Respostas dos Problemas

Capítulo 21

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 μC; (b) 3,00 μC
10	(a) −2,83; (b) não
11	(a) 0,17 N; (b) −0,046 N
12	(a) −83 μC; (b) 55 μC
13	(a) −14 cm; (b) 0
14	(a) 9,0; (b) −25
15	(a) 35 N; (b) −10°; (c) −8,4 cm; (d) +2,7 cm
16	(a) positiva; (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) menor
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

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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) pósitron; (b) elétron
37	(a) ^{9}B; (b) ^{13}N; (c) ^{12}C
38	$+16e$
39	$1{,}31 \times 10^{-22}$ N
40	–2,25
41	(a) $5{,}7 \times 10^{13}$ C; (b) porque as distâncias se cancelam; (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) $(3{,}52 \times 10^{-25}\ \text{N})\hat{\text{i}}$; (b) 0
47	$-45\ \mu$C
48	(a) 3,60 μN; (b) 2,70 μN; (c) 3,60 μN
49	3,8 N
50	(a) $(L/2)(1 + kqQ/Wh^2)$; (b) $(3kqQ/W)^{0,5}$
51	(a) $2{,}00 \times 10^{10}$ elétrons; (b) $1{,}33 \times 10^{10}$ elétrons
52	$-11{,}1\ \mu$C
53	(a) $8{,}99 \times 10^{9}$ N; (b) 8,99 kN
54	9,0 kN

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(*Continuação*)

55	(a) 0,5; (b) 0,15; (c) 0,85
56	(a) $1{,}25 \times 10^{13}$ elétrons; (b) do dono do gato para a torneira; (c) positivas; (d) da torneira para o gato; (e) ao acariciar o gato, você pode transferir elétrons para o pelo do gato. Esses elétrons podem repelir elétrons do corpo do gato para regiões mais afastadas do pelo, como, por exemplo, o focinho. Se você aproximar a mão (que, depois da transferência de carga, ficou positiva) do focinho negativo do gato, poderá ocorrer uma descarga elétrica.
57	$1{,}7 \times 10^{8}$ N
58	(a) $(89{,}9\ \text{N})\hat{\mathbf{i}}$; (b) $(-2{,}50\ \text{N})\hat{\mathbf{i}}$; (c) 68,3 cm; (d) 0
59	$-1{,}32 \times 10^{13}$ C
60	0
61	(a) $(0{,}829\ \text{N})\hat{\mathbf{i}}$; (b) $(-0{,}621\ \text{N})\hat{\mathbf{j}}$
62	(a) $6{,}16 \times 10^{-24}$ N; (b) 208°
63	$2{,}2 \times 10^{-6}$ kg
64	$1{,}2 \times 10^{-5}$ C
65	$4{,}68 \times 10^{-19}$ N
66	–5,1 m
67	(a) 2,72*L*; (b) 0
68	10^{18} N
69	(a) $5{,}1 \times 10^{2}$ N; (b) $7{,}7 \times 10^{28}$ m/s^2
70	0,707
71	(a) 0; (b) $3{,}43 \times 10^{9}$ 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) diminuiria
74	1,3 dia
75	$4{,}16 \times 10^{42}$

Capítulo 22

1	---
2	(a) $6{,}4 \times 10^{-18}$ N; (b) 20 N/C
3	(a) $3{,}07 \times 10^{21}$ N/C; (b) para fora
4	$(-6{,}39 \times 10^{5}\ \text{N/C})\hat{\mathrm{i}}$
5	56 pC
6	0,111 nC
7	$(1{,}02 \times 10^{5}\ \text{N/C})\hat{\mathrm{j}}$
8	0
9	(a) $1{,}38 \times 10^{-10}$ N/C; (b) 180°
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°
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) Quando o próton se aproxima do disco, a diferença entre as forças exercidas pelos elétrons diminui.
14	(a) $2{,}72L$
15	(a) 160 N/C; (b) 45°
16	(a) 67,8°; (b) –67,8°
17	(a) –90°; (b) +2,0 μC; (c) –1,6 μC
18	$qd^3/4\pi\varepsilon_0 z^5$
19	(a) $qd/4\pi\varepsilon_0 r^3$; (b) –90°
20	0,98
21	---
22	(a) $-1{,}72 \times 10^{-15}$ C/m; (b) $-3{,}82 \times 10^{-14}$ C/m^2; (c) $-9{,}56 \times 10^{-15}$ C/m^2; (d) $-1{,}43 \times 10^{-12}$ C/m^3
23	0,506
24	(a) 0; (b) 0; (c) $0{,}707R$; (d) $3{,}46 \times 10^{7}$ N/C
25	(a) $1{,}62 \times 10^{6}$ N/C; (b) –45°

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26	(a) 20,6 N/C; (b) –90°
27	(a) 23,8 N/C; (b) –90°
28	1,70 cm
29	1,57
30	–4,19Q
31	(a) $-5{,}19 \times 10^{-14}$ C/m; (b) $1{,}57 \times 10^{-3}$ N/C; (c) –180°; (d) $1{,}52 \times 10^{-8}$ N/C; (e) $1{,}52 \times 10^{-8}$ N/C
32	(a) 12,4 N/C; (b) 90°
33	---
34	$6{,}3 \times 10^{3}$ N/C
35	0,346 m
36	$2{,}4 \times 10^{-16}$ C
37	28%
38	6,9 cm
39	–5e
40	(a) 7,12 cm; (b) 28,5 ns; (c) 0,112
41	(a) $1{,}5 \times 10^{3}$ N/C; (b) $2{,}4 \times 10^{-16}$ N; (c) para cima; (d) $1{,}6 \times 10^{-26}$ N; (e) $1{,}5 \times 10^{10}$
42	(a) $4{,}8 \times 10^{-13}$ N; (b) $4{,}8 \times 10^{-13}$ N
43	$3{,}51 \times 10^{15}$ m/s^2
44	(a) $2{,}03 \times 10^{-7}$ N/C; (b) para cima
45	$6{,}6 \times 10^{-15}$ N
46	(a) $1{,}02 \times 10^{-2}$ N/C; (b) para oeste
47	(a) $1{,}92 \times 10^{12}$ m/s^2; (b) $1{,}96 \times 10^{5}$ m/s
48	(a) $1{,}16 \times 10^{16}$ m/s^2; (b) $3{,}94 \times 10^{16}$ m/s^2; (c) $3{,}97 \times 10^{16}$ m/s^2; (d) porque a resultante da força produzida pelas cargas próximas da borda do disco diminui
49	(a) 0,245 N; (b) –11,3°; (c) 108 m; (d) –21,6 m

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(*Continuação*)

50	(a) $(-2{,}1 \times 10^{13}\ \text{m/s}^2)\hat{\text{j}}$; (b) $(1{,}5 \times 10^{5}\ \text{m/s})\hat{\text{i}} - (2{,}8 \times 10^{6}\ \text{m/s})\hat{\text{j}}$
51	(a) $2{,}6 \times 10^{-10}$ N; (b) $3{,}1 \times 10^{-8}$ N; (c) salta para o estigma
52	(a) 27 km/s; (b) 50 μm
53	27 μm
54	$(1{,}53 \times 10^{6}\ \text{m/s})\hat{\text{i}} - (4{,}34 \times 10^{5}\ \text{m/s})\hat{\text{j}}$
55	(a) $2{,}7 \times 10^{6}$ 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) $2{,}05 \times 10^{-11}$ J
58	$5{,}0 \times 10^{-28}\ \text{C} \cdot \text{m}$
59	$1{,}22 \times 10^{-23}$ 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) $8{,}87 \times 10^{-15}$ N; (b) 120
64	$Q/3\pi\varepsilon_0 d^2$
65	217°
66	$3{,}6 \times 10^{2}$ N/C
67	61 N/C
68	$(1{,}08 \times 10^{-5}\ \text{N/C})\hat{\text{i}}$
69	(a) 47 N/C; (b) 27 N/C
70	$1{,}64 \times 10^{-19}$ C (≈ 2% acima do valor correto)
71	38 N/C
72	---
73	(a) –1,0 cm; (b) 0; (c) 10 pC
74	(a) 0,10 μC; (b) $1{,}3 \times 10^{17}$; (c) $5{,}0 \times 10^{-6}$
75	+1,00 μC
76	$-3{,}28 \times 10^{-21}$ J
77	(a) 6,0 mm; (b) 180°

(*Continua*)

(*Continuação*)

78	(a) $(2q/4\pi\varepsilon_0 d^2)\alpha/(1+\alpha^2)^{1,5}$; (c) 0,71; (d) 0,20 e 2,0
79	9:30
80	$6{,}88 \times 10^{-28}\,\text{C} \cdot \text{m}$
81	(a) –0,029 C; (b) porque a esfera seria desintegrada pela força de repulsão
82	5,39 N/C
83	(a) $-1{,}49 \times 10^{-26}$ J; (b) $(-1{,}98 \times 10^{-26}\,\text{N}\cdot\text{m})\hat{\text{k}}$; (c) $3{,}47 \times 10^{-26}$ J
84	(a) sim; (b) com a placa de cima; 2,72 cm
85	(a) linha de cima: 4, 8, 12; linha do meio: 5, 10, 14; linha de baixo: 7, 11, 16; (b) $1{,}63 \times 10^{-19}$ C
86	(a) 0°; (b) 9,96 pN
87	(a) $(-1{,}80\ \text{N/C})\hat{\text{i}}$; (b) $(43{,}2\ \text{N/C})\hat{\text{i}}$; (c) $(-6{,}29\ \text{N/C})\hat{\text{i}}$

