

**Halliday, Resnick, and Walker *Fundamentals of Physics 10e* Problem Answers**  
**Volume 2**

**Chapter 21 Answers**

1	0.500
2	0.375
3	1.39 m
4	0.50 C
5	2.81 N
6	(a) $4.9 \times 10^{-7}$ kg; (b) $7.1 \times 10^{-11}$ C
7	-4.00
8	0.375
9	(a) $-1.00 \mu\text{C}$ ; (b) $3.00 \mu\text{C}$
10	(a) -2.83; (b) no
11	(a) 0.17 N; (b) $-0.046$ N
12	(a) $-83 \mu\text{C}$ ; (b) $55 \mu\text{C}$
13	(a) -14 cm; (b) 0
14	(a) 9.0; (b) -25
15	(a) 35 N; (b) $-10^\circ$ ; (c) -8.4 cm; (d) +2.7 cm
16	(a) positive; (b) +9.0
17	(a) 1.60 N; (b) 2.77 N
18	1.333
19	(a) 3.00 cm; (b) 0; (c) -0.444
20	(a) -4; (b) +16
21	$3.8 \times 10^{-8}$ C
22	(a) 1.92 cm; (b) less than

23	(a) 0; (b) 12 cm; (c) 0; (d) $4.9 \times 10^{-26}$ N
24	(a) $8.99 \times 10^{-19}$ N; (b) 625
25	$6.3 \times 10^{11}$
26	$2.89 \times 10^{-9}$ N
27	(a) $3.2 \times 10^{-19}$ C; (b) 2
28	$2.25 \times 10^{20}$
29	(a) -6.05 cm; (b) 6.05 cm
30	(a) 2.00 cm; (b) $9.21 \times 10^{-24}$ N
31	122 mA
32	+13e
33	$1.3 \times 10^7$ C
34	(a) 0.654 rad; (b) 0.889 rad; (c) 0.988 rad
35	(a) 0; (b) $1.9 \times 10^{-9}$ N
36	(a) positron; (b) electron
37	(a) ${}^9\text{B}$ ; (b) ${}^{13}\text{N}$ ; (c) ${}^{12}\text{C}$
38	+16e
39	$1.31 \times 10^{-22}$ N
40	-2.25
41	(a) $5.7 \times 10^{13}$ C; (b) cancels out; (c) $6.0 \times 10^5$ kg
42	(b) $2.4 \times 10^{-8}$ C
43	(b) 3.1 cm
44	11.9 cm
45	0.19 MC
46	(a) $(3.52 \times 10^{-25} \text{ N})\hat{i}$ ; (b) 0
47	-45 $\mu\text{C}$
48	(a) 3.60 $\mu\text{N}$ ; (b) 2.70 $\mu\text{N}$ ; (c) 3.60 $\mu\text{N}$

49	3.8 N
50	(a) $(L/2)(1 + kqQ/Wh^2)$ ; (b) $(3kqQ/W)^{0.5}$
51	(a) $2.00 \times 10^{10}$ electrons; (b) $1.33 \times 10^{10}$ electrons
52	$-11.1 \mu\text{C}$
53	(a) $8.99 \times 10^9 \text{ N}$ ; (b) 8.99 kN
54	9.0 kN
55	(a) 0.5; (b) 0.15; (c) 0.85
56	(a) $1.25 \times 10^{13}$ electrons; (b) from you to faucet; (c) positive; (d) from faucet to the cat; (e) stroking the cat transfers electrons from you to the fur, which then induces charge in the cat's body, with negative charge on the surface away from the stroked region; if you bring your positive hand near the negative nose, electrons can spark across the gap
57	$1.7 \times 10^8 \text{ N}$
58	(a) $(89.9 \text{ N})\hat{i}$ ; (b) $(-2.50 \text{ N})\hat{i}$ ; (c) 68.3 cm; (d) 0
59	$-1.32 \times 10^{13} \text{ C}$
60	0
61	(a) $(0.829 \text{ N})\hat{i}$ ; (b) $(-0.621 \text{ N})\hat{j}$
62	(a) $6.16 \times 10^{-24} \text{ N}$ ; (b) $208^\circ$
63	$2.2 \times 10^{-6} \text{ kg}$
64	$1.2 \times 10^{-5} \text{ C}$
65	$4.68 \times 10^{-19} \text{ N}$
66	-5.1 m
67	(a) $2.72L$ ; (b) 0
68	$10^{18} \text{ N}$
69	(a) $5.1 \times 10^2 \text{ N}$ ; (b) $7.7 \times 10^{28} \text{ m/s}^2$
70	0.707
71	(a) 0; (b) $3.43 \times 10^9 \text{ m/s}^2$
72	1.6 nm

