Name KEY **Student ID** ______________

Check your (CRN) section number:

	14291	**8:00 – 8:50**
	14288	**9:05 – 9:55**
	14296	**10:10 – 11:00**
	14295	**11:15 – 12:05**

Students may also use there own two sided 8.5" x 11" formula sheet.

Chapter 15

$v = f\lambda$ $k = \frac{2\pi}{\lambda}$ $\omega = 2\pi f = \frac{2\pi}{T}$ $\frac{\partial^2 y(x,t)}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y(x,t)}{\partial t^2}$

$\frac{\partial y(x,t)}{\partial t} = \mp v \frac{\partial y(x,t)}{\partial x}$ $v = \sqrt{\frac{F}{\mu}}$ $Power = F_y(x,t)v_y(x,t)$ $P_{av} = \frac{1}{2}\sqrt{\mu F}\omega^2 A^2$

$\frac{I_1}{I_2} = \frac{r_2^2}{r_1^2}$ $y(x,t) = A_{sw}\sin(kx)\cos(\omega t)$

Chapter 16

$p(x,t) = -B\frac{\partial y(x,t)}{\partial x}$ $p_{max} = BkA$ $v = \sqrt{\frac{B}{\rho}}$ $v = \sqrt{\frac{\gamma RT}{M}}$

$T_{kelvin} = T_C + 273.15$ $v = \sqrt{\frac{Y}{\rho}}$ $I = \langle p(x,t)v_y(x,t)\rangle_t$ $I = \frac{1}{2}\sqrt{\rho B}\omega^2 A^2$

$\beta = (10dB)\log\frac{I}{I_0}$ $I_0 = 10^{-12}\frac{W}{m^2}$ $f_{beat} = f_a - f_b$ $f_L = \frac{v+v_L}{v+v_S}f_S$

Chapter 21

$F = k\frac{|q_1q_2|}{r^2} = \frac{1}{4\pi\epsilon_0}\frac{|q_1q_2|}{r^2}$ $\epsilon_0 = 8.85\times10^{-12}\frac{C^2}{Nm^2}$ $k = 8.988\times10^9\frac{Nm^2}{C^2}$ $\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$

$p = dq$ $\vec{\tau} = \vec{p}\times\vec{E}$

Chapter 22

$\Phi_E \equiv \int \vec{E}\cdot d\vec{A}$ $\oint \vec{E}\cdot d\vec{A} = \frac{Q_{encl}}{\epsilon_0}$

Chapter 23

$V = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$ $-\Delta V = V_a - V_b = \int_a^b \vec{E}\cdot d\vec{l}$ $\vec{E} = -\left(\hat{\imath}\frac{\partial V}{\partial x} + \hat{\jmath}\frac{\partial V}{\partial y} + \hat{k}\frac{\partial V}{\partial z}\right)$

Physics 2306 Exam 1 Makeup (Arsenault) Spring 2006

1. A transverse wave traveling on a string is described by the expression y(x,t) = 3.2 mm sin (1.3 x / m - 10 t / s), where m=meters, mm=millimeters, and s=seconds . What is the frequency, f, of this wave?

6

A	20 π Hz	F	1.59 Hz
B	1.3 Hz	G	2.42 Hz
C	10 Hz	H	20 Hz
D	0.628 Hz	I	0.314 Hz
E	12 Hz	J	314 Hz

$$2\pi f \cancel{t} = \frac{10\cancel{t}}{s} \Rightarrow f = \frac{10}{2\pi}\frac{1}{s} = \frac{5}{\pi}\frac{1}{s}$$

$$\Rightarrow f \simeq 1.5915494\ Hz \simeq \boxed{1.59\ Hz}$$

2. For the wave in problem 1, what is the period, T, of the wave?

4

A	0.1 s	F	0.159 s
B	10 s	G	7.69 s
C	1.3 s	H	76.9 s
D	0.628 s	I	769 s
E	62.8 s	J	1 s

