STUDENT NUMBER:

NAME:

SECTION NUMBER:

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KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS

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COURSE: PHYS102

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EXAM: FINAL EXAM - 992

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TEST CODE NUMBER: XXX

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INSTRUCTIONS:

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1. PRINT YOUR STUDENT NUMBER, NAME, AND SECTION NUMBER ON THE EXAM.

2. PRINT YOUR STUDENT NUMBER, SECTION NUMBER, AND YOUR NAME ON THE EXAM ANSWER FORM. PRINT THE TEST CODE NUMBER, OR CHECK IT IF IT HAS ALREADY BEEN PRINTED ON YOUR ANSWER FORM.

3. CODE YOUR STUDENT NUMBER AND SECTION NUMBER ON THE EXAM ANSWER FORM. CODE THE TEST CODE NUMBER, OR CHECK IT IF IT IS ALREADY CODED.

4. CODE YOUR ANSWERS ON THE EXAM ANSWER FORM. YOU MUST NOT GIVE MORE THAN ONE ANSWER PER QUESTION.

5. RETURN THE ANSWER FORM TO THE INSTRUCTOR WHEN YOU HAVE FINISHED.

Dear respected student,

To get the most benefit form this old exam, I suggest the following,

(1) Solve it without seeing the answers.

(2) Time yourself. A question should not take more than 6 minutes.

(3) Compare your answers with the answers provided at the end of this exam.

(4) If your answer is wrong, study why you did not get it right. If you cannot know your mistake, ask your friends or come to me.

The formula sheet, figures and answers are provided at the end of the exam.

***********************************************************************
QUESTION NO: 1
*****************

A gold ring has a diameter of 2.168 cm at a temperature of 15 degree-C. Determine its diameter when the temperature is 215 degree-C.(Alpha of gold = 1.42*10**(-5) /C-degree.)

A. 3.185 cm
B. 3.514 cm
C. 50.16 cm
D. 2.174 cm
E. 2.397 cm

***********************************************************************
QUESTION NO: 2
*****************

A segment of wire is formed into the shape shown in Figure 5 and carries a current I = 1.0 A. What is the magnitude of the resulting magnetic field at the point P if R = 10 cm?

A. 5.5 micro-T into the page
B. 1.8 micro-T out of the page
C. 1.8 micro-T into the page
D. 5.5 micro-T out of the page
E. 2.6 micro-T out of the page

***********************************************************************
QUESTION NO: 3
*****************

A current of 17 milli-A is maintained in a circular loop of 2 m circumference which is parallel to the y-z plane (see Figure 4). A magnetic field B = (- 0.8 k) T is applied. Calculate the torque exerted on the loop by the magnetic field. (i, j and k are the unit vectors in x, y and z directions, respectively.)

A. (-2.27*10**(-2) i) N*m
B. ( 4.33*10**(-3) j) N*m
C. ( 2.27*10**(-2) i) N*m
D. (-4.33*10**(-3) j) N*m
E. ( 3.54*10**(-3) k) N*m

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QUESTION NO: 4
*****************

By what factor will the intensity of a sound wave change if the sound level is increased by 3 dB?

A. 1000
B. 9
C. 2
D. 3
E. 4

************************************************************************
QUESTION NO: 5
*****************

The work done in the expansion of a gas from an initial to a final state

A. depends only on the end points.
B. is negative.
C. is the area under the curve of a PV diagram.
D. always equals P*(Vf - Vi).
E. is the slope of a PV curve.

************************************************************************
QUESTION NO: 6
*****************

A 30 micro-F capacitor charged to 3.0 V and a 50 micro-F capacitor charged to 4.0 V are connected to each other, positive plate to positive plate and negative to negative. What is the charge on the 50 micro-F capacitor after the two are so connected and equilibrium is reached?

