Practice Problems for Common Exam 3

Chapter 12 sect. 1-7 Chapter 16 sect. 1-5,7 Chapter 17 sect. 1-2 Chapter 18 sect. 1-7 Chapter 19 sect,1-2

$$I = \frac{1}{A}\frac{\Delta E}{\Delta t} = \frac{\wp}{A} \qquad I = \frac{\wp_{av}}{A} = \frac{\wp_{av}}{4\pi r^2}$$

$$\beta = 10\,\text{dB}\log\left(\frac{I}{I_o}\right) \qquad \beta_2 - \beta_1 = 10\text{dB}\log\frac{I_2}{I_1}$$

$$f_o = f_s\left(\frac{v + v_o}{v - v_s}\right)$$

$$f_n = n\frac{v}{2L} = nf_1 \qquad n = 1, 2, 3, \ldots$$

$$f_n = n\frac{v}{4L} = nf_1 \qquad n = 1, 3, 5, \ldots$$

1. The intensity at a distance of 4.0 m from a source that is radiating equally in all directions is 9.85×10^{-7} W/ m^2. What is the intensity level in dB at a distance of 6 m?

$$I = \frac{P}{4\pi R^2}$$

$$P = I*4\pi R^2 = 9.85x10^{-7} *4\pi 4^2 = 1.98x10^{-4} W$$

$$I = \frac{P}{4\pi R^2} = \frac{1.98x10^{-4}}{4\pi 6^2} = 4.37x10^{-7} \quad \beta = 10 dB \log \frac{4.37x10^{-7}}{10^{-12}} \quad 56.4 \text{ dB}$$

2. The intensity of a certain sound wave is $2x10^{-7}$ W/m^2. If its intensity is raised by 30 decibels, what is the new intensity in W/m^2?

$$\beta_2 - \beta_1 = 10dB \log \frac{I_2}{I_1}$$

$$3 = \log \frac{I_2}{I_1} \qquad I_2 = I_1 * 10^3 = 2x10^{-4}$$

3. A factory siren indicating the end of the shift has a frequency of 80 Hz. What frequency is perceived by the occupant of a car traveling away from the factory at 30 m/s? The speed of the sound is 343 m/s.

f_{source} =80Hz, **v_0 = - 30 m/s and v_{source} - 0**

$$f_o = f_s \left(\frac{v + v_o}{v - v_s} \right)$$

$$f_{driver} = 80 \frac{343 - 30 m/s}{343} = 73\text{Hz}$$

4. A factory siren indicating the end of the shift has a frequency of 82 Hz. If the occupant of a car traveling away from the factory perceives frequency of 76 Hz, what is the speed of the car? The speed of the sound is 343 m/s.

$$f_o = f_s\left(\frac{v + v_o}{v - v_s}\right)$$

$$\mathbf{82\ Hz\,\frac{343-v}{343} = 76\ Hz} \qquad \mathbf{\frac{343-v}{343} = \frac{76}{82} = 0.93}$$

$$\mathbf{\frac{343-v}{343} = 0.93 \quad 343 - v = 317.9 \quad v = 343 - 317.9 = 25.1\ m/s}$$

5. A 500-Hz whistle is moved toward a listener at a speed of 10.0 m/s. At the same time, the listener moves at a speed of 20.0 m/s in a direction away from the whistle. What is the apparent frequency heard by the listener? (The speed of sound is 340 m/s.)

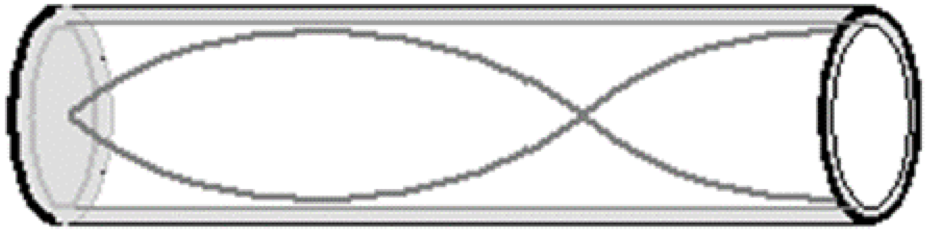
f_{source} =245Hz, **v_0 - negative and v_{source} - positive**