Capítulo 23

1	$-0{,}015\ \text{N} \cdot \text{m}^2/\text{C}$
2	(a) $-72\ \text{N} \cdot \text{m}^2/\text{C}$; (b) $+24\ \text{N} \cdot \text{m}^2/\text{C}$; (c) $-16\ \text{N} \cdot \text{m}^2/\text{C}$; (d) 0; (e) $-48\ \text{N} \cdot \text{m}^2/\text{C}$
3	(a) 0; (b) $-3{,}92\ \text{N} \cdot \text{m}^2/\text{C}$; (c) 0; (d) 0
4	$-1{,}1 \times 10^{-4}\ \text{N} \cdot \text{m}^2/\text{C}$
5	$3{,}01\ \text{nN} \cdot \text{m}^2/\text{C}$
6	−4,3 nC
7	$2{,}0 \times 10^5\ \text{N} \cdot \text{m}^2/\text{C}$
8	(a) $-1{,}3 \times 10^{-8}\ \text{C/m}^3$; (b) $8{,}2 \times 10^{10}$ cargas/m^3
9	(a) $8{,}23\ \text{N} \cdot \text{m}^2/\text{C}$; (b) 72,9 pC; (c) $8{,}23\ \text{N} \cdot \text{m}^2/\text{C}$; (d) 72,9 pC
10	+0,213 nC
11	−1,70 nC
12	$(-2{,}8 \times 10^4\ \text{N/C})\hat{\text{i}}$
13	3,54 μC
14	(a) +1,8 μC; (b) −5,3 μC; (c) +8,9 μC
15	(a) 0; (b) 0,0417
16	$2{,}00\ \text{N/C} \cdot \text{m}$
17	(a) 37 μC; (b) $4{,}1 \times 10^6\ \text{N} \cdot \text{m}^2/\text{C}$
18	2,0 $\mu\text{C/m}^2$
19	(a) $4{,}5 \times 10^{-7}\ \text{C/m}^2$; (b) $5{,}1 \times 10^4$ N/C
20	(a) −8,0 μC; (b) +12 μC; (c) −5,3 μC
21	(a) $-3{,}0 \times 10^{-6}$ C; (b) $+1{,}3 \times 10^{-5}$ C
22	$2{,}1 \times 10^{17}\ \text{m/s}^2$
23	(a) 0,32 μC; (b) 0,14 μC
24	(a) 0; (b) $5{,}99 \times 10^3$ N/C
25	5,0 μC/m

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(*Continuação*)

26	−5,8 nC/m
27	$3{,}8 \times 10^{-8}$ C/m^2
28	(a) 0,24 kN/C; (b) −6,4 nC/m^2; (c) +3,2 nC/m^2
29	(a) 0,214 N/C; (b) para dentro; (c) 0,855 N/C; (d) para fora; (e) $-3{,}40 \times 10^{-12}$ C; (f) $-3{,}40 \times 10^{-12}$ C
30	8,0 cm
31	(a) $2{,}3 \times 10^{6}$ N/C; (b) para fora; (c) $4{,}5 \times 10^{5}$ N/C; (d) para dentro
32	(a) 1,9 N/C; (b) 3,6 N/C
33	(a) 0; (b) 0; (c) $(-7{,}91 \times 10^{-11}$ N/C)$\hat{\mathrm{i}}$
34	(0,208 N/C)$\hat{\mathrm{k}}$
35	−1,5
36	(a) $(2{,}00 \times 10^{-11}$ N/C)$\hat{\mathrm{j}}$; (b) 0; (c) $(-2{,}00 \times 10^{-11}$ N/C)$\hat{\mathrm{j}}$
37	(a) $5{,}3 \times 10^{7}$ N/C; (b) 60 N/C
38	2,9 μC/m^2
39	5,0 nC/m^2
40	(a) +69,1 cm; (b) −69,1 cm; (c) +69,1 cm
41	0,44 mm
42	$4{,}9 \times 10^{-10}$ C
43	(a) 0; (b) 1,31 μN/C; (c) 3,08 μN/C; (d) 3,08 μN/C
44	2,2 μC
45	(a) $2{,}50 \times 10^{4}$ N/C; (b) $1{,}35 \times 10^{4}$ N/C
46	(a) 0,41R; (b) 0,50R
47	−7,5 nC
48	+6,6 μC

(*Continua*)

(*Continuação*)

49	(a) 0; (b) 56,2 mN/C; (c) 112 mN/C; (d) 49,9 mN/C; (e) 0; (f) 0; (g) −5,00 fC; (h) 0
50	−3,3 cm
51	$1{,}79 \times 10^{-11}$ C/m^2
52	(a) 0; (b) 0; (c) 0; (d) 7,32 N/C; (e) 12,1 N/C; (f) 1,35 N/C
53	(a) 7,78 fC; (b) 0; (c) 5,58 mN/C; (d) 22,3 mN/C
54	1,125
55	$6K\varepsilon_0 r^3$
56	(a) 0,50 N · m^2/C; (b) 2,2 pC
57	(a) 0; (b) $2{,}88 \times 10^4$ N/C; (c) 200 N/C
58	7,1 N · m^2/C
59	(a) 5,4 N/C; (b) 6,8 N/C
60	(a) $E = \lvert\rho\rvert r/2\varepsilon_0$; (b) aumenta; (c) para o eixo; (d) 3×10^6 N/C, na superfície interna do cano; (e) sim, ao longo da superfície interna do cano
61	(a) 0; (b) $q_a/4\pi\varepsilon_0 r^2$; (c) $(q_a + q_b)/4\pi\varepsilon_0 r^2$
62	(a) $4{,}0 \times 10^6$ N/C; (b) 0
63	−1,04 nC
64	---
65	(a) 0,125; (b) 0,500
66	(a) −750 N · m^2/C; (b) −6,64 nC

(*Continua*)

(*Continuação*)

67	(a) +2,0 nC; (b) –1,2 nC; (c) +1,2 nC; (d) +0,80 nC
68	26,6 nC
69	$(5{,}65 \times 10^4\ \text{N/C})\hat{\text{j}}$
70	(a) 4,2 kN/C; (b) 2,4 kN/C
71	(a) $-2{,}53 \times 10^{-2}\ \text{N} \cdot \text{m}^2/\text{C}$; (b) $+2{,}53 \times 10^{-2}\ \text{N} \cdot \text{m}^2/\text{C}$
72	$-4{,}2 \times 10^{-10}\ \text{C}$
73	---
74	(a) 3,62 $\text{N} \cdot \text{m}^2/\text{C}$; (b) 51,1 $\text{N} \cdot \text{m}^2/\text{C}$
75	3,6 nC
76	(b) $\rho R^2/2\varepsilon_0 r$
77	(a) +4,0 μC; (b) –4,0 μC
78	(a) 15,0 N/C; (b) 25,3 N/C
79	(a) 693 kg/s; (b) 693 kg/s; (c) 347 kg/s; (d) 347 kg/s; (e) 575 kg/s
80	(a) 0,282 kN/C; (b) 0,621 kN/C
81	(a) 0,25R; (b) 2,0R

Capítulo 24

1	(a) $3{,}0 \times 10^5$ C; (b) $3{,}6 \times 10^6$ J
2	$1{,}2 \times 10^9$ eV
3	(a) $3{,}0 \times 10^{10}$ J; (b) $7{,}7 \times 10^3$ m/s
4	(a) $2{,}4 \times 10^4$ V/m; (b) 2,9 kV
5	8,8 mm
6	(a) 2,46 V; (b) 2,46 V; (c) 0
7	–32,0 V
8	(a) 30 V; (b) 40 V; (c) 5,5 m
9	(a) $1{,}87 \times 10^{-21}$ J; (b) –11,7 mV
10	2,5 kV
11	(a) –0,268 mV; (b) –0,681 mV
12	–1,1 nC
13	(a) 3,3 nC; (b) 12 nC/m^2
14	(a) –4,5 kV; (b) –4,5 kV
15	(a) 0,54 mm; (b) 790 V
16	2,21 V
17	0,562 mV
18	$-32e$
19	(a) 6,0 cm; (b) –12,0 cm
20	Nenhum
21	16,3 μV
22	$5{,}6 \times 10^{-37}$ C·m
23	(a) 24,3 mV; (b) 0
24	–6,20 V
25	(a) –2,30 V; (b) –1,78 V
26	$2{,}18 \times 10^4$ V
27	13 kV
28	7,39 mV
29	32,4 mV
30	0
31	47,1 μV

(*Continua*)

(*Continuação*)