A. 109 micro-C
B. 181 micro-C
C. 320 micro-C
D. 157 micro-C
E. 290 micro-C

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QUESTION NO: 7
****************

An electron enters a region of magnetic field B = (0.40 i) T with a velocity v = (3.0*10**4 i + 2.0*10**5 j) m/s. (i, j and k are the unit vectors in x, y and z directions, respectively.) The magnetic force that the electron experiences is:

A. (-1.9*10**(-15) i) N
B. zero
C. (-1.3*10**(-14) k) N
D. ( 1.9*10**(-15) i) N
E. ( 1.3*10**(-14) k) N

****************************************************************************
QUESTION NO: 8
****************

An 800-MW electric power plant has an efficiency of 31%. How much heat is lost to the atmosphere per second?

A. 2677 MJ
B. 260 MJ
C. 807 MJ
D. 544 MJ
E. 1781 MJ

****************************************************************************
QUESTION NO: 9
****************

An electric device, which heats water by immersing a resistance wire in the water, generates 300 J of heat per second when an electric potential difference of 12 V is placed across its ends. What is the resistance of the heater wire?

A. 0.94 Ohms
B. 0.48 Ohms
C. 0.58 Ohms
D. 2.1 Ohms
E. 0.81 Ohms

****************************************************************************************
QUESTION NO: 10
*****************

Assume an ideal gas expands adiabatically.
Which one of the following statements is TRUE.

A. the pressure of the gas increases.
B. the internal energy of the gas remains constant.
C. the pressure of the gas remains constant.
D. the temperature of the gas increases.
E. the temperature of the gas decreases.

****************************************************************************************
QUESTION NO: 11
*****************

A single turn plane loop of wire of cross sectional area 40 cm**2 is perpendicular to a magnetic field that increases uniformly in magnitude from 0.5 T to 5.5 T in 2.0 seconds. What is the resistance of the wire if the induced current has a value of 1.0 milli-A.

A. 20 Ohms
B. 40 Ohms
C. 30 Ohms
D. 10 Ohms
E. 50 Ohms

****************************************************************************************
QUESTION NO: 12
*****************

The path difference between two waves is 5 m. If the wavelength of the waves emitted by the two sources is 4 m, what is the phase difference (in degrees)?

A. 75
B. 320
C. 45
D. 180
E. 450

*****************************************************************************
QUESTION NO: 13
*****************

Which one of the following statements is WRONG?

A. The total magnetic force on any closed current loop in a uniform magnetic field is zero.
B. The SI units of the magnetic moment is A*(m**2).
C. The work done by the magnetic force on a charge moving with a speed v in a static magnetic field B is always zero.
D. It is impossible to isolate magnetic monopoles.
E. A magnetic force acting on a moving negatively charged particle is always anti-parallel to its direction of motion.

*****************************************************************************
QUESTION NO: 14
*****************

Two long wires parallel to the x-axis carry currents I1 and I2 as shown in Figure 6. If I1 = 5 A, what is the magnitude and direction of I2 if the net magnetic field at the origin is 0.35 micro-T and directed out the page.

A. 5 A to the right
B. 5 A to the left
C. 2 A to the right
D. 1 A to the right
E. 1 A to the left

*****************************************************************************
QUESTION NO: 15
*****************

A uniform magnetic field B = (2.0 i + 4.0 j + 5.0 k) T intersects a circular surface of radius 2 cm lying in the yz plane. What is the magnetic flux through this surface?

A. 5.0*10**(-3) T*m**2
B. zero
C. 8.4*10**(-3) T*m**2
D. 6.3*10**(-3) T*m**2
E. 2.5*10**(-3) T*m**2

*******************************************************************************
QUESTION NO: 16
*****************

Two infinite non-conducting parallel surfaces carry uniform charge densities of 0.20 nano-C/m**2 and -0.60 nano-C/m**2. What is the magnitude of the electric field at a point between the two surfaces?

A. 34 N/C
B. 17 N/C
C. 45 N/C
D. 90 N/C
E. 23 N/C

*******************************************************************************
QUESTION NO: 17
*****************

A proton enters a region of uniform electric field (E = 80 N/C) with an initial velocity of 20 km/s directed perpendicularly to the electric field. What is the speed of the proton 2.0 micro-seconds after entering this region?

