PHY121 Summer 2018
Problem Set #1
Due Tuesday 5/22

1. Determine the SI units for the following:

   (a) Newtons law of universal gravitation is given by:

   $$F_g = \frac{Gm_1m_2}{r^2} \tag{1}$$

   where F is the magnitude of the gravitational force of one object acting on another (in N (newtons) = kg m s^{-2}), r is a distance, and m_i represent the masses of the objects. Find the units for Newtons gravitational constant G.

   (b) Coulombs Law for the interaction of two charged particles is given by:

   $$F_E = \frac{kq_1q_2}{r^2} \tag{2}$$

   where F is the magnitude of the electrostatic force of one particle on another (in N), r is a distance, and q_i represent the charges of the particles (in C (coulombs)). Find the units for the proportionality constant k.

2. Convert the following units:

   (a) 1175×10^{15} in/s to lightyear/jiffy; 1 jiffy = $\frac{1}{100}$ of a day; 1 lightyear = 9.461×10^{12} km; 1 m = 3.2808 ft

   (b) 170 pounds to slugs; 1 slug = 14.954 kg; 1 kg = 2.2046 lb

   (c) 7 dog years to shakes; 1 shake = 10 ns; 1 dog year = 52 days

3. Solve for x analytically and simplify (show your work):

   (a) $x^2 - x + 20 = 0$

   (b) $20e^{3x^2} = 15r + 5t$

   (c) $\sqrt[4]{(x^3 + y^3)^5} = rt^2$

   (d) $\sin\cos\sqrt[3]{x^7y^8z^9} = r^3 + t^4$

   (e) $\begin{cases} x + 2y + z = 5 \\ 3x - y + z = 2 \\ -x - 2y - 3z = 3 \end{cases}$ (Solve the system for x, y, and z).

4. Answer *one* of the following:

   (a) How many water balloons will it take to fill B&L 269?

(b) How many revolutions (of a single wheel) will it take for a Rochester Public Transit bus to complete one day's worth of driving?

(c) How many cellular messages will you and your classmates send over the duration of this course? (HINT: For 2.25 hours a day, the answer should be zero.)

5. Find (with respect to the independent variable) the derivative and *an* antiderivative of the following:

(a) $f(x) = x^{15} + 5x^{10} - 7x^5 + 81$

(b) $f(a) = t^3 e^{3at}$

(c) $f(x) = \sin(nax) + \ln(at)nx - axe^{tx}$