73	(a) $2.19 \times 10^6$ m/s; (b) $1.09 \times 10^6$ m/s; (c) decrease
74	1.3 days
75	$4.16 \times 10^{42}$

## Chapter 22 Answers

1	---
2	(a) $6.4 \times 10^{-18}$ N; (b) 20 N/C
3	(a) $3.07 \times 10^{21}$ N/C (b) outward
4	$(-6.39 \times 10^5 \text{ N/C})\hat{i}$
5	56 pC
6	0.111 nC
7	$(1.02 \times 10^5 \text{ N/C})\hat{j}$
8	0
9	(a) $1.38 \times 10^{-10}$ N/C; (b) $180^\circ$
10	(a) 34 cm; (b) $2.2 \times 10^{-8}$ N/C
11	-30 cm
12	(a) $3.93 \times 10^{-6}$ N/C; (b) $-76.4^\circ$
13	(a) $3.60 \times 10^{-6}$ N/C; (b) $2.55 \times 10^{-6}$ N/C; (c) $3.60 \times 10^{-4}$ N/C; (d) $7.09 \times 10^{-7}$ N/C; (e) As the proton nears the disk, the forces on it from electrons $e_s$ more nearly cancel.
14	(a) $2.72L$
15	(a) 160 N/C; (b) $45^\circ$
16	(a) $67.8^\circ$ ; (b) $-67.8^\circ$
17	(a) $-90^\circ$ ; (b) $+2.0 \mu\text{C}$ ; (c) $-1.6 \mu\text{C}$
18	$qd^3/4\pi\epsilon_0 z^5$
19	(a) $qd/4\pi\epsilon_0 r^3$ ; (b) $-90^\circ$
20	0.98
21	---

22	(a) $-1.72 \times 10^{-15} \text{ C/m}$ ; (b) $-3.82 \times 10^{-14} \text{ C/m}^2$ ; (c) $-9.56 \times 10^{-15} \text{ C/m}^2$ ; (d) $-1.43 \times 10^{-12} \text{ C/m}^3$
23	0.506
24	(a) 0; (b) 0; (c) $0.707R$ ; (d) $3.46 \times 10^7 \text{ N/C}$
25	(a) $1.62 \times 10^6 \text{ N/C}$ ; (b) $-45^\circ$
26	(a) $20.6 \text{ N/C}$ ; (b) $-90^\circ$
27	(a) $23.8 \text{ N/C}$ ; (b) $-90^\circ$
28	1.70 cm
29	1.57
30	$-4.19Q$
31	(a) $-5.19 \times 10^{-14} \text{ C/m}$ ; (b) $1.57 \times 10^{-3} \text{ N/C}$ ; (c) $-180^\circ$ ; (d) $1.52 \times 10^{-8} \text{ N/C}$ ; (e) $1.52 \times 10^{-8} \text{ N/C}$
32	(a) $12.4 \text{ N/C}$ ; (b) $90^\circ$
33	---
34	$6.3 \times 10^3 \text{ N/C}$
35	0.346 m
36	$2.4 \times 10^{-16} \text{ C}$
37	28%
38	6.9 cm
39	$-5e$
40	(a) 7.12 cm; (b) 28.5 ns; (c) 0.112
41	(a) $1.5 \times 10^3 \text{ N/C}$ ; (b) $2.4 \times 10^{-16} \text{ N}$ ; (c) up; (d) $1.6 \times 10^{-26} \text{ N}$ ; (e) $1.5 \times 10^{10}$
42	(a) $4.8 \times 10^{-13} \text{ N}$ ; (b) $4.8 \times 10^{-13} \text{ N}$
43	$3.51 \times 10^{15} \text{ m/s}^2$