A. 4.7 km/s
B. 25 km/s
C. 42 km/s
D. 15 km/s
E. 35 km/s

*******************************************************************************
QUESTION NO: 18
*****************

Calculate the voltage E of the battery shown in Figure 1.

A. 50 V
B. 40 V
C. 10 V
D. 20 V
E. 30 V

*************************************************************************
QUESTION NO: 19
*****************

The light bulbs in the circuit of Figure 2 are identical. When the switch S is closed, then:

A. nothing changes to the intensity of the light bulbs.
B. the intensity of light bulb B increases while the intensity of light bulb A decreases.
C. the intensity of light bulb A increases while the intensity of light bulb B decreases.
D. the intensities of both light bulbs increase.
E. both light bulbs turn off.

*************************************************************************
QUESTION NO: 20
*****************

The air in an automobile engine at 20 degree-C is compressed from an initial pressure of 1 atm and a volume of 200 cm**3 to a final volume of 20 cm**3. Find the final temperature if the air behaves like an ideal gas (gamma = 1.4) and the compression is adiabatic.

A. 463 degree-C
B. 10 degree-C
C. 20 degree-C
D. 50 degree-C
E. 526 degree-C

*************************************************************************
QUESTION NO: 21
*****************

Figure 7 shows a conducting bar moving with a constant speed of 5.0 m/s to the right. Assume that R = 5.0 Ohms, L = 0.20 m, and that a uniform magnetic field of 3.5 T is directed into the page. Calculate the magnitude of the applied force pulling the bar.(Neglect the mass of the bar.)

A. 0.25 N
B. 0.73 N
C. 1.5 N
D. 0.49 N
E. 0.92 N

**********************************************************************
QUESTION NO: 22
*****************

What must be the radius R of a long current-carrying wire if the magnetic field at r1 = 2.0 cm (inside the wire) is equal to three times the magnetic field at r2 = 8.0 cm (outside the wire).

A. 4.4 cm
B. 5.2 cm
C. 7.3 cm
D. 2.3 cm
E. 3.8 cm

**********************************************************************
QUESTION NO: 23
*****************

The circuit in Figure 3 has been connected for a long time. Find the potential difference Vb - Va.

A. 2 V
B. 8 V
C. 10 V
D. 6 V
E. 12 V

**********************************************************************
QUESTION NO: 24
*****************

One gram of water is heated from 0 degree-C to 80 degree-C at a constant pressure of 1 atm. Determine the change in internal energy of the water. Neglect the change in volume of the water. (Cwater = 4186 J/kg*K.)

A. 80 cal
B. 100 cal
C. 250 cal
D. 180 cal
E. 50 cal

*******************************************************************************
QUESTION NO: 25
*****************

Ocean waves, with a wavelength of 12 m, are coming in at a rate of 20 crests per minute. What is their speed?

A. 4.0 m/s
B. 30 m/s
C. 24 m/s
D. 16 m/s
E. 8.0 m/s

*******************************************************************************
QUESTION NO: 26
*****************

A 40 micro-C charge is positioned on the x axis at x = 4.0 cm. In order to produce a net electric field of zero at the origin, where, on the x-axis, should a -60 micro-C charge be placed?

A. 4.9 cm
B. -6.0 cm
C. -5.3 cm
D. 5.7 cm
E. 6.0 cm

*******************************************************************************
QUESTION NO: 27
*****************

A 4.0 nano-C point charge is located at the origin, and a second point charge (-5.0 nano-C) is placed on the y axis at y = 60 cm. If point A is at (45 cm, 0) and point B is at (80 cm, 0), what is the potential difference between points A and B (VA - VB)?

A. 17 V
B. 30 V
C. zero
D. 40 V
E. 20 V

*************************************************************************************
QUESTION NO: 28
*****************

An electron moving perpendicular to a 50 micro-T magnetic field, goes through a circular trajectory. What is the time required to complete one revolution?