$$T = \frac{1}{f} = \frac{\pi}{5} s \simeq 0.6283\ s \simeq \boxed{0.628\ s}$$

3. For the wave in problem 1, what is the wavelength, λ, of the wave?

10

A	1.3 m	F	3.2 mm
B	2.42 m	G	0.13 m
C	13 m	H	13 mm
D	0.769 m	I	2.6 m
E	7.69 m	J	4.83 m

$$\frac{2\pi}{\lambda}\cancel{x} = \frac{1.3\cancel{x}}{m} \Rightarrow \lambda = \frac{m}{1.3}2\pi = \frac{2\pi}{1.3} m$$

$$\Rightarrow T \simeq 4.833\ m \simeq \boxed{4.83\ m}$$

4. For the wave in problem 1, what is the speed, *v*, of the wave?

1

A	7.69 m/s	F	0.769 m/s
B	3.14 m/s	G	344 m/s
C	1.3 m/s	H	1 m/s
D	10 m/s	I	62.8 m/s
E	13 m/s	J	20 m/s

$$v = f\lambda = \left(\frac{5}{\cancel{\pi}}\frac{1}{s}\right)\left(\frac{2\cancel{\pi}}{1.3}m\right) = \frac{10}{1.3}\frac{m}{s}$$

$$\Rightarrow v \simeq 7.6923\ \frac{m}{s} \simeq \boxed{7.69\ m/s}$$

5. For the wave in problem 1, what is the direction the wave is traveling?

2

A	- x direction	F	- z direction
B	+x direction	G	it's not moving
C	up	H	cannot be determined
D	+ y direction	I	- y direction
E	+ z direction	J	down

x

The form of the wave is $y = f(x - vt)$, so it's moving in the +x direction

6. For the wave in problem 1, find the transverse velocity of the wave at time t=3s and position x=1m.

$y = A\sin(kx-\omega t)$ $\qquad \frac{\partial y}{\partial t} = -\omega A\cos(kx-\omega t) = -2\pi f A\cos(kx-\omega t)$

$\frac{\partial y}{\partial t}(1m, 3s) \quad -2\pi\left(\frac{5}{\pi}\frac{1}{s}\right)(3.2\ mm)\cos\left[1.3\left(\frac{1m}{m}\right) - \frac{10(3s)}{s}\right]$

$= -(10)(3.2)\frac{mm}{s}\cos[1.3-30]$

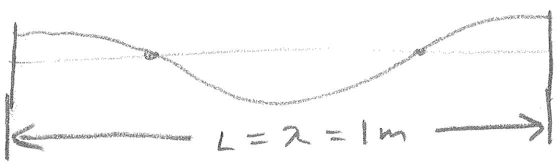
$= -32\frac{mm}{s}\cos[-28.7]$

$\simeq +29.1444\frac{mm}{s} \simeq \boxed{+29.1\frac{mm}{s}}$

A	13.2 mm/s	F	-29.1 mm/s
B	10.2 mm/s	G	-10.2 mm/s
C	65.8 mm/s	H	-62.1 mm/s
D	31.4 mm/s	I	-19.4 mm/s
E	0	J	3.14 mm/s

← Answer not found

7. A pipe of length L=1m is open at both ends. Use v=344 m/s for the speed of sound. Find the frequency of the first over tone (second harmonic).



