1. (1 point each)

   (a) i. NONE; ii. $(0, \pm 1, 0)$; iii. $(0, 0, \pm 2)$

   (b) i. ellipse; ii. hyperbola; iii. hyperbola

   (c) hyperboloid of one sheet

2. (a)   i. (2 points) $a = 12$, $b = 0$

   ii. (2 points) $\mathbf{proj_k n} = \langle 0, 0, -4 \rangle$

   (b) (3 points) $\theta = \cos^{-1} \left(\dfrac{1}{\sqrt{10}} \right)$

   (c) (3 points) Many possible correct answers. One is $x = \sin t, y = \cos t, z = 3 \sin t$

3. (2 points each) (a) T; (b) F; (c) T; (d) T; (e) F.

4. (7 points) Speed is $v(t) = \sqrt{4t^2 - 4t + 10}$, which is smallest when $4t^2 - 4t + 10$ is smallest. Use Calc I methods (or algebra) to find that smallest speed (occurring at $t = \frac{1}{2}$) is 3.

5. (8 points) $(\sqrt{6}, 2\sqrt{6}, 3 - \sqrt{6})$ and $(-\sqrt{6}, -2\sqrt{6}, 3 + \sqrt{6})$

6. (8 points) $r = \dfrac{1}{\kappa(\pi)} = \dfrac{(1 + \pi^2)^{3/2}}{2 + \pi^2}$