1. Given the position function of an object $\vec{r}(t)=t^3\mathbf{i}+6t^2\mathbf{j}+\sin t\mathbf{k}$ with $0\le t\le\pi$ find the velocity and acceleration vectors.

2. Let $\vec{u}=\langle 3,-2,-1\rangle$ and $\vec{v}=\langle 5,-3,-5\rangle$
   a. Find a unit vector in the direction of $\vec{u}$
   b. Find $\vec{u}\cdot\vec{v}$.
   c. Find $\vec{u}\times\vec{v}$.
   d. Find the projection of $\vec{v}$ onto $\vec{u}$.
   e. Find the angle between $\vec{u}$ and $\vec{v}$.
   f. Find a vector parallel to $\vec{v}$ with length 5 units.
   g. Compute the lengths of the diagonals of the parallelogram determined by $\vec{u}$ and $\vec{v}$.
   h. Find a vector orthogonal to both $\vec{u}$ and $\vec{v}$.
   i. Compute the area of the parallelogram determined by $\vec{u}$ and $\vec{v}$.

2. Find a vector equation of the line that passes through the points $(2,6,-1)$ and $(-6,4,0)$.

3. Find the parametric equations of the line that passes through the point $(0,1,1)$ and parallel to the vector $\langle 2,-1,3\rangle$.

4. Find a vector equation of the line that passes through $(2,1,0)$ and perpendicular to both $\mathbf{i}+\mathbf{j}$ and $\mathbf{j}+\mathbf{k}$.

5. Find the equation of the plane through $A(-1,6,-5)$ and parallel to the plane $x+y+z+2=0$.

6. Find an equation of the plane through $P(-2,3,1)$, $Q(1,1,0)$, and $R(-1,0,1)$.

7. Find the equation of the sphere with center $(2,-3,4)$ and tangent to the *xz*-plane.

8. Find the equation of the sphere with the line segment $(1,5,-2)$ and $(3,9,-1)$ is the diameter.

9. Find the distance between the points $P(1,2,-3)$ and $Q(4,7,-3)$.

10. Find an equation of the line of intersection of the two plane $y-5z=3$ and $6x-7y=5$.

11. Find an equation of the line tangent to the curve $\vec{r}(t)=\langle \sin 2t,\cos 2t,t\rangle$ at $t=\dfrac{\pi}{4}$

12. Determine the distance from the point $P(-6,3,0)$ to the line given by $\vec{r}(t)=\langle 3+4t,-2+6t,t\rangle$.

13. Show that the lines with equation

$$\vec{r}(t)=\langle 2t-1,3-4t,2+5t\rangle$$
$$\vec{R}(s)=\langle 4+3s,2s-1,3s\rangle$$

are skew, find the equations of the parallel planes containing the lines, and find the distance between the lines.

14. Let $\mathbf{r}(t)=\left\langle \sqrt{2-t},(e^t-1)/t,\ln(t+1)\right\rangle$.

   a. Find the domain of **r.**
   b. Find $\lim_{t\to 0}\vec{r}(t)$

15. Given the points A(1, 0 ,1), B(2, 3, 0) and C(-1, 1, 4), find the area of the triangle with vertices A, B, and C.

16. Find the length of the curve $\vec{r}(t)=\left\langle 2t^{3/2},\cos 2t,\sin 2t\right\rangle$ for $0\le t\le 1$.

17. Find the distance from the point $(2,0,-3)$ to the plane $3x-4y+5z=1$.

18. A particle moves in space with parametric equations $x=t, y=t^2, z=\frac{4}{3}t^{3/2}$. Find the curvature of its trajectory, the unit tangent vector, and the unit normal vector when t = 1.

19. Find the binormal vector for $x=t, y=t^2, z=\frac{4}{3}t^{3/2}$ at $t=1$.

20. Find the distance from the point $(-6,3,0)$ to the line given by $\vec{r}(t)=\langle 1+5t,-6+t,-4t\rangle$

21. A particle starts at the origin with initial velocity $\mathbf{i}-\mathbf{j}+3\mathbf{k}$. Its acceleration is $\mathbf{a}(t)=6t\,\mathbf{i}+12t^2\mathbf{j}-6t\,\mathbf{k}$. Find its position function.

22. Find the tangential and normal components of acceleration for a particle moving along a conical helix defined by $\vec{r}(t)=\langle t\cos t,t\sin t,t\rangle$.

23. The helix $\mathbf{r}_1(t)=\cos t\,\mathbf{i}+\sin t\,\mathbf{j}+t\,\mathbf{k}$ intersects the curve $\mathbf{r}_2(t)=(1+t)\mathbf{i}+t^2\mathbf{j}+t^3\mathbf{k}$ at point (1, 0, 0). Find the angle of intersection of these curves.

For additional problems, check out the review problems for Chapters 11. Note the questions above are simply a sample of questions possible for the exam; it is possible that other types of questions may appear on your exam.