $\rho_{\rm air} = 1.23\ {\rm kg\,m^{-3}}$. For Problem 2-15, you may need to utilize an integral table; see the third bullet point above.)

9. Gas of mass m is confined by a frictionless, massless piston in a cylinder of cross-section A. The gas in its equilibrium position occupies a volume $V = Al$ at pressure P. If the piston is slightly compressed inwards (i.e., $l \to l - x$) under isothermal conditions, find the period of simple harmonic oscillations.

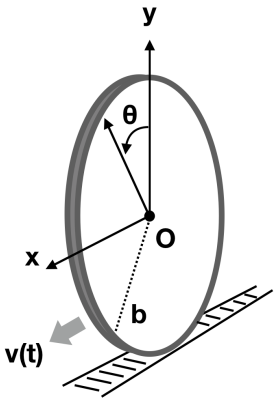


10. A wheel of radius b travels with constant forward acceleration a_0 and instantaneous forward velocity $v(t)$ relative to the ground at time t.

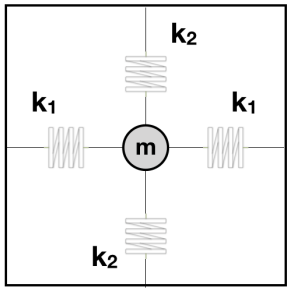
(a) Show that the magnitude of the acceleration of any point on the rim relative to the center of the wheel O is $\sqrt{a_0^2 + \frac{v^4(t)}{b^2}}$.

(b) Find the magnitude of the acceleration of point P on the rim (defined by an angle θ measured forward from the highest point of the wheel) relative to the ground.

(c) Which point has the maximum acceleration relative to the ground at given t?



11. In the class we discussed two-dimensional simple harmonic oscillators. (a) Describe an example of the physical realization of Eqs. (3.19) and (3.27) using the figure shown below. (b) Reproduce Figures 3-2 to 3-4 in your textbook with your favorite numerical tool. For Figure 3-2, you don't have to remake all 10 panels; 2-3 panels should be enough.



12. Consider a pendulum of length ℓ and a bob of mass m at its end. Assuming a small angular amplitude A, calculate the "average" tension (averaged over time) in the pendulum's string. Discuss the meaning of your answer by comparing it with mg.