44	(a) $2.03 \times 10^{-7} \text{ N/C}$ ; (b) up
45	$6.6 \times 10^{-15} \text{ N}$
46	(a) $1.02 \times 10^{-2} \text{ N/C}$ ; (b) west
47	(a) $1.92 \times 10^{12} \text{ m/s}^2$ ; (b) $1.96 \times 10^5 \text{ m/s}$
48	(a) $1.16 \times 10^{16} \text{ m/s}^2$ ; (b) $3.94 \times 10^{16} \text{ m/s}^2$ ; (c) $3.97 \times 10^{16} \text{ m/s}^2$ ; (d) because the net force due to the charged particles near the edge of the disk decreases
49	(a) 0.245 N; (b) $-11.3^\circ$ ; (c) 108 m; (d) -21.6 m
50	(a) $(-2.1 \times 10^{13} \text{ m/s}^2)\hat{j}$ ; (b) $(1.5 \times 10^5 \text{ m/s})\hat{i} - (2.8 \times 10^6 \text{ m/s})\hat{j}$
51	(a) $2.6 \times 10^{-10} \text{ N}$ ; (b) $3.1 \times 10^{-8} \text{ N}$ ; (c) moves to stigma
52	(a) 27 km/s; (b) $50 \mu\text{m}$
53	$27 \mu\text{m}$
54	$(1.53 \times 10^6 \text{ m/s})\hat{i} - (4.34 \times 10^5 \text{ m/s})\hat{j}$
55	(a) $2.7 \times 10^6 \text{ m/s}$ ; (b) 1.0 kN/C
56	(a) 0; (b) $8.5 \times 10^{-22} \text{ N}\cdot\text{m}$ ; (c) 0
57	(a) $9.30 \times 10^{-15} \text{ C}\cdot\text{m}$ ; (b) $2.05 \times 10^{-11} \text{ J}$
58	$5.0 \times 10^{-28} \text{ C}\cdot\text{m}$
59	$1.22 \times 10^{-23} \text{ J}$
60	$2.5 \times 10^{-28} \text{ C}\cdot\text{m}$
61	$(1/2\pi)(pE/I)^{0.5}$
62	(a) $2.46 \times 10^{17} \text{ m/s}^2$ ; (b) 0.122 ns; (c) 1.83 mm
63	(a) $8.87 \times 10^{-15} \text{ N}$ ; (b) 120
64	$Q/3\pi\epsilon_0 d^2$
65	$217^\circ$
66	$3.6 \times 10^2 \text{ N/C}$

67	61 N/C
68	$(1.08 \times 10^{-5} \text{ N/C})\hat{i}$
69	(a) 47 N/C; (b) 27 N/C
70	$1.64 \times 10^{-19} \text{ C}$ (approx 2% high)
71	38 N/C
72	---
73	(a) -1.0 cm; (b) 0; (c) 10 pC
74	(a) $0.10 \mu\text{C}$ ; (b) $1.3 \times 10^{17}$ ; (c) $5.0 \times 10^{-6}$
75	$+1.00 \mu\text{C}$
76	$-3.28 \times 10^{-21} \text{ J}$
77	(a) 6.0 mm; (b) $180^\circ$
78	(a) $(2q/4\pi\epsilon_0 d^2)\alpha/(1 + \alpha^2)^{1.5}$ ; (c) 0.71; (d) 0.20 and 2.0
79	9:30
80	$6.88 \times 10^{-28} \text{ C}\cdot\text{m}$
81	(a) -0.029 C; (b) repulsive forces would explode the sphere
82	5.39 N/C
83	(a) $-1.49 \times 10^{-26} \text{ J}$ ; (b) $(-1.98 \times 10^{-26} \text{ N}\cdot\text{m})\hat{k}$ ; (c) $3.47 \times 10^{-26} \text{ J}$
84	(a) yes; (b) upper plate, 2.72 cm
85	(a) top row: 4, 8, 12; middle row: 5, 10, 14; bottom row: 7, 11, 16; (b) $1.63 \times 10^{-19} \text{ C}$
86	(a) $0^\circ$ ; (b) 9.96 pN
87	(a) $(-1.80 \text{ N/C})\hat{i}$ ; (b) $(43.2 \text{ N/C})\hat{i}$ ; (c) $(-6.29 \text{ N/C})\hat{i}$