Q1...[15 points] Write down the equation of the line through the point \((2, -1, 1)\) which is parallel to the vector \(\langle 1, 2, 3 \rangle\).
Write down the equation of the plane through the point \((1, 1, 1)\) which is perpendicular to the line above. Write down the equation of any plane which is perpendicular to the plane \(2x - 3y + 4z = 17\) and verify that the two planes are indeed perpendicular.

Q2...[22 points] Sketch the polar curves \(r = \sin \theta\) and \(r = 1 - \sin \theta\) on the same graph, and compute (and draw in) their points of intersection.
Compute the area which is common to both curves \(r = \sin \theta\) and \(r = 1 - \sin \theta\) above. Find the arclength of the portion of the curve \(r = \sin \theta\) which lies outside of the curve \(r = 1 - \sin \theta\).

Q3...[20 points] Compute the McLaurin series for the function \(f(x) = \ln(3 + x)\). Write down the general term in your series.
What are the radius and interval of convergence of the series above?
Write down the power series for the function \(g(x) = \ln(3 - x^2)\). What is its radius of convergence?

Q4...[21 points] Use the various series tests learned in class to determine whether each of the following are absolutely convergent, conditionally convergent, or divergent.

\[
\sum_{n=1}^{\infty} \frac{3^n}{n!}
\]
\[
\sum_{n=1}^{\infty} \frac{\cos(n\pi)}{2n - 1}
\]
\[
\sum_{n=1}^{\infty} \frac{(-1)^n}{\sqrt{n^2}2^n}
\]

Q5...[20 points] At time \(t = 0\) a ball is kicked horizontally off a cliff of height 200ft with an initial speed of 40ft/sec. Assume that the only force acting on the ball is due to gravity, and that produces an acceleration of 32ft/sec\(^2\) vertically downwards. See the diagram.
Compute \(r(t)\), the position vector of the ball at time \(t\).
Find the time taken for the ball to reach the ground.
Compute the horizontal distance that the ball has travelled during this time.
Write down an expression for the total distance the ball travels through the air (you do not have to evaluate this expression).

Q6...[22 points] Compute the curvature \(k(x)\) of the graph of \(y = \sin x\) at the point \((x, \sin x)\).
Find the points where \(k(x)\) has local maxima/minima. Indicate these points on a graph of \(y = \sin x\).
Suppose that a point with position vector \(r(t)\) moves around on a sphere of radius 3 centered on the origin in \(\mathbb{R}^3\). The point does not necessarily move in a circle. Show that it’s velocity \(v(t)\) is always perpendicular to \(r(t)\).