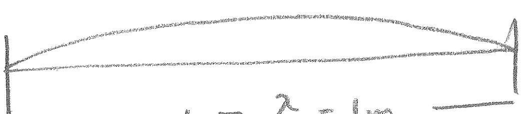
$f = \frac{v}{\lambda} = \frac{344\ m/s}{1m} = 344\frac{1}{s}$

$= \boxed{344\ Hz}$

10

A	34 Hz	F	688 Hz
B	3.44 Hz	G	229 Hz
C	2160 Hz	H	516 Hz
D	1080 Hz	I	444 Hz
E	172 Hz	J	344 Hz

8. A string of length 1 m and mass 0.01 kg is fixed a both ends. If the first harmonic resonant frequency is 30 Hz, then the tension in the string is:



$\lambda = 2L$

$v = f\lambda \qquad v = \sqrt{\frac{F}{\mu}} \qquad \mu = \frac{M}{L}$

$\Rightarrow \sqrt{\frac{F}{\frac{M}{L}}} = f\,2L$

$\Rightarrow \sqrt{F} = \sqrt{\frac{M}{L}}\,L\,2f = \sqrt{ML}\,2f$

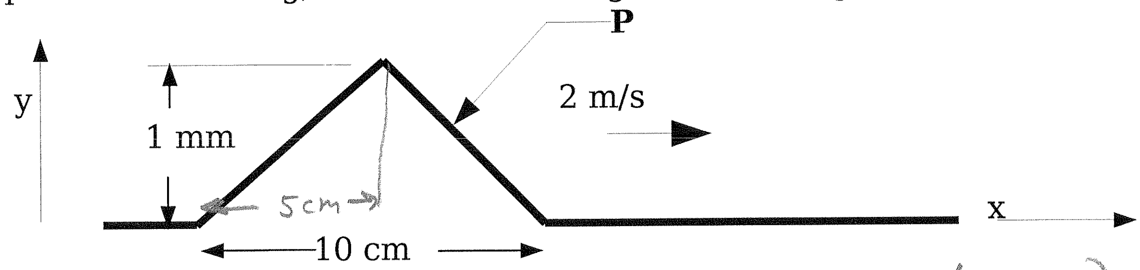
$\Rightarrow F = ML4f^2 = (0.01kg)(1m)4\left(30\frac{1}{s}\right)^2$

$= (9)4\ kg\ m/s^2 = \boxed{36\ N}$

1

A	36 N	F	30 N
B	18 N	G	0.6 N
C	144 N	H	100 N
D	72 N	I	12 N
E	50 N	J	24 N

9. The triangular wave pulse, 1 mm high and 10 cm wide with a peak 5 cm from the start of the pulse, illustrated below, moves on a string at a speed of 2 m/s to the right. What is the transverse velocity of the string, v_y, at the point on the string, at the forward edge of the triangle, labeled as **P**?



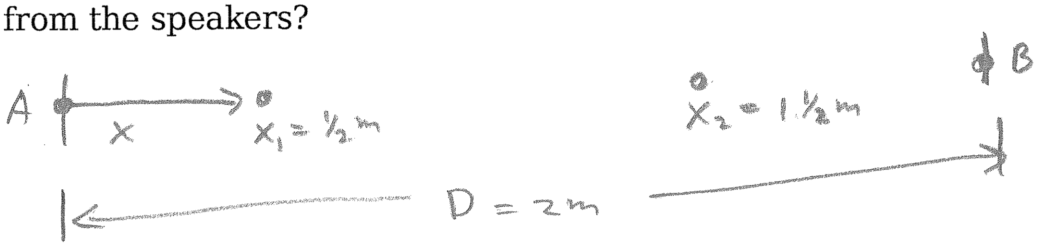
$$v_y = -\frac{\Delta y}{\Delta x} v = -\left(\frac{-1\,\text{mm}}{5\,\text{cm}}\right) 2\,\text{m/s} \left(\frac{10^{-3}\,\text{m}}{\text{mm}}\right)\left(\frac{\text{cm}}{10^{-2}\,\text{m}}\right)$$

$$= \frac{2}{5} 10^{-1}\,\text{m/s} = \frac{2}{50}\,\frac{\text{m}}{\text{s}} = \boxed{0.04\,\frac{\text{m}}{\text{s}}}$$

A	20 m/s	F	25 m/s
B	10 m/s	G	2.5 m/s
C	0.08 m/s	H	- 0.085 m/s
D	0.04 m/s	I	- 12.5 m/s
E	12.5 m/s	J	- 0.08 m/s