A. 420 nano-seconds
B. 150 nano-seconds
C. 420 micro-seconds
D. 840 micro-seconds
E. 715 nano-seconds

*************************************************************************************
QUESTION NO: 29
*****************

A 500 turns solenoid is 30 cm long, has a radius of 0.5 cm and carries a current of 2.0 A. The magnitude of the magnetic field at the center of the solenoid is:

A. 9.9*10**(-8) T
B. 1.3*10**(-3) T
C. 5.6*10**(-8) T
D. 8.2*10**(-3) T
E. 4.2*10**(-3) T

*************************************************************************************
QUESTION NO: 30
*****************

A 4.00 micro-F capacitor is charged to 24.0 V. Find the charge on the capacitor 4.00 milli-seconds after it is connected across a 200-Ohm resistor.

A. 2.45 micro-C
B. 0.647 micro-C
C. 100 micro-C
D. 0.324 micro-C
E. 15.5 micor-C

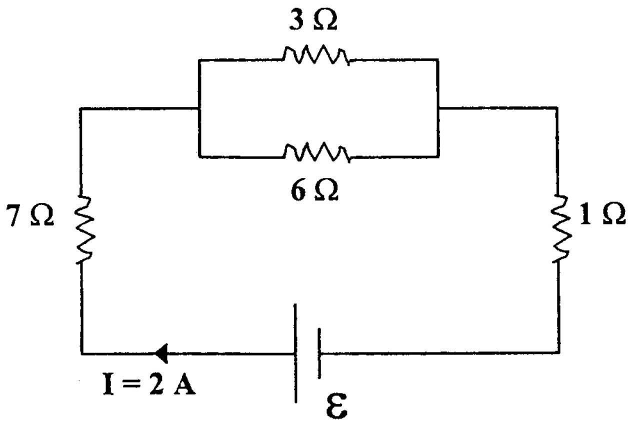



FIGURE 1

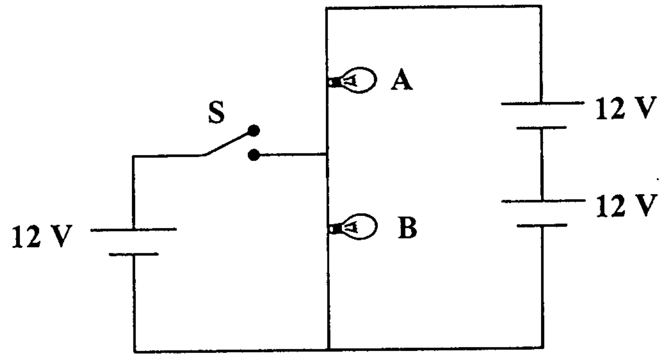



FIGURE 2

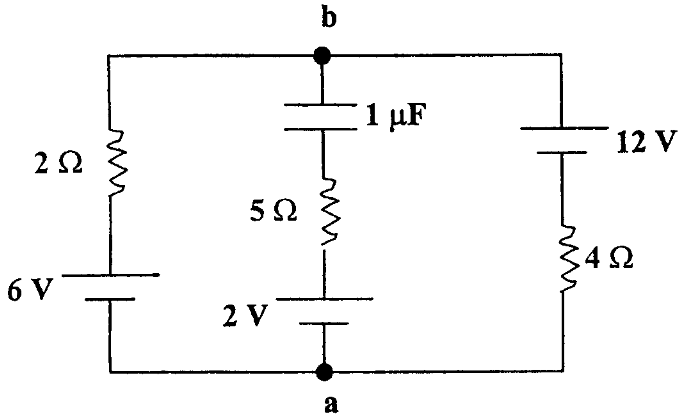