32	(a) 36 V; (b) 18 V
33	18,6 mV
34	$6{,}7 \times 10^2$ V/m
35	$(-12\ \text{V/m})\hat{\mathbf{i}} + (12\ \text{V/m})\hat{\mathbf{j}}$
36	(a) 39 V/m; (b) para a placa 1
37	150 N/C
38	(a) $(2{,}90\ \text{mV})\ \ln(1 + (0{,}135\ \text{m})/d)$; (b) $(0{,}392\ \text{mN}\cdot\text{m}^2/\text{C})/[x(x + 0{,}135\ \text{m})]$; (c) 180°; (d) 32,1 mN/C; (e) 0
39	$(-4{,}0 \times 10^{-16}\ \text{N})\hat{\mathbf{i}} + (1{,}6 \times 10^{-16}\ \text{N})\hat{\mathbf{j}}$
40	(a) 31,6 mV; (b) 0,298 N/C
41	(a) 0,90 J; (b) 4,5 J
42	(a) $1{,}15 \times 10^{-19}$ J; (b) diminui
43	–0,192 pJ
44	$2{,}1 \times 10^{-25}$ J
45	2,5 km/s
46	$1{,}8 \times 10^{-10}$ J
47	22 km/s
48	$6{,}63 \times 10^6$ m/s
49	0,32 km/s
50	0
51	(a) $+6{,}0 \times 10^4$ V; (b) $-7{,}8 \times 10^5$ V; (c) 2,5 J; (d) aumentar; (e) igual; (f) igual
52	$4{,}5 \times 10^{-12}\ \text{C} \cdot \text{m}$
53	(a) 0,225 J; (b) *A* 45,0 m/s², *B* 22,5 m/s²; (c) *A* 7,75 m/s, *B* 3,87 m/s
54	(a) 0; (b) $1{,}0 \times 10^7$ m/s
55	$1{,}6 \times 10^{-9}$ m
56	$-5{,}7\ \mu$C
57	(a) 3,0 J; (b) –8,5 m

(*Continua*)

(*Continuação*)

58	(a) 1,7 cm; (b) 20 km/s; (c) $4{,}8 \times 10^{-17}$ N; (d) sentido positivo; (e) $3{,}2 \times 10^{-17}$ N; (f) sentido negativo
59	(a) um próton; (b) 65,3 km/s
60	(a) −12,0 μC; (b) +0,216 pJ
61	(a) 12; (b) 2
62	(a) igual; (b) 0,333; (c) 0,667; (d) 2,00
63	(a) $-1{,}8 \times 10^{2}$ V; (b) 2,9 kV; (c) −8,9 kV
64	400 V
65	$2{,}5 \times 10^{-8}$ C
66	(a) 1,69 kV/m; (b) 36,7 kV/m; (c) 0; (d) 6,74 kV; (e) 27,0 kV; (f) 34,7 kV; (g) 45,0 kV; (h) 45,0 kV; (i) 45,0 kV
67	(a) 12 kN/C; (b) 1,8 kV; (c) 5,8 cm
68	−1,93 J
69	(a) 64 N/C; (b) 2,9 V; (c) 0
70	(a) $V = \rho(R^2 - r^2)/4\varepsilon_0$; (b) 78 kV
71	$p/2\pi\varepsilon_0 r^3$
72	$(2{,}9 \times 10^{-2}\ \text{m}^{-3})A$
73	(a) $3{,}6 \times 10^{5}$ V; (b) não
74	(a) −24 J; (b) 0
75	$6{,}4 \times 10^{8}$ V
76	$3{,}71 \times 10^{4}$ V
77	2,90 kV

(*Continua*)

(*Continuação*)

78	0,956 V
79	$7{,}0 \times 10^5$ m/s
80	10,3 mV
81	(a) 1,8 cm; (b) $8{,}4 \times 10^5$ m/s; (c) $2{,}1 \times 10^{-17}$ N; (d) positivo; (e) $1{,}6 \times 10^{-17}$ N; (f) negativo
82	(a) –0,12 V; (b) $1{,}8 \times 10^{-8}$ N/C; (c) para baixo
83	(a) $+7{,}19 \times 10^{-10}$ V; (b) $+2{,}30 \times 10^{-28}$ J; (c) $+2{,}43 \times 10^{-29}$ J
84	(a) 3,6 kV; (b) 3,6 kV
85	$2{,}30 \times 10^{-28}$ J
86	240 kV
87	2,1 dias
88	(a) 2,5 MV; (b) 5,1 J; (c) 6,9 J
89	$2{,}30 \times 10^{-22}$ J
90	$(qQ/8\pi\varepsilon_0)(1/r_1 - 1/r_2)$
91	$1{,}48 \times 10^7$ m/s
92	0,334 mV
93	–1,92 MV
94	(a) esférica, centro em q, raio 4,5 m; (b) não
95	(a) $Q/4\pi\varepsilon_0 r$; (b) $(\rho/3\varepsilon_0)(1{,}5r_2^2 - 0{,}50r^2 - r_1^3 r^{-1})$, $\rho = Q/[(4\pi/3)(r_2^3 - r_1^3)]$; (c) $(\rho/2\varepsilon_0)(r_2^2 - r_1^2)$, com ρ como em (b); (d) sim
96	(a) $q(3R^2 - r^2)/8\pi\varepsilon_0 R^3$; (b) $q/8\pi\varepsilon_0 R$
97	(a) 38 s; (b) 280 dias
98	(a) 749 kV; (b) 0; (c) 20 μC
99	---
100	$8{,}8 \times 10^{-14}$ m
101	(a) 0,484 MeV; (b) 0
102	843 V
103	–1,7

Capítulo 25

1	(a) 3,5 pF; (b) 3,5 pF; (c) 57 V
2	3,0 mC
3	(a) 144 pF; (b) 17,3 nC
4	(a) 84,5 pF; (b) 191 cm^2
5	0,280 pF
6	(a) $8{,}85 \times 10^{-12}$ m
7	$6{,}79 \times 10^{-4}$ F/m^2
8	$9{,}09 \times 10^{3}$
9	315 mC
10	7,33 μF
11	3,16 μF
12	(a) 60 μC; (b) 60 μC
13	43 pF
14	(a) 100 μC; (b) 20,0 μC
15	(a) 3,00 μF; (b) 60,0 μC; (c) 10,0 V; (d) 30,0 μC; (e) 10,0 V; (f) 20,0 μC; (g) 5,00 V; (h) 20,0 μC
16	12 μC
17	(a) 789 μC; (b) 78,9 V
18	(a) 2,0 μF; (b) 0,80 μF
19	(a) 4,0 μF; (b) 2,0 μF
20	2,28 pF
21	(a) 50 V; (b) $5{,}0 \times 10^{-5}$ C; (c) $1{,}5 \times 10^{-4}$ C
22	20 μC
23	(a) $4{,}5 \times 10^{14}$; (b) $1{,}5 \times 10^{14}$; (c) $3{,}0 \times 10^{14}$; (d) $4{,}5 \times 10^{14}$; (e) para cima; (f) para cima

(*Continua*)

(*Continuação*)

24	(a) $2{,}0 \times 10^7$; (b) na direção do capacitor 1
25	3,6 pC
26	(a) 10 V; (b) 8,0 μF; (c) 2,0 μF
27	(a) 9,00 μC; (b) 16,0 μC; (c) 9,00 μC; (d) 16,0 μC; (e) 8,40 μC; (f) 16,8 μC; (g) 10,8 μC; (h) 14,4 μC
28	(a) 32,0 μC; (b) 16,0 μC; (c) 16,0 μC
29	72 F
30	99,6 nJ
31	0,27 J
32	(a) 35 pF; (b) 21 nC; (c) 6,3 μJ; (d) 0,60 MV/m; (e) 1,6 J/m^3
33	0,11 J/m^3
34	(a) 400 μC; (b) 100 V; (c) 20,0 mJ; (d) 333 μC; (e) 33,3 V; (f) 5,55 mJ; (g) 333 μC; (h) 66,7 V; (i) 11,1 mJ
35	(a) $9{,}16 \times 10^{-18}$ J/m^3; (b) $9{,}16 \times 10^{-6}$ J/m^3; (c) $9{,}16 \times 10^{6}$ J/m^3; (d) $9{,}16 \times 10^{18}$ J/m^3; (e) ∞
36	(a) –0,50 μC; (b) 3,6 mJ; (c) não
37	(a) 16,0 V; (b) 45,1 pJ; (c) 120 pJ; (d) 75,2 pJ

(*Continua*)

(*Continuação*)

38	(a) 750 μC; (b) 50,0 V; (c) 18,8 mJ; (d) 500 μC; (e) 50,0 V; (f) 12,5 mJ; (g) 250 μC; (h) 50,0 V; (i) 6,25 mJ
39	(a) 190 V; (b) 95 mJ
40	4,0
41	81 pF/m
42	(a) 6,2 cm; (b) 0,28 nF
43	Pyrex
44	(a) 0,73 nF; (b) 28 kV
45	66 μJ
46	1,06 nC
47	0,63 m^2
48	8,41 pF
49	17,3 pF
50	45,5 pF
51	(a) 10 kV/m; (b) 5,0 nC; (c) 4,1 nC
52	(a) 13,4 pF; (b) 1,15 nC; (c) $1{,}13 \times 10^4$ N/C; (d) $4{,}33 \times 10^3$ N/C
53	(a) 89 pF; (b) 0,12 nF; (c) 11 nC; (d) 11 nC; (e) 10 kV/m; (f) 2,1 kV/m; (g) 88 V; (h) –0,17 μJ
54	(a) 7,2; (b) 0,77 μC
55	(a) 0,107 nF; (b) 7,79 nC; (c) 7,45 nC
56	(a) 100 μC; (b) 20,0 μC
57	45 μC

(*Continua*)

(*Continuação*)

