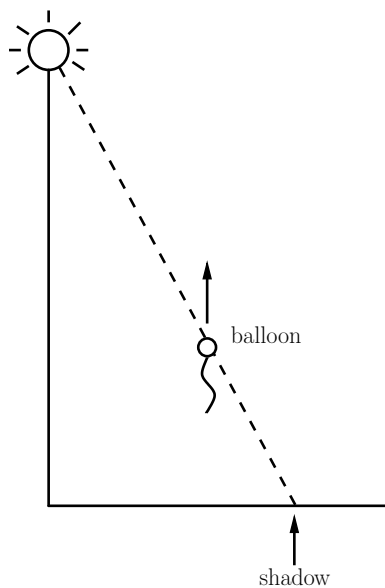**Question 1:**

(a)[3 points] Find the linearization $L(x)$ (that is, the linear approximation) of $g(x) = \cos^2 x$ at $a = \pi/4$.

(b)[3 points] The point $(4, -1)$ is on the graph of the function $f(x)$. Using a linear approximation (or differentials), $f(3.9) \approx -0.8$. Determine the slope of the tangent line to $y = f(x)$ at the point where $x = 4$.

(c)[4 points] Compute $q''(0)$ if $q(x) = \log_2 (2^x + 1)$.

Question 2 [10 points]:   A balloon is released from ground level 4 m from the base of a 12 m tall lamppost. As the balloon rises vertically at a rate of 2 m/s it casts a shadow on the ground as a result of the light atop the lamppost. As what rate is the shadow moving along the ground 2 s after the balloon is released?

Question 3:

(a)[5 points] Determine the equation of the tangent line to the curve $xe^y = y - 1$ at the point where $x = 0$.

(b)[5 points] Use logarithmic differentiation to determine y': $\quad y = xe^{\sin^2 x}$

Question 4 [10 points]:   Determine the absolute maximum and absolute minimum values of $f(x) = x(2 - \ln x)$ on the interval $[1, e^2]$.

Question 5:

(a)[8 points] Determine the intervals of increase and decrease of $f(x) = (x^2 - 4)^{2/3}$.

(b)[2 points] Use your result from part (a) to determine the relative extrema of $f(x)$.