$$f_o = f_s \left(\frac{V + V_o}{V - V_s} \right)$$

$$f_{driver} = f_{source} \frac{343 - 20\ m/s}{343 - 10\ m/s}$$ **= 485Hz**

6. If an organ pipe shown is to resonate at 370 Hz, what is its required length?
v = 343 m/s

$$f_n = n\frac{v}{4L}$$



n=3

$$L = \frac{nv}{4f_3} = \frac{3*343}{4*370} = 0.70\ m$$

7. An organ pipe, open at both ends, is 2.2 m long. If the velocity of sound in air is 343 m/s, the frequency of third harmonic of this pipe is:

$$f_n = n\frac{v}{2L}$$

$$f = 3\frac{343}{2*2.2} = 234\ Hz$$

In a resonating pipe that is open at one end and closed at the other end, there

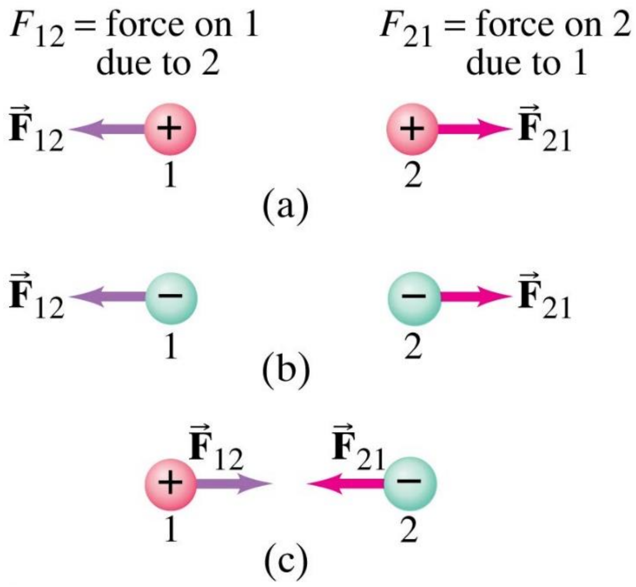
A) are displacement nodes at each end.

B) are displacement antinodes at each end.

C) is a displacement node at the open end and a displacement antinode at the closed end.

D) is a displacement node at the closed end and a displacement antinode at the open end.

Electric charge:



$q = Ne$ 8.99x109 Nm^2/C^2

$$F = k\frac{q_1 q_2}{r^2}$$ $$E = k\frac{q}{r^2}$$ $F = qE$ $qE = ma$

$PE = q\Delta V$ KE = ½ mv2 $q\Delta V + \Delta K = 0$

qΔV = ½ mv2 $\Delta V = Ed$

8. The attractive electrostatic force between the two point charges 4x10 =6C and Q has a magnitude of 1.77 N when the separation between charges is 25 cm. The sign and magnitude of the charge Q is closest to ($k=8.99x10^9 N/mC^2$)

F=k$\frac{q_1 q_2}{r^2}$

$$q_2 = \frac{Fr^2}{kq_1} = \frac{1.77 * 0.25^2}{8.99x10^9 4x10^{-6}}$$ **= $3x10^{-6}$C**

negative

9. A 2 mg particle carrying a charge of 4nC is placed in an uniform electric field of magnitude of 100 N/C. Find the particle's acceleration.

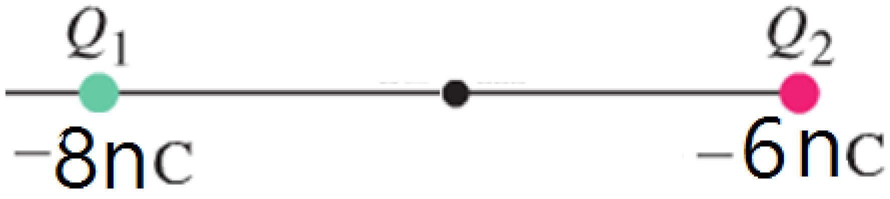
ma = qE m = $2x10^{-6}$kg q = $4x10^{-9}$C

$$a = \frac{qE}{m} = \frac{4x10^{-9} * 100}{2x10^{-6}} = 0.2\ m/s^2$$

If a point charge of -3.0 μC experiences an electrostatic upward force of 27 μN at a certain location in the laboratory, what are the magnitude and direction of the electric field at that location?

$$F = qE \qquad E = \frac{F}{q} = \frac{27x10^{-6}}{3x10^{-6}} = 9N/C \ \text{downward}$$

10. Determine the magnitude and direction of the electric field midway between a -8nC and a -6 nC charge 60 cm apart. ($k=8.99x10^9 N/mC^2$)



