1. (25pts) Integrate:
   
a. \( \int \frac{1}{2x^2 + x - 1} \, dx = \)

b. Compute \( \int_{2}^{\infty} \frac{\ln t}{t^2} \, dt \)
2. (25pts) A bike rolls down a $45^\circ$ incline with a constant acceleration of $5 \text{ m/sec}^2$ (from left to right). We study the rear wheel which has radius $25cm$ and has a light placed midway along a spoke. Take the coordinate system to be horizontal/vertical with units in meters. At $t = 0$, the bike is at rest, the hub of the rear wheel is at $(0, 6)$, and the light is directly below the hub.

(a) Write equations for the hub for $t \geq 0$.

(b) Write equations for the light for $t \geq 0$. 
(c) After 3 seconds, the wheel starts to free fall. Without restarting time write new parametric equations for the light that match up with the ones for $0 \leq t \leq 3$. 
3. (25 pts) A particle travels with parametric equations \( x(t) = 2 \ln t \) and \( y(t) = t + \frac{1}{t} \).

(a) Compute the velocity vector \( \vec{v}(t) = \left( \frac{dx}{dt}, \frac{dy}{dt} \right) \).

(b) What is the distance traveled for \( 1 \leq t \leq 2 \)? (Hint: use \( u = 1/t^2 \))
4. (25pts) A football is kicked with initial velocity $\vec{v}_0$ making an angle of $30^\circ$ above the (positive) horizontal and of magnitude 100 ft/sec. Assume that unfavorable winds contribute a resistance equal to $-\vec{v}$.
(a) Integrate the law of motion $d\vec{v}/dt = \vec{g} - \vec{v}$ to find the velocity vector $\vec{v} = (v_x, v_y)$ of the football at time $t$. (Assume for simplicity that the mass of the ball is one).
(b) Find the $y$ coordinate of the highest point reached by the ball, assuming the ball is at $(0, 0)$ at first.