58	(a) 41 μF; (b) 42 μF
59	16 μC
60	(a) 4,9 mJ; (b) não
61	(a) 7,20 μC; (b) 18,0 μC; (c) A bateria fornece carga apenas às placas às quais está ligada; a carga das outras placas se deve apenas à transferência de elétrons de uma placa para outra de acordo com a nova distribuição de tensões pelos capacitores. Assim, a bateria não fornece carga diretamente ao capacitor 4.
62	(a) 2,0 μF; (b) 6,0 μF
63	(a) 10 μC; (b) 20 μC
64	(a) 36 μC; (b) 12 μC
65	1,06 nC
66	---
67	(a) 2,40 μF; (b) 0,480 mC; (c) 80 V; (d) 0,480 mC; (e) 120 V
68	(a) 10,0 μF; (b) 1,20 mC; (c) 200 V; (d) 0,800 mC; (e) 200 V
69	4,9%
70	(a) 0,708 pF; (b) 1,67; (c) –5,44 J; (d) atraída
71	(a) 0,708 pF; (b) 0,600; (c) $1{,}02 \times 10^{-9}$ J; (d) atraída
72	(a) 0,480 mC; (b) 240 V; (c) 0,480 mC; (d) 60,0 V; (e) 0,192 mC; (f) 96,0 V; (g) 0,768 mC; (h) 96,0 V; (i) 0; (j) 0; (k) 0; (l) 0

(*Continua*)

(*Continuação*)

73	5,3 V
74	Mica
75	40 μF
76	4
77	(a) 200 kV/m; (b) 200 kV/m; (c) 1,77 μC/m^2; (d) 4,60 μC/m^2; (e) –2,83 μC/m^2
78	(a) cinco capacitores em série; (b) uma possível resposta: três ramos em paralelo, cada ramo com cinco capacitores em série
79	(a) $q^2/2\varepsilon_0 A$
80	(a) 2,00 J; (b) Quando metade da carga é transferida para o segundo capacitor, parte da energia armazenada no primeiro capacitor é dissipada na resistência dos fios usados para ligar os capacitores, e parte é irradiada na forma de ondas eletromagnéticas.

Capítulo 26

1	(a) 1,2 kC; (b) $7,5 \times 10^{21}$
2	5,6 ms
3	6,7 μC/m^2
4	14
5	(a) 6,4 A/m^2; (b) norte; (c) a área da seção reta
6	(a) sim; (b) $4,0 \times 10^2$ A/m^2
7	0,38 mm
8	(a) $2,4 \times 10^{-5}$ A/m^2; (b) $1,8 \times 10^{-15}$ m/s
9	18,1 μA
10	2,59 mA
11	(a) 1,33 A; (b) 0,666 A; (c) J_a
12	(a) 0,654 μA/m^2; (b) 83,4 MA
13	13 min
14	100 V
15	2,4 Ω
16	(a) $5,32 \times 10^5$ A/m^2; (b) 1,01 kg/m; (c) $3,27 \times 10^5$ A/m^2; (d) 0,495 kg/m
17	$2,0 \times 10^6$ $(\Omega \cdot m)^{-1}$
18	(a) 1,53 kA; (b) 54,1 MA/m^2; (c) $10,6 \times 10^{-8}$ $\Omega \cdot$ m; (d) platina
19	$2,0 \times 10^{-8}$ $\Omega \cdot$ m
20	$2R$
21	$(1,8 \times 10^3)$°C
22	9,42 mA
23	$8,2 \times 10^{-4}$ $\Omega \cdot$ m
24	(a) 1,55 mm; (b) 1,22 mm
25	54 Ω
26	(a) $6,00 \times 10^7$ $(\Omega \cdot m)^{-1}$; (b) $7,50 \times 10^6$ $(\Omega \cdot m)^{-1}$
27	3,0
28	3,0 mA
29	$3,35 \times 10^{-7}$ C
30	0,40 Ω

(*Continua*)

(*Continuação*)

31	(a) 6,00 mA; (b) $1,59 \times 10^{-8}$ V; (c) 21,2 nΩ
32	(a) 3,24 pA/m^2; (b) 1,73 cm/s
33	(a) 38,3 mA; (b) 109 A/m^2; (c) 1,28 cm/s; (d) 227 V/m
34	$5,44 \times 10^{-9}$ m/s
35	981 kΩ
36	52 mA
37	---
38	0,10 V
39	150 s
40	11,1 Ω
41	(a) 1,0 kW; (b) $ 0,25
42	(a) para cima; (b) 12 eV; (c) 12 eV
43	0,135 W
44	14 kC
45	(a) 10,9 A; (b) 10,6 Ω; (c) 4,50 MJ
46	(a) 16,9 mV/m; (b) 243 J
47	(a) 5,85 m; (b) 10,4 m
48	13,0 A
49	(a) $ 4,46; (b) 144 Ω; (c) 0,833 A
50	12 mW
51	(a) 5,1 V; (b) 10 V; (c) 10 W; (d) 20 W
52	756 kJ
53	(a) 28,8 Ω; (b) $2,60 \times 10^{19}$ s^{-1}
54	0,224 m
55	660 W
56	(a) 1,74 A; (b) 2,15 MA/m^2; (c) 36,3 mV/m; (d) 2,09 W

(*Continua*)

(*Continuação*)

57	28,8 kC
58	(a) 1,3 mΩ; (b) 4,6 mm
59	(a) prata; (b) 51,6 nΩ
60	(a) $\rho\pi R^2 v$; (b) 17 μA; (c) não, porque a corrente é perpendicular à diferença de potencial radial; (d) 1,3 W; (e) 0,27 J; (f) na entrada do silo
61	(a) $2{,}3 \times 10^{12}$; (b) $5{,}0 \times 10^{3}$; (c) 10 MV
62	13,3 Ω
63	2,4 kW
64	(a) $1{,}3 \times 10^{5}$ A/m^2; (b) 94 mV
65	(a) 1,37; (b) 0,730
66	0,20 hp
67	(a) –8,6%; (b) menor
68	57°C
69	146 kJ
70	(a) 0,38 mV; (b) negativa; (c) 3 min 58 s
71	(a) 250°C; (b) sim
72	0,536 Ω
73	$3{,}0 \times 10^{6}$ J/kg
74	$3{,}4 \times 10^{4}$ s
75	560 W
76	(a) 0,67 A; (b) do eletrodo positivo para o eletrodo negativo
77	0,27 m/s
78	$6{,}7 \times 10^{-6}$ C/m^2
79	(a) 10 A/cm^2; (b) para leste
80	(a) 0,0017%; (b) 0,0034%; (c) 0,43%
81	(a) $9{,}4 \times 10^{13}$ s^{-1}; (b) $2{,}40 \times 10^{2}$ W

(*Continua*)

(*Continuação*)

82	(a) $3{,}1 \times 10^{11}$; (b) 25 μA; (c) 25 MW; (d) 1,3 kW
83	113 min
84	(a) 35 min; (b) 1,96 h
85	(a) 225 μC; (b) 60,0 μA; (c) 0,450 mW

Capítulo 27

1	(a) 0,50 A; (b) 1,0 W; (c) 2,0 W; (d) 6,0 W; (e) 3,0 W; (f) fornecendo; (g) recebendo
2	–10 V
3	(a) 14 V; (b) $1,0 \times 10^2$ W; (c) $6,0 \times 10^2$ W; (d) 10 V; (e) $1,0 \times 10^2$ W
4	(a) 80 Ω; (b) 200 Ω
5	11 kJ
6	(a) $\$ 3,2 \times 10^2$; (b) $ 0,048
7	(a) 80 J; (b) 67 J; (c) 13 J
8	14,4 h
9	(a) 12,0 eV; (b) 6,53 W
10	(a) $9,9 \times 10^2$ Ω; (b) $9,9 \times 10^{-4}$ W
11	(a) 50 V; (b) 48 V; (c) negativo
12	(a) 12,0 V; (b) 2,15 mV; (c) 24,0 W; (d) 4,30 mW
13	(a) 6,9 km; (b) 20 Ω
14	(a) 0,20 Ω; (b) 0,30 Ω
15	8,0 Ω
16	(a) 1,0 kΩ; (b) 0,30 V; (c) 0,23%
17	(a) 0,004 Ω; (b) 1
18	0,25 V
19	(a) 4,00 Ω; (b) em paralelo

(*Continua*)

(*Continuação*)

20	(a) 4,0 Ω; (b) 12 Ω
21	5,56 A
22	(a) 2,50 Ω; (b) 3,13 Ω
23	(a) 50 mA; (b) 60 mA; (c) 9,0 V
24	4,50 Ω
25	$3d$
26	$\frac{100R(\varepsilon x/R_0)^2}{(100R/R + 10x - x^2)^2}$, com x em cm
27	$3{,}6 \times 10^3$ A
28	0,82 mA
29	(a) 0,333 A; (b) para a direita; (c) 720 J
30	(a) 0; (b) 1,25 A
31	(a) –11 V; (b) –9,0 V
32	(a) 6,0 V; (b) 20 Ω; (c) 40 Ω
33	48,3 V
34	(a) nenhuma; (b) –2,0 V
35	(a) 5,25 V; (b) 1,50 V; (c) 5,25 V; (d) 6,75 V
36	(a) 38,2 mA; (b) para baixo; (c) 10,9 mA; (d) para a direita; (e) 27,3 mA; (f) para a esquerda; (g) +3,82 V
37	1,43 Ω
38	(a) cedendo; (b) $3{,}6 \times 10^2$ W
39	(a) 0,150 Ω; (b) 240 W
40	(a) 24,0 A; (b) 30,0 A; (c) em série; (d) 60,0 A; (e) 48,0 A; (f) em paralelo