FIGURE 3

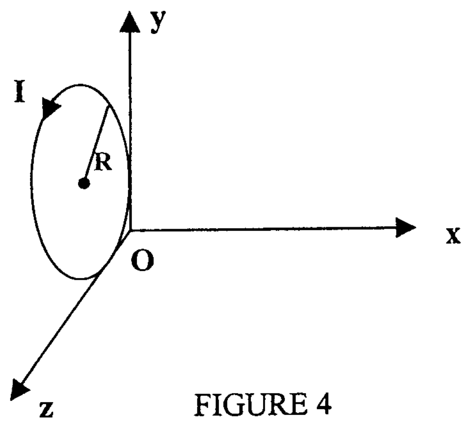



FIGURE 4

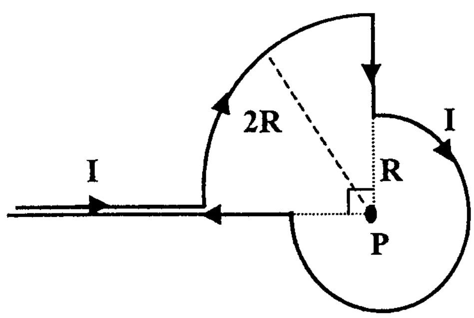



FIGURE 5

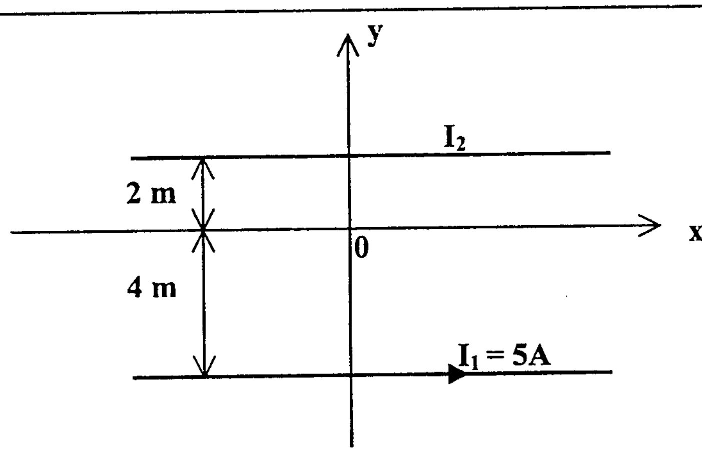



FIGURE 6

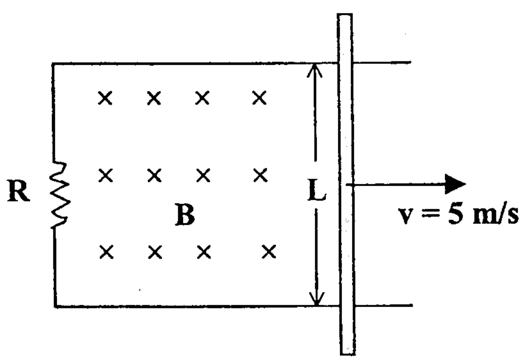



FIGURE 7

وفقكم الله و رفع درجاتكم. آمين

Phys-102
Final exam
Term-992

# Physics 102-Formula sheet for Final Exam
## Srping Semester 1999-2000 (Term 992)

$v=\sqrt{\dfrac{B}{\rho}}$; $v=\sqrt{\dfrac{F}{\mu}}$; $v=\lambda f$

$y = A\sin(kx-\omega t-\phi)$

$P=\dfrac{1}{2}\mu\omega^2A^2v$

$\Delta P = \Delta P_m \sin(kx-\omega t)$

$\Delta P_m = \rho v\omega S_m$

$I=\dfrac{1}{2}\rho(\omega S_m)^2 v$

$\beta = 10\log\dfrac{I}{I_0}$, $I_0=10^{-12} W/m^2$

$f_0 = f_s\left(\dfrac{v\pm v_o}{v\mp v_s}\right)$

$y=\left(2A_0\cos\dfrac{\phi}{2}\right)\sin\left(kx-\omega t-\dfrac{\phi}{2}\right)$

$f_n=\dfrac{nv}{2L}$, $n=1,2,3,\ldots$

$f_n=\dfrac{n}{2L}\sqrt{\dfrac{F}{\mu}}$, $n=1,2,3,\ldots$

$f_n=\dfrac{nv}{4L}$, $n=1,3,5,\ldots$

(Pipe closed at one end)

