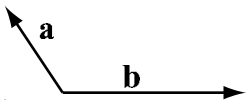
1. (6pts) Find $\langle 3, 2+t, 5-2t\rangle \times \langle 2, 1, t+1\rangle =$

2. (17pts) Let $\mathbf{a}$ and $\mathbf{b}$ be vectors sketched below.
a) draw the vectors $-3\mathbf{a}$, $\mathbf{a}-\mathbf{b}$ and $2\mathbf{a}+\mathbf{b}$.
b) draw the vector $\text{proj}_{\mathbf{b}}\,\mathbf{a}$.
c) If $\mathbf{a} = -2\mathbf{i}+3\mathbf{j}$ and $\mathbf{b} = 7\mathbf{i}$, find the coordinates of $\text{proj}_{\mathbf{b}}\,\mathbf{a}$.



3. (6pts) Let $\mathbf{a}$, $\mathbf{b}$ and $\mathbf{c}$ be vectors, and u, v scalars. Are the following expressions defined? For those that are not, explain what is wrong.

$\mathbf{a} \times (\mathbf{b} \cdot \mathbf{c})$ $(\mathbf{b} \cdot \mathbf{c})\mathbf{a} \times \mathbf{c}$

4. (10pts) The spherical coordinates of a point are $\left(4, \frac{2\pi}{3}, \frac{3\pi}{4}\right)$. Sketch the point and find its cylindrical coordinates (exact numbers, not decimal).

5. (9pts) In cylindrical coordinates, draw the solid described by:

$3 \leq r \leq 5$, $\frac{\pi}{4} \leq \theta \leq \frac{3\pi}{4}$, $0 \leq z \leq 4$

6. (13pts) This problem is about the surface $y = \frac{x^2}{9} + \frac{z^2}{16}$.

a) Sketch and identify the intersections of this surface with the coordinate planes.

b) Sketch the surface in 3D, with coordinate system visible.

7. (9pts) The parametric equations of a curve are $x = 3\cos t$, $y = t^2$, $z = 3\sin t$, $0 \leq t \leq 6\pi$. Sketch this curve.

8. (17pts) A jet-powered eggplant travels along the path $x = t^2 + 2t$, $y = \dfrac{3}{t+1}$, $z = t^2 e^t$. At the point $(8, 1, 4e^2)$ it experiences engine failure, so from this point on, it continues along the tangent line to this curve and splatters on the xz-plane.
a) Find the parametric equations of the line tangent to the curve at $(8, 1, 4e^2)$.
b) At which point does the tangent line intersect the xz-plane? (This is where the eggplant splatters if gravitation is ignored.)

9. (13pts) Find the equation of the plane that contains the line $\dfrac{x-2}{1} = \dfrac{y+4}{-3} = \dfrac{z-1}{2}$ and the point $(3, 0, 4)$.

Bonus. (10pts) This problem is about the vector $\mathbf{d} = \mathbf{a} \times (\mathbf{b} \times \mathbf{c})$.
a) Explain why $\mathbf{d}$ lies in the plane spanned by $\mathbf{b}$ and $\mathbf{c}$.
b) Since $\mathbf{d}$ lies in the plane spanned by $\mathbf{b}$ and $\mathbf{c}$, it can be written as $\mathbf{d} = u\mathbf{b} + v\mathbf{c}$, for some scalars u and v. Find a relationship between u and v by dotting the equation $\mathbf{d} = u\mathbf{b} + v\mathbf{c}$ by $\mathbf{a}$.