4

10. Two sound speakers are driven in phase, by a single tone, and are separated by D=2 meters. An observer walking between the two speakers notices that the sound she hears becomes louder and softer as she moves. If she hears only two minimums, which are when she is between the speakers at ½ meter (¼ D) from either speaker. What is the wavelength of the sound from the speakers?



path diff $= d = x - (D - x) = 2x - D$

n odd

① $2x_2 - D = n\frac{\lambda}{2}$

② $2x_1 - D = (n-2)\frac{\lambda}{2} = n\frac{\lambda}{2} - \lambda$

A	2 m	F	½ m
B	4 m	G	¼ m
C	10 m	H	3.14 m
D	344 m	I	8 m
E	172 m	J	16 m

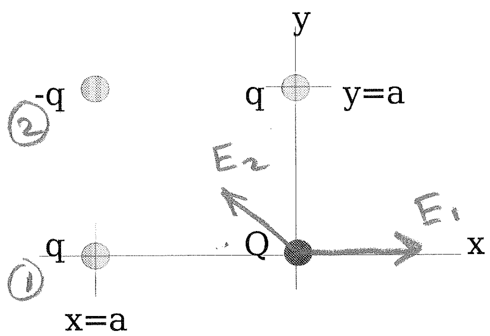
1

① − ② $\Rightarrow 2x_2 - 2x_1 = \lambda$

$\Rightarrow \lambda = 2(x_2 - x_1) = 2(1½\,\text{m} - ½\,\text{m})$

$= \boxed{2\,\text{m}}$

11. Three charges: q at (-a, 0), q at (0, a), and -q at (-a, a) are shown in the figure act on a fourth charge, Q, that is at the origin. Q and q are both positive. So -q < 0. Find the x component of the force on the charge at the origin. Use $k = 1/(4\pi\varepsilon_0)$.



$$E_x = E_1 - E_2 \cos 45^\circ = E_1 - E_2 \frac{1}{\sqrt{2}}$$

$$E_1 = k\frac{qQ}{a^2} \qquad E_2 = \frac{kqQ}{(\sqrt{2}a)^2} = \frac{kqQ}{2a^2}$$

$$\Rightarrow E_x = \frac{kqQ}{a^2} - \frac{1}{2}\frac{kqQ}{a^2}\frac{1}{\sqrt{2}}$$

$$= \frac{kqQ}{a^2}\left(1 - \frac{1}{2\sqrt{2}}\right)$$

$$\simeq 0.6464466\,\frac{kqQ}{a^2}$$

	A	3.83 k q Q / a²	F	1.71 k q Q / a²
	B	1.83 k q Q / a²	G	0.414 k q Q / a²
3	C	0.646 k q Q / a²	H	-0.414 k q Q / a²
	D	-0.65 k q Q / a²	I	-0.293 k q Q / a²
	E	0.5 k q Q / a²	J	0.293 k q Q / a²

12. A spherical sound wave with 20 Watt of power is emitted from a point. What is the intensity of the sound, in dB, that will be heard at a distance of 10 meters from this source?

$$\beta = 10\,dB \log\left(\frac{\frac{Power}{4\pi r^2}}{I_0}\right) = 10\,dB \log\left(\frac{\frac{20W}{4\pi(10m)^2}}{10^{-12}\frac{W}{m^2}}\right)$$

$$= 10\,dB \log\left(\frac{5}{\pi}10^{10}\right) \simeq 102.018\,dB$$

$$\simeq \boxed{102\,dB}$$

	A	-10 dB	F	48 dB
7	B	13 dB	G	102 dB
	C	20 dB	H	113 dB
	D	33 dB	I	123 dB
	E	41 dB	J	200 dB

13. Two toning forks are ringing. One of the toning forks rings with a frequency of 256 Hz and the other is a little less. If the beat frequency for the two forks is measured to be 3 Hz, what is the frequency of the fork with the lower frequency?

