

73 (a)  $x = 2 + at, y = 1 + bt, z = 3 + ct$   
 (b)  $a/2 = b/1 = c/3$

75  $\alpha$  is radius of cylinder  
 $\beta$  determines vertical distance moved

- 77 (a) (vii)  
 (b) (ii)  
 (c) (iv)

79  $\vec{r} = 9.65\vec{k} + t(325\vec{i} + 563\vec{j} - 0.84\vec{k})$

- 81 (a) Parallel  
 (b) (i) Perpendicular  
 (ii) Parallel

83 Different parameterization of same curve

85  $x = \cos t, y = \sin t, z = 0$   
 $x = 0, y = \cos t, z = \sin t$

87  $x = t^3, y = 2t^3, z = 3 + 4t^3$

- 89 True  
 91 True  
 93 True  
 95 True  
 97 False  
 99 False

### Section 17.2

1  $\vec{v} = 3\vec{i} + \vec{j} - \vec{k}, \vec{a} = \vec{0}$   
 3  $\vec{v} = \vec{i} + 2t\vec{j} + 3t^2\vec{k}, \vec{a} = 2\vec{j} + 6t\vec{k}$   
 5  $\vec{v} = -3 \sin t\vec{i} + 4 \cos t\vec{j},$   
 $\vec{a} = -3 \cos t\vec{i} - 4 \sin t\vec{j}$

7  $\vec{v} = \vec{i} + 2t\vec{j} + 3t^2\vec{k},$   
 Speed  $= \sqrt{1 + 4t^2 + 9t^4},$   
 Particle never stops

9  $\vec{v} = 6t\vec{i} + 3t^2\vec{j},$   
 $\|\vec{v}\| = 3|t| \cdot \sqrt{4 + t^2},$   
 Stops when  $t = 0$

11  $\vec{v} = 6t \cos(t^2)\vec{i} - 6t \sin(t^2)\vec{j},$   
 $\|\vec{v}\| = 6|t|,$   
 Stops when  $t = 0$

13 Length  $= \sqrt{42}$

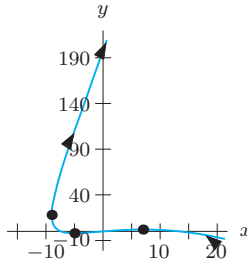
15 Length  $= e - 1$

17  $\vec{v} = -6\pi \sin(2\pi t)\vec{i} + 6\pi \cos(2\pi t)\vec{j},$   
 $\vec{a} = -12\pi^2 \cos(2\pi t)\vec{i} - 12\pi^2 \sin(2\pi t)\vec{j},$   
 $\vec{v} \cdot \vec{a} = 0, \|\vec{v}\| = 6\pi, \|\vec{a}\| = 12\pi^2$

19 Line through  $(2, 3, 5)$  in direction of  
 $\vec{i} - 2\vec{j} - \vec{k},$   
 $\vec{v} = 2t(\vec{i} - 2\vec{j} - \vec{k}), \vec{a} = 2(\vec{i} - 2\vec{j} - \vec{k})$

21  $x = 1 + 2(t - 2), y = 2, z = 4 + 12(t - 2)$

- 23 Vertical:  $t = 3$   
 Horizontal:  $t = \pm 1$   
 As  $t \rightarrow \infty, x \rightarrow \infty, y \rightarrow \infty$   
 As  $t \rightarrow -\infty, x \rightarrow \infty, y \rightarrow -\infty$



25 (a)  $\vec{v}(2) \approx -4\vec{i} + 5\vec{j},$   
 Speed  $\approx \sqrt{41}$   
 (b) About  $t = 1.5$   
 (c) About  $t = 3$

27 (a)  $x = 2 + 0.6t, y = -1 + 0.8t, z = 5 - 1.2t, 0 \leq t \leq 5$   
 (b)  $x = 2 + 1.92t, y = -1 + 2.56t, z = 5 - 3.84t, 0 \leq t \leq 1.56$