(*Continua*)

(*Continuação*)

41	(a) 0,709 W; (b) 0,050 W; (c) 0,346 W; (d) 1,26 W; (e) –0,158 W
42	8
43	9
44	(a) 119 Ω; (b) 50,5 mA; (c) 19,0 mA; (d) 19,0 mA; (e) 12,5 mA
45	(a) 0,67 A; (b) para baixo; (c) 0,33 A; (d) para cima; (e) 0,33 A; (f) para cima; (g) 3,3 V
46	(a) 2,0 kΩ; (b) 4,0 kΩ
47	(a) 1,11 A; (b) 0,893 A; (c) 126 m
48	(a) 19,5 Ω; (b) 0; (c) ∞; (d) 82,3 W; (e) 57,6 W
49	(a) 0,45 A
50	0,143
51	(a) 55,2 mA; (b) 4,86 V; (c) 88,0 Ω; (d) diminui
52	(a) 13,5 kΩ; (b) 1,50 kΩ; (c) 167 Ω; (d) 1,48 kΩ
53	–3,0%
54	(a) 12,5 V; (b) 50,0 A
55	---
56	(a) 70,9 mA; (b) 4,70 V; (c) 66,3 Ω; (d) diminui
57	0,208 ms

(*Continua*)

(*Continuação*)

58	(a) 2,52 s; (b) 21,6 μC; (c) 3,40 s
59	4,61
60	(a) 0,41; (b) 1,1
61	(a) 2,41 μs; (b) 161 pF
62	2,35 MΩ
63	(a) 1,1 mA; (b) 0,55 mA; (c) 0,55 mA; (d) 0,82 mA; (e) 0,82 mA; (f) 0; (g) $4{,}0 \times 10^2$ V; (h) $6{,}0 \times 10^2$ V
64	(a) 2,17 s; (b) 39,6 mV
65	411 μA
66	162 μs
67	0,72 MΩ
68	(a) $1{,}0 \times 10^{-3}$ C; (b) $1{,}0 \times 10^{-3}$ A; (c) $(1{,}0 \times 10^3\,\text{V})e^{-t}$; (d) $(1{,}0 \times 10^3\,\text{V})e^{-t}$; (e) e^{-2t} W
69	(a) 0,955 μC/s; (b) 1,08 μW; (c) 2,74 μW; (d) 3,82 μW
70	(a) 6,0 A; (b) 8,0 V; (c) 60 W; (d) 36 W
71	(a) 3,00 A; (b) 3,75 A; (c) 3,94 A
72	(a) 3,0 A; (b) 10 A; (c) 13 A; (d) 1,5 A; (e) 7,5 A
73	(a) $1{,}32 \times 10^7$ A/m^2; (b) 8,90 V; (c) cobre; (d) $1{,}32 \times 10^7$ A/m^2; (e) 51,1 V; (f) ferro

(*Continua*)

(*Continuação*)

74	(a) 4,0 A; (b) para cima
75	(a) 3,0 kV; (b) 10 s; (c) 11 GΩ
76	(a) 5,00 A; (b) para a esquerda; (c) fornece; (d) 100 W; (e) fornece; (f) 50,0 W; (g) fornece; (h) 56,3 W
77	(a) 85,0 Ω; (b) 915 Ω
78	0,90%
79	---
80	250 μJ
81	4,0 V
82	2,5 V
83	(a) 24,8 Ω; (b) 14,9 kΩ
84	(a) 80 mA; (b) 0,13 A; (c) 0,40 A
85	o cabo
86	(a) 38 Ω; (b) 260 Ω
87	–13 μC
88	13,3 Ω
89	20 Ω
90	---
91	(a) 3,00 A; (b) para baixo; (c) 1,60 A; (d) para baixo; (e) fornece; (f) 55,2 W; (g) fornece; (h) 6,40 W
92	2,00 A
93	(a) 1,0 V; (b) 50 mΩ
94	(a) 6,67 Ω; (b) 6,67 Ω; (c) 0
95	3
96	2,5 A

(*Continua*)

(*Continuação*)

97	---
98	(a) 0; (b) 14,4 W
99	(a) 1,5 mA; (b) 0; (c) 1,0 mA
100	(a) 7,50 A; (b) da direita para a esquerda; (c) 10,0 A; (d) da direita para a esquerda; (e) 87,5 W; (f) A fonte A está fornecendo energia ao circuito.
101	7,50 V
102	(a) $V_T = \mathcal{E} - ir$; (b) 13,6 V; (c) 0,060 Ω
103	(a) 60,0 mA; (b) para baixo; (c) 180 mA; (d) da direita para a esquerda; (e) 240 mA; (f) de baixo para cima
104	(a) A posição de menor luminosidade corresponde à ligação com a maior resistência (R_1), a posição de luminosidade intermediária corresponde à ligação com a menor resistência (R_2), e a posição de maior luminosidade corresponde à ligação com R_1 e R_2 em paralelo. (b) 72 Ω; (c) 144 Ω
105	(a) 4,0 A; (b) de baixo para cima; (c) 0,50 A; (d) de cima para baixo; (e) 64 W; (f) 16 W; (g) fornecendo energia; (h) absorvendo energia

Capítulo 28

1	(a) 400 km/s; (b) 835 eV
2	$-61\hat{k}$ mT
3	(a) $(6{,}2 \times 10^{-14}\ \text{N})\hat{k}$; (b) $(-6{,}2 \times 10^{-14}\ \text{N})\hat{k}$
4	(a) $6{,}2 \times 10^{-18}$ N; (b) $9{,}5 \times 10^{8}$ m/s^2; (c) permanece constante
5	–2,0 T
6	(a) –3,5 km/s; (b) 7,0 km/s
7	$(-11{,}4\ \text{V/m})\hat{i} - (6{,}00\ \text{V/m})\hat{j} + (4{,}80\ \text{V/m})\hat{k}$
8	3,75 km/s
9	$-(0{,}267\ \text{mT})\hat{k}$
10	(a) $(1{,}44 \times 10^{-18}\ \text{N})\hat{k}$; (b) $(1{,}60 \times 10^{-19}\ \text{N})\hat{k}$; (c) $(6{,}41 \times 10^{-19}\ \text{N})\hat{i} + (8{,}01 \times 10^{-19}\ \text{N})\hat{k}$
11	0,68 MV/m
12	(a) 1,25 V/m; (b) $(25{,}0\ \text{mT})\hat{k}$
13	7,4 μV
14	38,2 cm/s
15	(a) $(-600\ \text{mV/m})\hat{k}$; (b) 1,20 V
16	(a) 25 cm; (b) 30 cm; (c) 20 cm
17	(a) $2{,}60 \times 10^{6}$ m/s; (b) 0,109 μs; (c) 0,140 MeV; (d) 70,0 kV
18	(a) $4{,}99 \times 10^{6}$ m/s; (b) 7,10 mm; (c) 8,93 ns
19	$1{,}2 \times 10^{-9}$ kg/C
20	$6{,}7 \times 10^{-2}$ T
21	(a) $2{,}05 \times 10^{7}$ m/s; (b) 467 μT; (c) 13,1 MHz; (d) 76,3 ns
22	(a) 1,0 MeV; (b) 0,50 MeV
23	21,1 μT
24	(a) $1{,}11 \times 10^{7}$ m/s; (b) 0,316 mm

(*Continua*)

(*Continuação*)

25	(a) 0,978 MHz; (b) 96,4 cm
26	(a) 0,252 T; (b) 130 ns
27	(a) 495 mT; (b) 22,7 mA; (c) 8,17 MJ
28	$2{,}09 \times 10^{-22}$ J
29	65,3 km/s
30	8,7 ns
31	5,07 ns
32	0,53 m
33	(a) 0,358 ns; (b) 0,166 mm; (c) 1,51 mm
34	(a) 84°; (b) não; (c) não; (d) 5,7 nm
35	(a) 200 eV; (b) 20,0 keV; (c) 0,499%
36	(a) 0,787 T; (b) 8,34 MeV; (c) 23,9 MHz; (d) 33,2 MeV
37	$2{,}4 \times 10^{2}$ m
38	(a) 18,3 MHz; (b) 17,2 MeV
39	(a) 28,2 N; (b) horizontal, para oeste
40	20,1 N
41	(a) 467 mA; (b) para a direita
42	(a) $-16\hat{\mathrm{j}}$ N; (b) 0
43	(a) 0; (b) 0,138 N; (c) 0,138 N; (d) 0
44	0,60 μN
45	$(-2{,}50\ \mathrm{mN})\hat{\mathrm{j}} + (0{,}750\ \mathrm{mN})\hat{\mathrm{k}}$
46	(a) 3,34 cm/s; (b) para a esquerda
47	(a) 0,10 T; (b) 31°
48	$(-0{,}35\hat{\mathrm{k}})$ N

(*Continua*)

(*Continuação*)

