Difficulty guide for worksheet:	
C-level or B-level exam problem:	1, 2, 4, 6
A-level exam problem or challenge for extra study:	5
beyond the scope and/or removed from syllabus:	3

1. Which of the following does *not* parametrize a line or some portion of a line? Explain your answer.

(a) $\boldsymbol{r}(t) = \langle 2+3t,\ 9-t,\ 12+7t\rangle$

(b) $\boldsymbol{r}(t) = \langle 1-t^2,\ 3+3t^2,\ t^3\rangle$

(c) $\boldsymbol{r}(t) = \langle 2\cos(2t),\ 5+3\cos(2t),\ \sin(2t)\rangle$

(d) $\boldsymbol{r}(t) = \langle t^3,\ 4-8t^3,\ 8+3t^3\rangle$

2. Find a parametrization of each described curve.

(a) A circle of radius 3 with center $(-2,3,1)$, lying in a plane parallel to the xz-plane.

(b) The ellipse $4y^2+9z^2=36$ translated to have center $(-1,10,-5)$.

(c) The intersection of the surfaces $y^2-z^2=x-2$ and $y^2+z^2=9$.

(d) The intersection of the sphere $x^2+y^2+z^2=1$ and the paraboloid $z=x^2+y^2$.

3. We will show that the curve with the following parametrization lies in a plane.

$$\boldsymbol{r}(t) = \langle t^2-1,\ t-2t^2,\ 4-6t\rangle$$

(a) Show that the points on the curve at $t=0$, $t=1$, and $t=2$ do not lie on a line. Then find an equation of the plane that they determine.

(b) Show that for all t, the points on $\mathcal{C}$ satisfy the equation of the plane from part (a).

4. Find a parametrization of the line tangent to the curve at the indicated value of t.

(a) $\boldsymbol{r}(t) = \langle 1-t^2,\ 5t,\ 2t^3\rangle$ at $t=2$

(b) $\boldsymbol{r}(t) = 4t^{-1}\boldsymbol{i} - 6t^{-3}\boldsymbol{k}$ at $t=1$

5. For $0\le t\le 4\pi$, the path of a particle is parametrized by

$$\boldsymbol{r}(t) = \langle \cos(t)\sin(t),\ \sin(t)^2,\ \sin(t)\rangle$$

(a) Show that the path of the particle is a closed loop.

(b) Let $\mathcal{C}$ be the *curve* on which the particle travels. How many times does the particle traverse $\mathcal{C}$ from $t=0$ to $t=4\pi$? Justify your answer.

(c) Find an integral whose value is the length of $\mathcal{C}$.

(d) Find an integral whose value is the distance traveled by the particle.

6. Calculate the length of the described curve.

(a) $\boldsymbol{r}(t) = \langle 4t,\ \sqrt{3}t^{3/2},\ t^{3/2}\rangle$, $0\le t\le 1$

(b) $\boldsymbol{r}(t) = \langle 2t,\ \ln(t),\ t^2\rangle$, $1\le t\le 4$