- 29 (a) 6.4 meters  
 (b) 1.14 sec  
 (c) 15.81 m/sec  
 (d)  $(11.4, -5.7, 0)$   
 (e)  $-9.8 \text{ m/sec}^2$

31 (a) 5 secs;  $(10, 15, 100)$   
 (b)  $t = 0, 10 \text{ secs}, \sqrt{113} \text{ cm/sec}$   
 (c) 5 secs,  $\sqrt{13} \text{ cm/sec}$

33 (a)  $t = 5.181 \text{ sec}$   
 (b)  $x = 103.616 \text{ meters}$   
 (c) 2 meters  
 (d) 9.8 meters/sec<sup>2</sup>  
 (e)  $\theta = 0.896; v = 32.016 \text{ meters/sec}$

35 (a) (IV); 4.5 sec;  $(0, 8.9 \text{ m}, 0)$   
 (b) (II); 3.2 sec; base of tower  
 (c) (V); 10 sec; halfway up

37  $\vec{r}(t) = 22.1t\vec{i} + 66.4t\vec{j}$   
 $+ (442.7t - 4.9t^2)\vec{k}$

41 (a) No  
 (b)  $t = 5$   
 (c)  $\vec{v}(5) \approx 0.959\vec{i} + 0.284\vec{j} + 2\vec{k}$   
 (d)  $\vec{r} \approx 0.284\vec{i} - 0.959\vec{j} + 10\vec{k}$   
 $+ (t - 5)(0.959\vec{i} + 0.284\vec{j} + 2\vec{k}).$

43 (a)  $\vec{r}(t) = t \cos(2\pi t)\vec{i} + t \sin(2\pi t)\vec{j},$   
 $0 \leq t \leq 100$

(b)  $\vec{v} = \vec{r}'(t) =$   
 $(\cos(2\pi t) - 2\pi t \sin(2\pi t))\vec{i} +$   
 $(\sin(2\pi t) + 2\pi t \cos(2\pi t))\vec{j}$   
 $\|\vec{v}\| = (1 + 4\pi^2 t^2)^{1/2} \text{ cm/sec}$   
 (c)  $\vec{a} = \vec{v}'(t) =$   
 $(-4\pi \sin(2\pi t) - 4\pi^2 t \cos(2\pi t))\vec{i} +$   
 $(4\pi \cos(2\pi t) - 4\pi^2 t \sin(2\pi t))\vec{j}$   
 $\|\vec{a}\| = 4\pi(1 + \pi^2 t^2)^{1/2} \text{ cm/sec}^2$

45 (a)  $x \approx 694.444t$   
 $+ 20 \cos(2\pi t) \text{ cm}$   
 $y = 30 + 20 \sin(2\pi t) \text{ cm}$   
 (c) At least 5.526 revs/sec

47 No

- 49 (a)  $2\vec{r} \cdot d\vec{r}/dt$   
 (b)  $\vec{a} \times d\vec{r}/dt$   
 (c)  $r^3 d\vec{r}/dt + 3r^2 \vec{r}$

55 Acceleration is a vector, not a scalar

57  $\vec{r}(t) = (t + 2t^2)\vec{i} + 2t\vec{j} + 3t^2\vec{k}$

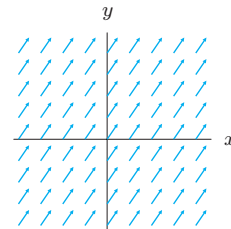
- 59 False  
 61 False  
 63 False  
 65 False  
 67 True  
 69 False

### Section 17.3

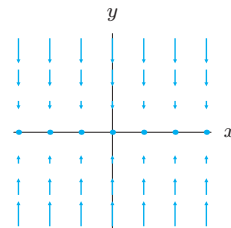
1  $\vec{V} = x\vec{i}$   
 3  $\vec{V} = x\vec{i} + y\vec{j} = \vec{r}$   
 5  $\vec{V} = -x\vec{i} - y\vec{j} = -\vec{r}$

