

Show **ALL** work for credit; be neat; and use only **ONE** side of each page of paper.

1. If the position function is  $\mathbf{r}(t) = \langle t^3, t^2 + 1, t^3 - 1 \rangle$ , find the velocity, the speed and the acceleration.
2. Find the equation of the plane through the point  $(6, 5, -2)$  parallel to the plane  $x + 2y - z + 1 = 0$ .
3. Find the point where the line  $x = 1 + t, y = 2t, z = 3t$  intersects the plane  $3x - 2y + z = 9$ .
4. Find the value of  $x$  such that the vectors  $\langle 2, x, 3 \rangle$  and  $\langle x, 8, 6 \rangle$  are perpendicular and find the value  $x$  such the vectors are parallel.
5. Find the scalar and vector projections of  $\mathbf{b} = \mathbf{i} + 6\mathbf{j} - 2\mathbf{k}$  onto  $\mathbf{a} = 2\mathbf{i} - 3\mathbf{j} - 6\mathbf{k}$ .
6. Find parametric equations for the line of intersection of the planes  $2x + 5z = -3$ , and  $x - 3y + z = -2$ .
7. Identify and sketch the graph of the equation  $x^2 + y^2 + z^2 = 2x$  and re-write the equation in both cylindrical and spherical co-ordinates.
8. Find the equation of the plane that passes through the point  $(0, 1, 2)$  and contains the line  $x = y - 1 = z$ .
9. Find and simplify both the unit tangent vector  $\mathbf{T}(t)$  and the curvature  $\kappa = \frac{|\mathbf{r}'(t) \times \mathbf{r}''(t)|}{|\mathbf{r}'(t)|^3}$  of the space curve  $\mathbf{r}(t) = \langle t^2, 2t^3/3, t \rangle$ .
10. Find and simplify the arclength of  $\mathbf{r}(t) = \langle e^t, e^t \sin(t), e^t \cos(t) \rangle, 0 \leq t \leq 2\pi$ .