Answer each of the following questions. Show all work, as partial credit may be given.

1. (5 pts. each) Let $a = i + 2j + 2k$, $b = 3i + 5j - 4k$, and $c = i + j - 3k$.

(a) Find the cosine of the angle between $a$ and $b$.

(b) Write the vector $a$ as the product of its magnitude and its direction.

(c) $a \times b$

(d) $\text{proj}_a(b)$

(e) Write the vector $b$ as the sum of a vector parallel to $a$ and a vector perpendicular to $a$.

(f) Find the area of the parallelogram determined by the vectors $a$ and $b$.

(g) Find the volume of the box determined by the vectors $a$, $b$ and $c$.

(h) Find parametric equations of the line parallel to $a$ and containing the point $(6, 5, -1)$.

(i) Find an equation for the plane perpendicular to $a$ and containing the point $(6, 5, -1)$.

2. (8 pts. each) A projectile is fired from ground level with an initial speed of 500 meters per second at an angle of elevation of 30 degrees.

(a) Find the maximum height of the projectile.

(b) When and how far away will the projectile strike the ground?

3. (8 pts. each) Consider the vector–valued function $r(t) = t i + (1/3)t^{3/2}j + t k$.

(a) Find $r'(t)$, $r''(t)$, $|r'(t)|$, and $T(t)$ (the unit tangent vector).

(b) Find the arclength of the above curve for $0 \leq t \leq 4$.

4. (8 pts. each) Let $A = (2, 4, 5)$, $B = (0, 0, 1)$ and $C = (3, -1, 2)$.

(a) Find an equation for the plane containing the points $A$, $B$, and $C$. Put your answer in the form $Ax + By + Cz = D$.

(b) Find parametric equations for the line that contains the points $B$ and $C$.

(c) Find the distance from the point $A$ to the line you found in part (b).