49	$(-4{,}3 \times 10^{-3}\ \text{N} \cdot \text{m})\hat{\text{j}}$
50	$6{,}58 \times 10^{-26}\ \text{N} \cdot \text{m}$
51	2,45 A
52	3,0 mA
53	---
54	(a) 77°; (b) 77°
55	(a) $2{,}86\ \text{A} \cdot \text{m}^2$; (b) $1{,}10\ \text{A} \cdot \text{m}^2$
56	(a) $0{,}184\ \text{A} \cdot \text{m}^2$; (b) $1{,}45\ \text{N} \cdot \text{m}$
57	(a) 12,7 A; (b) $0{,}0805\ \text{N} \cdot \text{m}$
58	2,08 GA
59	(a) $0{,}30\ \text{A} \cdot \text{m}^2$; (b) $0{,}024\ \text{N} \cdot \text{m}$
60	$(0{,}150\ \hat{\text{j}} - 0{,}300\ \hat{\text{k}})\ \text{A} \cdot \text{m}^2$
61	(a) $-72{,}0\ \mu\text{J}$; (b) $(96{,}0\ \hat{\text{i}} + 48{,}0\ \hat{\text{k}})\ \mu\text{N} \cdot \text{m}$
62	$4{,}8 \times 10^{-5}\ \text{A} \cdot \text{m}^2$
63	(a) $-(9{,}7 \times 10^{-4}\ \text{N} \cdot \text{m})\ \hat{\text{i}} - (7{,}2 \times 10^{-4}\ \text{N} \cdot \text{m})\hat{\text{j}} + (8{,}0 \times 10^{-4}\ \text{N} \cdot \text{m})\hat{\text{k}}$; (b) $-6{,}0 \times 10^{-4}\ \text{J}$
64	110°
65	(a) 90°; (b) 1; (c) $1{,}28 \times 10^{-7}\ \text{N} \cdot \text{m}$
66	$\vec{v} = v_{0x}\ \hat{\text{i}} + v_{0y} \cos(\mu t)\ \hat{\text{j}} - v_{0y}\ \text{sen}(\mu t)\hat{\text{k}}$, em que $\omega = eB/m$
67	(a) 20 min; (b) $5{,}9 \times 10^{-2}\ \text{N} \cdot \text{m}$
68	$(18{,}8\ \mu\text{N})\hat{\text{k}}$
69	8,2 mm
70	$(-0{,}34\ \text{mT})\hat{\text{k}}$
71	127 u
72	(b) para fora do papel
73	(a) $6{,}3 \times 10^{14}\ \text{m/s}^2$; (b) 3,0 mm
74	$(-3{,}0\hat{\text{i}} - 3{,}0\ \hat{\text{j}} - 4{,}0\ \hat{\text{k}})\ \text{T}$
75	(a) 1,4; (b) 1,0
76	---
77	$(-500\ \text{V/m})\ \hat{\text{j}}$
78	(b) $2{,}84 \times 10^{-3}$
79	(a) 0,50; (b) 0,50; (c) 14 cm; (d) 14 cm

(*Continua*)

(*Continuação*)

80	(a) $9{,}56 \times 10^{-14}$ N; (b) 0; (c) 0,267°
81	$(0{,}80\,\hat{j} - 1{,}1\,\hat{k})$ mN
82	(a) 0,67 mm/s; (b) $2{,}8 \times 10^{29}\ m^{-3}$
83	–40 mC
84	$(-0{,}600\ N)\hat{k}$
85	(a) $(12{,}8\hat{i} + 6{,}41\hat{j}) \times 10^{-22}$ N; (b) 90°; (c) 173°
86	(a) 3,8 mm; (b) 19 mm; (c) no sentido horário
87	(a) para cima; (b) perto da borda; (c) 47,1 V; (d) 47,1 V; (e) 2,36 kW
88	3,8 C
89	$(2\,mV/2ed^2)^{0,5}$
90	$qvrB/2$
91	$n = JB/eE$
92	$(0{,}75\ T)\hat{k}$

Capítulo 29

1	(a) 3,3 μT; (b) sim
2	3,0 μT
3	(a) 16 A; (b) leste
4	0
5	(a) 1,0 mT; (b) para fora; (c) 0,80 mT; (d) para fora
6	(a) 0; (b) 3,82 cm
7	(a) 0,102 μT; (b) para fora
8	(a) 1,67 μT; (b) para dentro
9	(a) opostos; (b) 30 A
10	(a) 0,118 μT; (b) para dentro
11	(a) 4,3 A; (b) para fora
12	(a) 4,0 cm; (b) permanece onde está
13	50,3 nT
14	14,1
15	(a) 1,7 μT; (b) para dentro do papel; (c) 6,7 μT; (d) para dentro do papel
16	144°
17	132 nT
18	2,00 cm
19	5,0 μT
20	(a) (253 nT)$\hat{k}$; (b) (192 nT)$\hat{i}$ + (61,2 nT)$\hat{k}$
21	256 nT
22	(a) 30 cm; (b) 2,0 nT; (c) para fora; (d) para dentro
23	$(-7{,}75 \times 10^{-23}\ \text{N})\hat{i}$
24	(a) –7,0 cm; (b) 7,0 cm
25	2,00 rad
26	1,8 rad
27	61,3 mA

(*Continua*)

(*Continuação*)

28	1,0 rad
29	$(80\ \mu\text{T})\hat{j}$
30	(a) –90°; (b) 4,0 A; (c) para fora; (d) 2,0 A; (e) para dentro
31	(a) 20 μT; (b) para dentro
32	2,3 cm
33	$(22{,}3\ \text{pT})\hat{j}$
34	104°
35	88,4 pN/m
36	(a) $(469\ \mu\text{N})\hat{j}$; (b) $(188\ \mu\text{N})\hat{j}$; (c) 0; (d) $(-188\ \mu\text{N})\hat{j}$; (e) $(-469\ \mu\text{N})\hat{j}$
37	$(-125\ \mu\text{N/m})\hat{i} + (41{,}7\ \mu\text{N/m})\hat{j}$
38	(a) 0,50 A; (b) para fora
39	800 nN/m
40	$(0{,}794\ \text{mN/m})\hat{i} + (-0{,}794\ \text{mN/m})\hat{j}$
41	$(3{,}20\ \text{mN})\hat{j}$
42	$4{,}5 \times 10^{-6}\ \text{T} \cdot \text{m}$
43	(a) 0; (b) 0,850 mT; (c) 1,70 mT; (d) 0,850 mT
44	(a) –2,5 μT · m; (b) –16 μT · m
45	(a) –2,5 μT · m; (b) 0
46	+28,3 nT · m
47	(a) 0; (b) 0,10 μT; (c) 0,40 μT
48	(a) 3,00 mA; (b) para dentro
49	(a) 533 μT; (b) 400 μT
50	5,71 mT
51	0,30 mT
52	108 m
53	0,272 A
54	$1{,}6 \times 10^{6}$ rev

(*Continua*)

(*Continuação*)

55	(a) 4,77 cm; (b) 35,5 μT
56	8,78 μT
57	(a) 2,4 A · m^2; (b) 46 cm
58	(a) 4,0; (b) 0,50
59	0,47 A · m^2
60	(a) 0,90 A; (b) 2,7 A
61	(a) 79 μT; (b) $1{,}1 \times 10^{-6}$ N · m
62	(a) 0,497 μT; (b) para dentro; (c) 1,06 mA · m^2; (d) para dentro
63	(a) (0,060 A · m^2)$\hat{j}$; (b) (96 pT)$\hat{j}$
64	(a) 27,5 nT; (b) para dentro
65	1,28 mm
66	(a) (−52,0 μT)$\hat{k}$; (b) 8,13 cm; (c) 17,5 cm
67	---
68	(a) $3{,}2 \times 10^{-16}$ N; (b) $3{,}2 \times 10^{-16}$ N; (c) 0
69	(a) 15 A; (b) $-z$
70	157 nT
71	7,7 mT
72	(a) 5,0 mA; (b) para baixo
73	(a) 15,3 μT
74	32,1 A
75	(a) (0,24$\hat{i}$) nT; (b) 0; (c) (−43$\hat{k}$)pT; (d) (0,14$\hat{k}$)nT
76	(a) (−400 μT)$\hat{i}$; (b) (400 μT)$\hat{j}$
77	---
78	4,0 mm
79	(a) 4,8 mT; (b) 0,93 mT; (c) 0

(*Continua*)

(*Continuação*)

80	5,3 mm
81	---
82	$(1{,}25\ \mu\text{T})\hat{\text{i}}$
83	$(-0{,}20\ \text{mT})\ \hat{\text{k}}$
84	(a) 0,17 mN; (b) 0,021 mN
85	---
86	---
87	(a) $\mu_0 ir/2\pi c^2$; (b) $\mu_0 i/2\pi r$; (c) $\mu_0 i(a^2 - r^2)/2\pi(a^2 - b^2)r$; (d) 0
88	(b) 2,3 km/s

Capítulo 30

1	0
2	0,452 V
3	30 mA
4	(a) −11 mV; (b) 0; (c) 11 mV
5	0
6	$8{,}0 \times 10^{-3}$ T/s
7	(a) 31 mV; (b) para a esquerda
8	1,4 T/s
9	0,198 mV
10	(a) 51 mV; (b) horário
11	(b) 0,796 m^2
12	(a) 0; (b) nenhum; (c) 6,00 mV; (d) horário; (e) 1,00 mV; (f) horário; (g) 0; (h) nenhum; (i) 0; (j) nenhum
13	29,5 mC
14	1,2 mΩ
15	(a) 21,7 V; (b) anti-horário
16	(a) 8,0 μA; (b) anti-horário
17	(a) $1{,}26 \times 10^{-4}$ T; (b) 0; (c) $1{,}26 \times 10^{-4}$ T; (d) sim; (e) $5{,}04 \times 10^{-8}$ V
18	(a) 85,2 Wb; (b) 56,8 V; (c) 1
19	5,50 kV
20	15,5 μC
21	(a) 40 Hz; (b) 3,2 mV
22	18 mV
23	(a) $\mu_0 i R^2 \pi r^2 / 2x^3$; (b) $3\mu_0 i \pi R^2 r^2 v / 2x^4$; (c) anti-horário