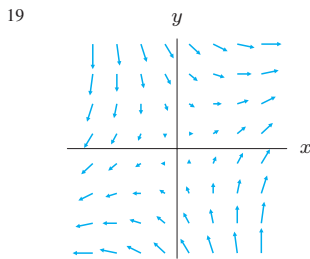
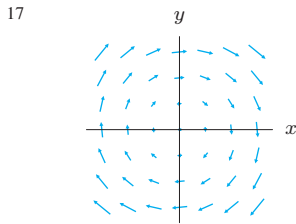
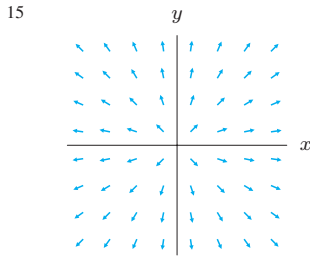
- 7 (a)  $y$ -axis  
 (b) Increasing  
 (c) Neither

- 9 (a)  $x$ -axis  
 (b) Increases  
 (c) Decreases



13





- 21 (a) IV  
 (b) III  
 (c) I  
 (d) II

23  $(1 + x^2)(3\vec{i} + 2\vec{j})$ , other answers possible

25  $x\vec{i} + y\vec{j}$ , other answers possible

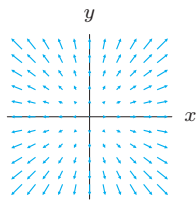
27 (A) = (IV); (B) = (II); (C) = (I); (D) = (III)

- 29 (a) II  
 (b) III  
 (c) IV  
 (d) I

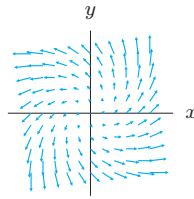
31  $\vec{F}(x, y) = \frac{-x\vec{i} - y\vec{j}}{\sqrt{x^2 + y^2}}$  (for example)

- 33 (a)  $(1, -3, -7)$ ; other answers possible  
 (b)  $(0, 0, 0)$ ; other answers possible  
 (c)  $-4x + y - 3z = 0$ ; plane through origin

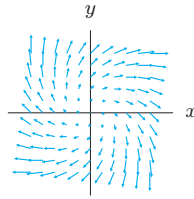
- 35 (a) Radiates out from origin



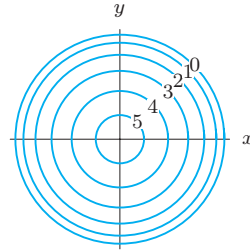
- (b) Spirals outward counterclockwise around origin



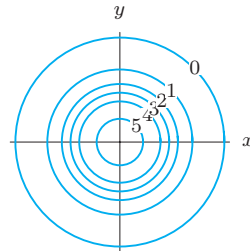
(c) Spirals outward clockwise around origin



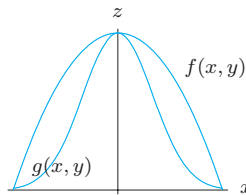
37 (a)  $z = f(x, y)$ :



$z = g(x, y)$ :



(b)

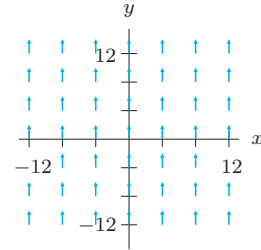


39 To plot  $\vec{C}(x, y, z)$  move arrows of  $\vec{F}(2x, 2y, 2z)$  halfway to origin

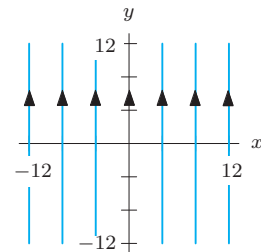
41  $(x^2 + 1)(\vec{i} + \vec{j} + \vec{k})$

### Section 17.4

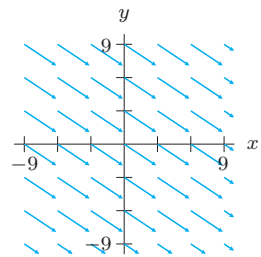
1 Field:



Flow,  $x = \text{constant}$ :



3 Field:



Flow,  $y = -(2/3)x + c$ :