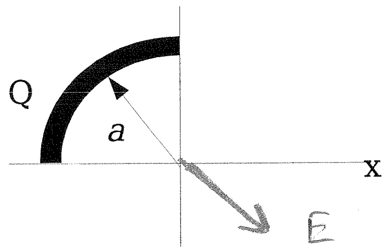
$$f_{beat} = f_1 - f_2$$

$$\Rightarrow f_2 = f_1 - f_{beat} = 256\,Hz - 3\,Hz$$

$$= \boxed{253\,Hz}$$

	A	249 Hz	F	254 Hz
	B	250 Hz	G	255 Hz
	C	251 Hz	H	256 Hz
	D	252 Hz	I	257 Hz
5	E	253 Hz	J	258 Hz

14. Consider the circular arc with total charge Q uniformly distributed over the arc. Q is greater than zero. The radius of the arc is *a, with the angle of arc swing being 90°*. The arc is in the quadrant shown in the figure below. The center of the arc is at the origin. Find the direction of the electric field at the origin.

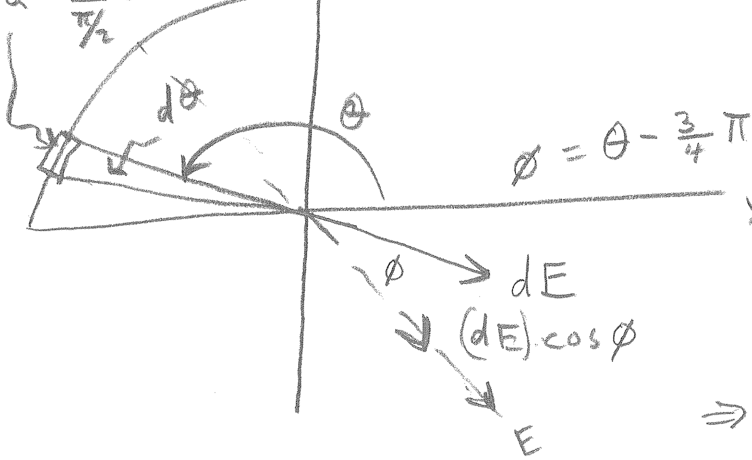


cw = clockwise ccw = counter-clockwise

A	x direction	F	45° cw from - x
B	y direction	G	none E=0
C	45° ccw from x	H	55° ccw from x
D	45° cw from x	I	90° ccw from x
E	45° ccw from - x	J	55° cw from x

15. From problem ~~13~~ 14, in terms of $k=1/(4\pi\varepsilon_0)$, Q, and a, find the magnitude of the electric field.

$$dQ = \frac{Q}{\pi/2}\,d\theta$$



$$\phi = \theta - \tfrac{3}{4}\pi$$

$$dE = k\frac{dQ}{a^2} = k\frac{Q\,d\theta}{\frac{\pi}{2}a^2} = \frac{2kQ\,d\theta}{\pi a^2}$$

$$E = \int_{\theta=\frac{\pi}{2}}^{\pi} dE\,\cos\left(\theta - \tfrac{3}{4}\pi\right)$$

$$\Rightarrow E = \frac{2kQ}{\pi a^2}\int_{\theta=\frac{\pi}{2}}^{\pi} \cos\left(\theta - \tfrac{3}{4}\pi\right) d\theta$$