$E_1 = k\frac{Q_1}{r^2} = 8.99x10^9 \frac{8x10^{-9}}{0.3^2} = 799\frac{N}{C}$ to the left

$E_2 = k\frac{Q_2}{r^2} = 8.99x10^9 \frac{6x10^{-9}}{0.3^2} = 599\frac{N}{C}$ to the right

E_{net} = 599N/C- 799N/C= -200N/C to the left

11. What is the speed of a proton that has been accelerated from rest through a potential difference of 4.0 kV? (m_p=1.67x10^{-27} kg, e=1.6x10^{-19}C

$$q\Delta V = \tfrac{1}{2}mv^2$$

$$v = \sqrt{\frac{2q\Delta V}{m}} = \sqrt{\frac{2*1.6x10^{-19}4000V}{1.67x10^{-27}}} = 8.8x10^{5}\text{m/s}$$

Two tiny beads are 25 cm apart with no other charges or fields present. Bead A carries 10 μC of charge and bead B carries 1 μC. Which one of the following statements is true about the magnitudes of the electric forces on these beads?

A) The force on A is 10 times the force on B.

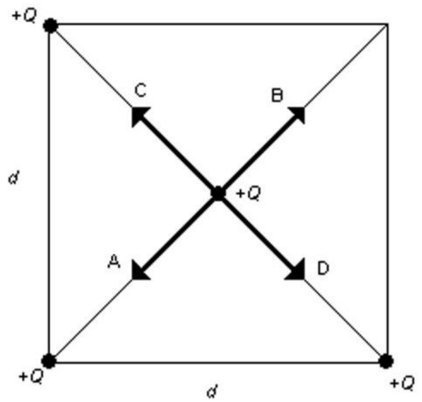
B) The force on B is 10 times the force on A.

C) The force on A is exactly equal to the force on B.

D) The force on A is 100 times the force on B.

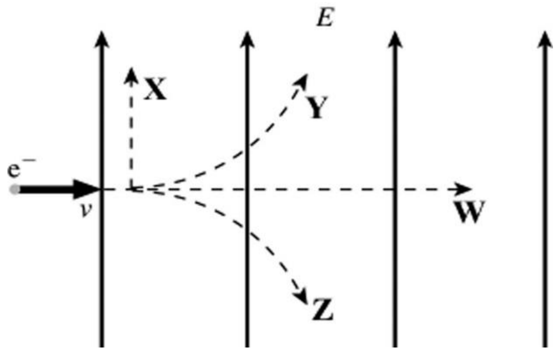
E) The force on B is 100 times the force on A.

Three equal charges +*Q* are at three of the corners of a square of side *d*.
A fourth charge +*Q* of equal magnitude is at the center of the square as shown in the figure
Which one of the arrows shown represents the net force acting on the charge at the center of the square?



A) A
B) B
C) C
D) D
E) None of the above

An electron is initially moving to the right when it enters a uniform electric field directed upwards, as shown in the figure. Which trajectory (**X**, **Y**, **Z**, or **W**) will the electron follow in the field?



A) trajectory **W**
B) trajectory **X**
C) trajectory **Y**
D) trajectory Z
E) None of the above

Current: $I = \frac{\Delta q}{\Delta t} = \frac{Ne}{t}$ $R = \rho \frac{L}{A}$; $V = I*R$ $P = \frac{E}{\Delta t}$ $P = I*V$; $P = I^2R$ $P = \frac{V^2}{R}$

AC current: $V = V_m \sin\omega t$ $V_{rms} = \frac{V_m}{\sqrt{2}}$ $I_{rms} = \frac{I_m}{\sqrt{2}}$ $P_{avg} = \frac{V_{rms}^2}{R}$ $P_{avg} = I_{rms}^2 R$

Circuits: in series : $R_{eq} = R_1 + R_2 + \ldots + R_n$ **in parallel:** $R_{eqv} = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1}$ $\sum V = 0$ $\sum I = 0$

12. A current of 1.60 mA flows in a wire. How many electrons are flowing past any point in the wire in 5 min? e = $1.6x10^{-19}$C   5 min = 300 s

I = $\frac{Ne}{t}$ N = $\frac{I*t}{e} = \frac{1.6x10^{-3}*300}{1.6x10^{-19}}$ = $3x10^{18}$ electrons