(*Continua*)

(*Continuação*)

24	(a) 24 μV; (b) de *c* para *b*
25	(a) 13 μWb/m; (b) 17%; (c) 0
26	(a) 0,598 μV; (b) anti-horário
27	(a) 80 μV; (b) horário
28	(a) 14 nWb; (b) 10 μA
29	(a) 48,1 mV; (b) 2,67 mA; (c) 0,129 mW
30	1,0 mΩ
31	3,68 μW
32	750 pJ
33	(a) 240 μV; (b) 0,600 mA; (c) 0,144 μW; (d) $2{,}87 \times 10^{-8}$ N; (e) 0,144 μW
34	$v_t = mgR/B^2L^2$
35	(a) 0,60 V; (b) para cima; (c) 1,5 A; (d) horário; (e) 0,90 W; (f) 0,18 N; (g) 0,90 W
36	(a) –1,07 mV; (b) –2,40 mV; (c) 1,33 mV
37	(a) 71,5 μV/m; (b) 143 μV/m
38	0,030 T/s
39	0,15 V/m
40	0,10 μWb
41	(a) 2,45 mWb; (b) 0,645 mH
42	(a) 0,27 μT; (b) 8,0 nH
43	1,81 μH/m
44	5,0 A/s
45	(a) diminuindo; (b) 0,68 mH

(*Continua*)

(*Continuação*)

46	(a) 16 kV; (b) 3,1 kV; (c) 23 kV
47	(b) $L_{eq} = \Sigma\, L_j$, de $j = 1$ a $j = N$
48	(b) $1/L_{eq} = \Sigma\, 1/L_j$, de $j = 1$ a $j = N$
49	59,3 mH
50	12,3 s
51	46 Ω
52	(a) 1,00; (b) 0,135; (c) 0,693
53	(a) 8,45 ns; (b) 7,37 mA
54	(a) 3,33 A; (b) 3,33 A; (c) 4,55 A; (d) 2,73 A; (e) 0; (f) −1,82 A (o sentido inverso); (g) 0; (h) 0
55	6,91
56	$7{,}1 \times 10^2$ A/s
57	(a) 1,5 s
58	$(42 + 20t)$ V
59	(a) $i[1 - \exp(-Rt/L)]$; (b) $(L/R) \ln 2$
60	(a) 0,29 mH; (b) 0,29 ms
61	(a) 97,9 H; (b) 0,196 mJ
62	(a) $2{,}4 \times 10^2$ W; (b) $1{,}5 \times 10^2$ W; (c) $3{,}9 \times 10^2$ W
63	25,6 ms
64	1,23
65	(a) 18,7 J; (b) 5,10 J; (c) 13,6 J
66	(a) 1,3 mT; (b) 0,63 J/m^3
67	(a) 34,2 J/m^3; (b) 49,4 mJ
68	5,58 A
69	$1{,}5 \times 10^8$ V/m
70	(a) 23 mA; (b) 70 mA

(*Continua*)

(*Continuação*)

71	(a) 1,0 J/m^3; (b) $4{,}8 \times 10^{-15}$ J/m^3
72	(a) 1,5 μWb; (b) $1{,}0 \times 10^2$ mV; (c) 90 nWb; (d) 12 mV
73	(a) 1,67 mH; (b) 6,00 mWb
74	13 H
75	13 μH
76	(b) o campo magnético existe apenas no interior do solenoide
77	(b) enrolando as espiras dos dois solenoides em sentidos opostos
78	95,4 Ω
79	(a) 2,0 A; (b) 0; (c) 2,0 A; (d) 0; (e) 10 V; (f) 2,0 A/s; (g) 2,0 A; (h) 1,0 A; (i) 3,0 A; (j) 10 V; (k) 0; (l) 0
80	1,0 ns
81	(a) 10 μT; (b) para fora; (c) 3,3 μT; (d) para fora
82	$(\pi B_0 r^2/\tau)\exp(-t/\tau)$
83	0,520 ms
84	(a) 25 μT/s; (b) 13 μT/s; (c) aumentando
85	(a) $(4{,}4 \times 10^7\ \text{m/s}^2)\hat{\imath}$; (b) 0; (c) $(-4{,}4 \times 10^7\ \text{m/s}^2)\hat{\imath}$
86	81,1 μs
87	(a) 0,40 V; (b) 20 A
88	(a) 3,75 mH; (b) 3,75 mH; (c) 100 nWb; (d) 4,24 mV
89	(a) 10 A; (b) $1{,}0 \times 10^2$ J
90	1,54 s

(*Continua*)

(*Continuação*)

91	(a) 0; (b) $8{,}0 \times 10^2$ A/s; (c) 1,8 mA; (d) $4{,}4 \times 10^2$ A/s; (e) 4,0 mA; (f) 0
92	(a) 4,7 mH; (b) 2,4 ms
93	1,15 W
94	(a) 0,10 H/m; (b) 1,3 V/m
95	(a) 20 A/s; (b) 0,75 A
96	2,9 mV
97	12 A/s
98	(a) 0,600 mH; (b) 120
99	3×10^{36} J
100	(a) $3{,}4(2 + \theta)$ mΩ; (b) $4{,}3\theta$ mWb; (c) 2,0 rad; (d) 2,2 A
101	(a) 13,9 H; (b) 120 mA

Capítulo 31

1	(a) 1,17 μJ; (b) 5,58 mA
2	(a) 5,00 μs; (b) 2,50 μs; (c) 1,25 μs
3	(a) 6,00 μs; (b) 167 kHz; (c) 3,00 μs
4	9,14 nF
5	45,2 mA
6	(a) 89 rad/s; (b) 70 ms; (c) 25 μF
7	(a) 1,25 kg; (b) 372 N/m; (c) $1{,}75 \times 10^{-4}$ m; (d) 3,02 mm/s
8	---
9	$7{,}0 \times 10^{-4}$ s
10	38 μH
11	(a) 6,0; (b) 36 pF; (c) 0,22 mH
12	(a) 0,500; (b) 0,866
13	(a) 0,180 mC; (b) 70,7 μs; (c) 66,7 W
14	(a) $6{,}0 \times 10^{2}$ Hz; (b) $7{,}1 \times 10^{2}$ Hz; (c) 1,1 kHz; (d) 1,3 kHz
15	(a) 3,0 nC; (b) 1,7 mA; (c) 4,5 nJ
16	---
17	(a) 275 Hz; (b) 365 mA
18	(a) 46,1 μs; (b) 6,88 nJ; (c) 6,88 nJ; (d) $1{,}02 \times 10^{3}$ A/s; (e) 0,938 mW
19	---
20	(a) 3,60 mH; (b) 1,33 kHz; (c) 0,188 ms

(*Continua*)

(*Continuação*)

21	(a) 356 μs; (b) 2,50 mH; (c) 3,20 mJ
22	ω
23	(a) 1,98 μJ; (b) 5,56 μC; (c) 12,6 mA; (d) −46,9°; (e) +46,9°
24	(a) 5,85 μC; (b) 5,52 μC; (c) 1,93 μC
25	8,66 mΩ
26	(L/R) ln 2
27	---
28	(a) 0,283 A; (b) 2,26 A
29	(a) 95,5 mA; (b) 11,9 mA
30	(a) 0,600 A; (b) 0,600 A
31	(a) 0,65 kHz; (b) 24 Ω
32	(a) 5,22 mA; (b) 0; (c) 4,51 mA
33	(a) 6,73 ms; (b) 11,2 ms; (c) um indutor; (d) 138 mH
34	(a) 39,1 mA; (b) 0; (c) 33,8 mA
35	89 Ω
36	(a) 500 Ω; (b) 40 μF
37	7,61 A
38	(a) 8,0 μF; (b) 2,0 Ω
39	(a) 267 Ω; (b) −41,5°; (c) 135 mA
40	−8,00 V
41	(a) 206 Ω; (b) 13,7°; (c) 175 mA
42	(a) 40 Ω; (b) 60 mH

(*Continua*)

(*Continuação*)

43	(a) 218 Ω; (b) 23,4°; (c) 165 mA
44	(a) 16,6 Ω; (b) 422 Ω; (c) 0,521 A; (d) aumenta; (e) diminui; (f) aumenta
45	(a) sim; (b) 1,0 kV
46	(b) 159 Hz; (c) –45°; (d) $1{,}00 \times 10^3$ rad/s; (e) 170 mA
47	(a) 224 rad/s; (b) 6,00 A; (c) 219 rad/s; (d) 228 rad/s; (e) 0,040
48	(a) 100 Ω; (b) 30,6 μF; (c) 301 mH
49	(a) 796 Hz; (b) permanece a mesma; (c) diminui; (d) aumenta
50	(b) 318 Hz; (c) +45°; (d) $2{,}00 \times 10^3$ rad/s; (e) 53,0 mA
51	---
52	100 V
53	(a) 12,1 Ω; (b) 1,19 kW
54	141 V
55	1,84 A
56	(a) 76,4 mH; (b) sim; (c) 17,8 Ω
57	(a) 117 μF; (b) 0; (c) 90,0 W; (d) 0°; (e) 1; (f) 0; (g) –90°; (h) 0