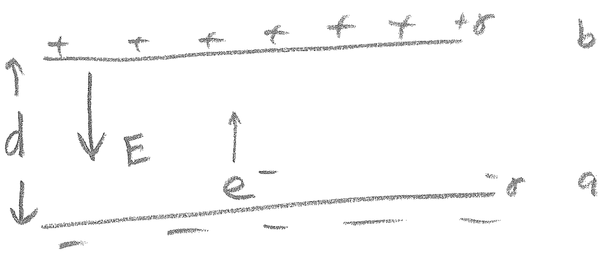
$$= \frac{2kQ}{\pi a^2}\left[\sin\left(\theta - \tfrac{3}{4}\pi\right)\Big|_{\theta=\frac{\pi}{2}}^{\pi}\right]$$

$$= \frac{2kQ}{\pi a^2}\left[\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}\right]$$

$$= \frac{2\cdot 2}{\sqrt{2}}\frac{kQ}{\pi a^2} = 2\sqrt{2}\,\frac{kQ}{\pi a^2}$$

A	$kQ/(\pi^2 a^2)$	F	$kQ/(\pi a^2)$
B	$2kQ/(\pi^2 a^2)$	G	$2kQ/(\pi a^2)$
C	$kQ/(2^{1/2}\pi^2 a^2)$	H	$kQ/(2^{1/2}\pi a^2)$
D	$2^{1/2}kQ/(\pi^2 a^2)$	I	$2^{1/2}kQ/(\pi a^2)$
E	$2^{3/2}kQ/(\pi^2 a^2)$	J	$2^{3/2}kQ/(\pi a^2)$

16. Two infinite parallel conducting plates have equal but opposite charge density with magnitude $\sigma = 10^{-12}$ C/m^2 on them. The plates are separated by a distance d=1 cm. An electron starts at rest on the negatively charged plate and moves to the other plate. You may ignore the effect of gravity. What is the speed of the electron when it reaches the other plate? [the mass of the electron is $m_e = 1.9\times10^{-31}$ kg, the charge on the electron is $-e = -1.6\times10^{-19}$ C, $\varepsilon_0 = 8.85\times10^{-12}$ C^2/(N m^2)]



$$U_a + \cancel{K_a}^{\,0} = U_b + K_b$$

$$\Rightarrow K_b = -(U_b - U_a)$$

$$\Rightarrow \frac{1}{2} m_e v_b^2 = eEd = e\left(\frac{\sigma}{\varepsilon_0}\right)d \Rightarrow v_b^2 = \frac{2e\sigma d}{m_e \varepsilon_0}$$

$$\Rightarrow v_b = \sqrt{\frac{2e\sigma d}{m_e \varepsilon_0}} = \sqrt{\frac{2(1.6\times10^{-19}\,C)(10^{-12}\,C/m^2)(10^{-2}\,m)}{(1.9\times10^{-31}\,kg)\,8.85\times10^{-12}\frac{C^2}{Nm^2}}\;\frac{N}{kg\,m/s^2}}$$

A	11.1 m/s	F	19,900 m/s
B	13.4 m/s	G	43,600 m/s
C	220 m/s	H	1.33×10^6 m/s
D	234 m/s	I	1.99×10^8 m/s
E	14,100 m/s	J	3.97×10^8 m/s

$\simeq 43{,}624.107$ m/s

$\simeq \boxed{43{,}600 \text{ m/s}}$

17. A spherical sound wave is emitted by a point source. How many decibels does the sound intensity level change when you move from 1/2 meter from the source to 5 meters from the source?

$$\Delta\beta = \beta_2(\text{at } 5m) - \beta_1(\text{at } \tfrac{1}{2}m) = 10dB\log\left(\frac{\frac{Power}{4\pi r_2^2}}{I_0}\right) - 10dB\log\left(\frac{\frac{Power}{4\pi r_1^2}}{I_0}\right)$$