13. When a 1.0-m length of metal wire is connected to a 1.5 V battery, a current of 8.0 mA flows through it. What is the diameter of the wire? The resistivity of the metal is 2.24 × 10^{-8} Ω · m.

$$R = \rho \frac{\ell}{A}$$

V = IR

$$R = \frac{v}{I} = \frac{1.5\,V}{8x10^{-3}} = 187.5\ \Omega$$

$$A = \pi r^2$$

$$\pi r^2 = \frac{\rho L}{R}$$

$$\text{diameter} = 2r = 2\sqrt{\frac{\rho L}{\pi R}} = 2\sqrt{\frac{2.24x10^{-8} * 1m}{\pi 187.5}} = 12x10^{-6}\ m$$

15. A 100 W lightbulb has a resistance of 12 Ω when cold (20^oC) and 140 Ω when on (hot). Calculate the temperature of the filament when hot assuming an average temperature coefficient of resistivity $\alpha = 0.0045/^oC$.

$$R - R_o = R_o\alpha(T - T_o)$$

$$(T - T_o) = \frac{R - Ro}{R_0\alpha} \qquad T = T_o + \frac{R - Ro}{R_0\alpha} = 20^0C + \frac{140 - 20}{20 * 0.0045} = 1353^oC$$

16. An electrical heating coil of resistance of 28 Ω is used to heat up a 3.0 kg of water at 20.0^{0}C. What is the current in the heating coil if the water warms up to 60.0^0 C in 5 min? (specific heat of water is 4186 J/kg^{0}C)

$mc\Delta T = Pt$ $\quad$ $mc\Delta T = I^2R*t$

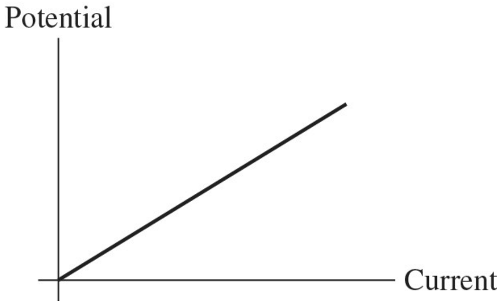
$$I = \sqrt{\frac{mc\Delta T}{Rt}} = \sqrt{\frac{3*4186*(60-20)}{28*5*60}} = 7.7\ A$$

17. A 200-W driveway light bulb is on 10 hours per day. Assuming the power company charges 10 cents for each kilowatt-hour of electricity used, estimate the annual cost to operate the bulb. (1 year = 365 days)

$E = Pt = 0.2\ kW*(10x365)hours = 730\ kWh$

$cost = \$0.1 * 730\ kWh = \$\ 73.0$

For the graph shown in the figure, what physical quantity does the slope of the graph represent for ohmic material?



A) power
B) resistivity
C) 1/(resistivity)
D) resistance
E) 1/(resistance)

A wire of resistivity ρ must be replaced in a circuit by a wire of the same material but four times as long. If, however, the total resistance is to remain as before, the diameter of the new wire must

A) be the same as the original diameter.
B) be one-half the original diameter.
C) be one-fourth the original diameter.
D) be two times the original diameter.
E) be four times the original diameter.

When the current through a resistor is increased by a factor of 4, the power dissipated by the resistor

A) decreases by a factor of 4.
B) decreases by a factor of 16.
C) increases by a factor of 16.
D) increases by a factor of 4.
E) increases by a factor of 2.

18. An ac voltage of $80V \cdot \sin(377 rad/s \cdot t)$ is applied across a resistor of 35 Ω. What is the average power dissipated in the resistor?

$$V_{rms} = \frac{V_{max}}{\sqrt{2}} = \frac{80}{\sqrt{2}} = 56.7V \qquad I_{rms} = \frac{V_{rms}}{R} = \frac{56.7}{35} = 1.62\ A$$

$$P = I_{rms}^2 * R = 1.62^2 * 35 = 92\ W$$

or

$$P = \frac{V_{rms}^2}{R} = \frac{56.7^2}{35} = 92\ W$$

For R_1 = 5 Ω, R_2 = 10 Ω and emf = 30 V, (a) find the current in the circuit , (b) potential difference across the resistor R_2 , and (c) power dissipated in the R_2 resistor

$V = IR_{eqv}$

(a) $I = \frac{emf}{R_1+R_2} = \frac{30}{15} = 2A$

(b) $V=IR_2$ = 2A*10Ω = 20V

© $P = I^2R_2 = (2A)^2 * 10\Omega = 40\ W$