(*Continua*)

(*Continuação*)

58	---
59	(a) 2,59 A; (b) 38,8 V; (c) 159 V; (d) 224 V; (e) 64,2 V; (f) 75,0 V; (g) 100 W; (h) 0; (i) 0
60	(a) 41,4 W; (b) –17,0 W; (c) 44,1 W; (d) 14,4 W; (e) igual
61	(a) 0,743; (b) adiantada; (c) capacitivo; (d) não; (e) sim; (f) não; (g) sim; (h) 33,4 W; (i) porque, como são dados os valores da tensão e da corrente da fonte, a reatância da carga é conhecida.
62	1,0 kV
63	(a) 2,4 V; (b) 3,2 mA; (c) 0,16 A
64	(a) 1,25; (b) 4,00; (c) 5,00; (d) 0,200; (e) 0,250; (f) 0,800
65	(a) 1,9 V; (b) 5,9 W; (c) 19 V; (d) $5{,}9 \times 10^2$ W; (e) 0,19 kV; (f) 59 kW
66	(b) 10
67	(a) 6,73 ms; (b) 2,24 ms; (c) capacitor; (d) 59,0 μF
68	(a) +1,22 rad; (b) 0,288 A

(*Continua*)

(*Continuação*)

69	(a) –0,405 rad; (b) 2,76 A; (c) capacitivo
70	(a) 4,60 kHz; (b) 26,6 nF; (c) 2,60 kΩ; (d) 0,650 kΩ
71	(a) 64,0 Ω; (b) 50,9 Ω; (c) capacitivo
72	(a) 0,588 rad; (b) indutivo; (c) 12,0 V
73	(a) 2,41 μH; (b) 21,4 pJ; (c) 82,2 nC
74	(a) $5{,}77 \times 10^3$ rad/s; (b) 1,09 ms
75	(a) 39,1 Ω; (b) 21,7 Ω; (c) capacitivo
76	(a) 8,84 kHz; (b) 6,00 Ω
77	---
78	(a) 177 Ω; (b) não
79	(a) 0,577*Q*; (b) 0,152
80	(a) 37,0 V; (b) 60,9 V; (c) 113 V; (d) 68,6 W
81	(a) 45,0°; (b) 70,7 Ω
82	0,115 A
83	1,84 kHz
84	(a) 707 Ω; (b) 32,2 mH; (c) 21,9 nF
85	(a) 0,689 μH; (b) 17,9 pJ; (c) 0,110 μC
86	69,3 Ω
87	(a) 165 Ω; (b) 313 mH; (c) 14,9 μF

(*Continua*)

(*Continuação*)

88	(a) 1,27 μC; (b) 83,1 μs; (c) 5,44 mW
89	---
90	1,59 μF
91	---
92	---
93	(a) 36,0 V; (b) 29,9 V; (c) 11,9 V; (d) –5,85 V

Capítulo 32

1	+3 Wb
2	(a) 1,1 mWb; (b) para dentro
3	(a) 47,4 μWb; (b) para dentro
4	$(\mu_0 iL/\pi)$ ln 3
5	$2{,}4 \times 10^{13}$ V/m · s
6	52 nT · m
7	(a) $1{,}18 \times 10^{-19}$ T; (b) $1{,}06 \times 10^{-19}$ T
8	(a) $3{,}54 \times 10^{-17}$ T; (b) $2{,}13 \times 10^{-17}$ T
9	(a) $5{,}01 \times 10^{-22}$ T; (b) $4{,}51 \times 10^{-22}$ T
10	(a) $3{,}09 \times 10^{-20}$ T; (b) $1{,}67 \times 10^{-20}$ T
11	(a) 1,9 pT
12	(a) 30 mm; (b) 53 mm; (c) $3{,}0 \times 10^{-5}$ T
13	$7{,}5 \times 10^{5}$ V/s
14	---
15	---
16	$7{,}2 \times 10^{12}$ V/m · s
17	(a) 0,324 V/m; (b) $2{,}87 \times 10^{-16}$ A; (c) $2{,}87 \times 10^{-18}$
18	$8{,}40 \times 10^{-13}$ T
19	(a) 75,4 nT; (b) 67,9 nT
20	(a) 2,22 μT; (b) 2,00 μT
21	(a) 27,9 nT; (b) 15,1 nT
22	(a) 20,0 μT; (b) 12,0 μT
23	(a) 2,0 A; (b) $2{,}3 \times 10^{11}$ V/m · s; (c) 0,50 A; (d) 0,63 μT·m
24	(a) $2{,}1 \times 10^{-8}$ A; (b) para baixo; (c) horário
25	(a) 0,63 μT; (b) $2{,}3 \times 10^{12}$ V/m · s

(*Continua*)

(*Continuação*)

26	(a) 1,33 A; (b) 0,300 cm; (c) 4,80 cm
27	(a) 0,71 A; (b) 0; (c) 2,8 A
28	(a) 0,089 mT; (b) 0,18 mT; (c) 0,22 mT; (d) $6{,}4 \times 10^{-22}$ T; (e) $6{,}4 \times 10^{-22}$ T; (f) 0; (g) para fora; (h) para fora
29	(a) 7,60 μA; (b) 859 kV · m/s; (c) 3,39 mm; (d) 5,16 pT
30	(a) 13 MWb; (b) para fora
31	55 μT
32	(a) 0; (b) –1, 0, 1; (c) $4{,}64 \times 10^{-24}$ J
33	(a) 0; (b) 0; (c) 0; (d) $\pm 3{,}2 \times 10^{-25}$ J; (e) $-3{,}2 \times 10^{-34}$ J·s; (f) $2{,}8 \times 10^{-23}$ J/T; (g) $-9{,}7 \times 10^{-25}$ J; (h) $\pm 3{,}2 \times 10^{-25}$ J
34	$4{,}6 \times 10^{-24}$ J
35	(a) $-9{,}3 \times 10^{-24}$ J/T; (b) $1{,}9 \times 10^{-23}$ J/T
36	32,3 mT
37	(b) $+x$; (c) horário; (d) $+x$
38	$e^2r^2B/4m$
39	sim
40	(a) $1{,}5 \times 10^2$ T; (b) $6{,}0 \times 10^2$ T; (c) não
41	20,8 mJ/T
42	0,48 K
43	(b) K_f/B; (c) $-z$; (d) 0,31 kA/m

(*Continua*)

(*Continuação*)

44	0,30
45	---
46	$3{,}19 \times 10^{-9}\,\text{kg} \cdot \text{m}^2$
47	(a) $1{,}8 \times 10^{2}$ km; (b) $2{,}3 \times 10^{-5}$
48	(a) 8,9 A · m^2; (b) 13 N · m
49	(a) 3,0 μT; (b) $5{,}6 \times 10^{-10}$ eV
50	(a) $1{,}49 \times 10^{-4}$ N · m; (b) –72,9 μJ
51	$5{,}15 \times 10^{-24}$ A · m^2
52	25 km
53	(a) 0,14 A; (b) 79 μC
54	(a) $1{,}66 \times 10^{3}$ km; (b) 383 μT; (c) 61,1 μT; (d) 84,2°
55	(a) $6{,}3 \times 10^{8}$ A; (b) sim; (c) não
56	(b) na direção do vetor momento angular
57	0,84 kJ/T
58	(a) 222 μT; (b) 167 μT; (c) 22,7 μT; (d) 1,25 μT; (e) 3,75 μT; (f) 22,7 μT
59	(a) $(1{,}2 \times 10^{-13}\,\text{T})\,\exp[-t/(0{,}012\ \text{s})]$; (b) $5{,}9 \times 10^{-15}$ T
60	(a) 9,2 mWb; (b) para dentro
61	---
62	(a) 31,0 μT; (b) 0°; (c) 55,9 μT; (d) 73,9°; (e) 62,0 μT; (f) 90,0°
63	(a) 27,5 mm; (b) 110 mm
64	(a) 4 K; (b) 1 K
65	8,0 A
66	$3{,}5 \times 10^{-5}$ A

(*Continua*)

(*Continuação*)

67	(a) $-8{,}8 \times 10^{15}$ V/m · s; (b) $5{,}9 \times 10^{-7}$ T · m
68	(a) $-2{,}78 \times 10^{-23}$ J/T; (b) $3{,}71 \times 10^{-23}$ J/T
69	(b) negativo; (c) não, porque existe um fluxo positivo penetrando na base do cilindro mais próxima do ímã
70	(a) $5{,}3 \times 10^{11}$ V/m; (b) 20 mT; (c) $6{,}6 \times 10^{2}$
71	(b) $-x$; (c) anti-horário; (d) $-x$
72	(a) 16,7 nT; (b) 5,00 mA
73	(a) 7; (b) 7; (c) $3h/2\pi$; (d) $3eh/4\pi m$; (e) $3{,}5h/2\pi$; (f) 8
74	0,300 A
75	(a) 9; (b) $3{,}71 \times 10^{-23}$ J/T; (c) $+9{,}27 \times 10^{-24}$ J; (d) $-9{,}27 \times 10^{-24}$ J
76	(a) $-2{,}78 \times 10^{-23}$ J/T; (b) $3{,}71 \times 10^{-23}$ J/T