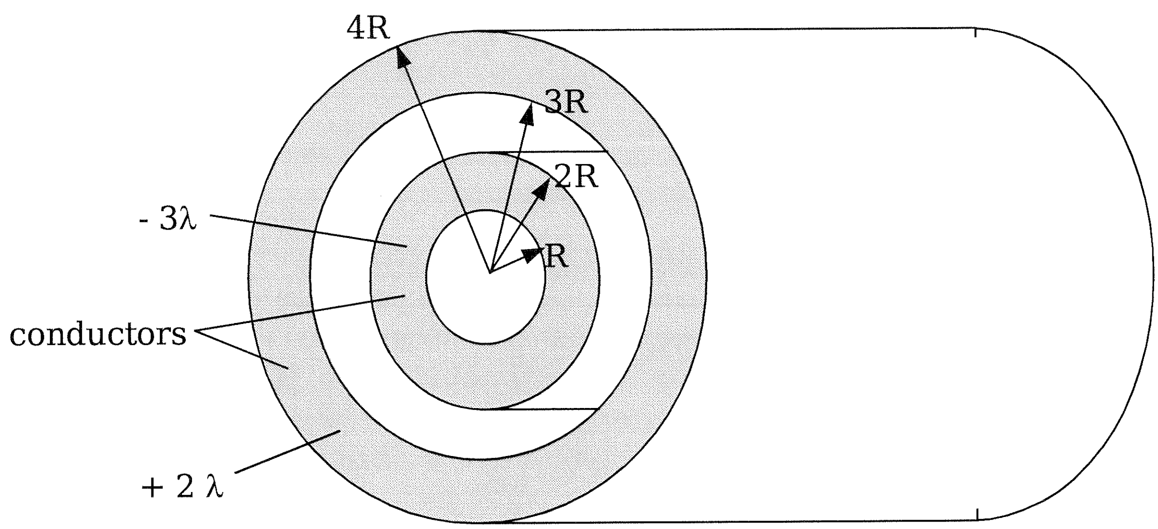
$$= 10dB\left[\log\left(\frac{\frac{Power}{4\pi r_2^2}}{I_0}\right) - \log\left(\frac{\frac{Power}{4\pi r_1^2}}{I_0}\right)\right] = 10dB\log\left[\frac{r_1^2}{r_2^2}\right]$$

A	- 40 dB	F	40 dB
B	- 20 dB	G	100 dB
C	0 dB	H	200 dB
D	10 dB	I	400 dB
E	20 dB	J	800 dB

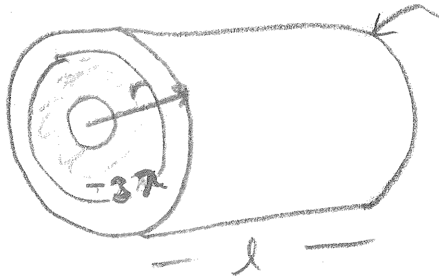
$$= 10dB\cdot\log\left[\frac{(\frac{1}{2}m)^2}{(5m)^2}\right] = 20dB\log\left[\frac{1}{10}\right]$$

$$= \boxed{-20\,dB}$$

For problems 18, 19, 20 consider the figure shown below. In these problems λ is a positive number, and r is the variable radial distance from the center of these long concentric cylinders. There are two conducting, concentric, cylindrical shells, one between r=R and r=2R has a total linear charge density (charge per unit length) of -3 λ on it, and the one between r=3R and r=4R has a total linear charge density of +2 λ on it. There is no charge within the inner conductor where r is less than of equal to R. The system is in static equilibrium.



18. The radial electric field in the region 2R < r < 3R is [positive r being radial outward]:

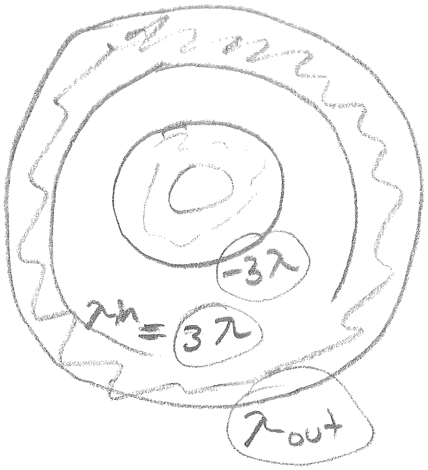


$$\oint \vec{E}\cdot d\vec{A} = E(\cancel{\ell}\, 2\pi r) = \frac{\cancel{\ell}(-3\lambda)}{\epsilon_0}$$

$$\Rightarrow E = \boxed{-\frac{3}{2}\frac{\lambda}{\pi \epsilon_0 r}}$$

A	$\lambda / (4 \pi \varepsilon_0 r)$	F	$- \lambda / (4 \pi \varepsilon_0 r)$
B	$\lambda / (\pi \varepsilon_0 r)$	G	$- \lambda / (2 \pi \varepsilon_0 r)$
C	$2 \lambda / (\pi \varepsilon_0 r)$	H	$- 3 \lambda / (2 \pi \varepsilon_0 r)$
D	$3 \lambda / (4 \pi \varepsilon_0 r)$	I	$- 3 \lambda / (4 \pi \varepsilon_0 r)$
E	$4 \lambda / (\pi \varepsilon_0 r)$	J	0

19. The linear charge density at r=4R on the outer surface of the outer conductor is:

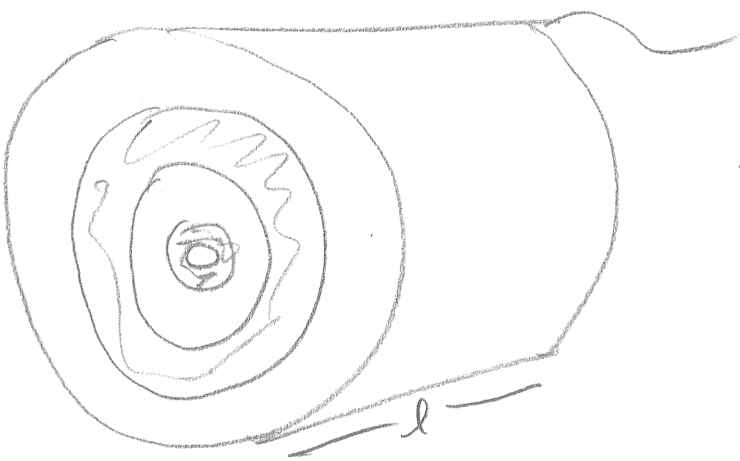


$$\lambda_{\substack{cond\\Total}} \equiv 2\lambda = \lambda_{in} + \lambda_{out} = (3\lambda) + \lambda_{out}$$

$$\Rightarrow \lambda_{out} = 2\lambda - 3\lambda = \boxed{-\lambda}$$

A	λ / 2	F	- λ / 2
B	λ	G	- λ
C	3 λ / 2	H	- 3 λ / 2
D	2 λ	I	- 2 λ
E	3 λ	J	0

20. The electric field for the region r > 4R is:



$$\oint \vec{E} \cdot d\vec{A} = E(\ell\, 2\pi r) = \frac{\ell \lambda_{net}}{\epsilon_0}$$

$$\Rightarrow E = \frac{\lambda_{net}}{2\pi \epsilon_0 r}$$

$$\lambda_{net} = -3\lambda + 2\lambda = -\lambda$$

$$\Rightarrow E = \boxed{\frac{-\lambda}{2\pi \epsilon_0 r}}$$

A	$\lambda / (4 \pi \varepsilon_0 r)$	F	$- \lambda / (4 \pi \varepsilon_0 r)$
B	$\lambda / (\pi \varepsilon_0 r)$	G	$- \lambda / (2 \pi \varepsilon_0 r)$
C	$2 \lambda / (\pi \varepsilon_0 r)$	H	$- 3 \lambda / (2 \pi \varepsilon_0 r)$
D	$3 \lambda / (4 \pi \varepsilon_0 r)$	I	$- 3 \lambda / (4 \pi \varepsilon_0 r)$
E	$4 \lambda / (\pi \varepsilon_0 r)$	J	0