$y=2A_0\sin kx\cos\omega t$

$\alpha=\dfrac{\Delta L}{L}\dfrac{1}{\Delta T}$

$PV=nRT=Nk_BT$

$\beta=\dfrac{1}{V}\dfrac{\Delta V}{\Delta T}$

$n=\dfrac{m}{M}=\dfrac{N}{N_A}$

$Q=mL$

$\Delta U = Q-W$

$W=\int PdV$

$W = nRT\ \ln(\dfrac{V_f}{V_i})$

$P=\dfrac{2}{3}\dfrac{N}{V}(\dfrac{1}{2}m\bar{v}^2)$

$\dfrac{1}{2}m\bar{v}^2=\dfrac{3}{2}k_BT$

$U=\dfrac{3}{2}nRT$

$\Delta U = nC_v\Delta T$, $Q=mc\Delta T$

$Q=nC_p\Delta T$, $Q=nC_v\Delta T$

$PV^\gamma=\text{constant}$, $TV^{\gamma-1}=\text{constant}$

$F=\dfrac{9}{5}C+32$, $K=C+273$

$W=Q_h-Q_c$, $e=\dfrac{W}{Q_h}$

$(COP)_{Ref}=\dfrac{Q_c}{W}$,

$(COP)_{Heat-Pump}=\dfrac{Q_h}{W}$

$ds=\dfrac{Q_T}{T}$

$F=\dfrac{kq_1q_2}{r^2}$, $F=q_0E$

$\phi=\int_{Surface}\vec{E}.d\vec{A}$; $E=\dfrac{kQ}{r^2}$; $E=\dfrac{\sigma}{\varepsilon_o}$

$\phi_c=\oint\vec{E}.d\vec{A}=\dfrac{q_{in}}{\varepsilon_0}$

$\Delta V=V_B-V_A=-\int_A^B\vec{E}.d\vec{S}=\dfrac{\Delta U}{q_0}$

$E_x=-\dfrac{\partial V}{\partial x}$, $E_y=-\dfrac{\partial V}{\partial y}$,

$E_z=-\dfrac{\partial V}{\partial z}$

$U=\dfrac{kq_1q_2}{r_{12}}$

$C=\dfrac{Q}{V}$, $C=\dfrac{\varepsilon_0A}{d}$

$U=\dfrac{1}{2}CV^2$

$C=KC_0$, $E=\dfrac{E_0}{K}$, $V=\dfrac{V_0}{K}$

$I=\dfrac{dQ}{dt}$, $I=nqv_dA$

$R=\dfrac{V}{I}=\rho\dfrac{L}{A}$

$J=\sigma E$

$\rho=\rho_0[1+\alpha(T-T_0)]$

$P=IV$

$I(t)=\dfrac{\varepsilon}{R}e^{-t/RC}$

$q(t)=Q[1-e^{-t/RC}]$

$q(t)=Q\,e^{-t/RC}$

$I(t)=I_0\,e^{-t/RC}$

$\vec{F}=q\vec{v}\times\vec{B}+q\vec{E}$

$d\vec{F}=I\,d\vec{s}\times\vec{B}$

$\vec{\tau}=\vec{\mu}\times\vec{B}$, $\vec{\mu}=I\vec{A}$

$r=\dfrac{mv}{qB}$

$d\vec{B}=\dfrac{\mu_0}{4\pi}\dfrac{I\,d\vec{s}\times\hat{r}}{r^2}$

$\oint\vec{B}.d\vec{s}=\mu_0 I_{in}$; $B=\dfrac{\mu_o I}{2\pi R^2}r$

$B=\dfrac{\mu_0 I}{4\pi R}\theta$, $B=\dfrac{\mu_0 I}{2\pi a}$

$B=\dfrac{\mu_0 I}{4\pi a}(\cos\theta_1-\cos\theta_2)$

$B_s=\mu_0 nI$

$\dfrac{F}{L}=\dfrac{\mu o I_1 I_2}{2\pi r}$; $\phi_m=\int_{Surface}\vec{B}.d\vec{A}$

$\varepsilon=-\dfrac{d\phi_m}{dt}$, $\varepsilon=BLv$

$W=\Delta K=-\Delta U$

$\varepsilon_0 = 8.85\times10^{-12}\ C^2/N.m^2$

$k=9.0\times10^9\ N.m^2/C^2$

$q_e=-1.6\times10^{-19}\ C$

$m_e=9.11\times10^{-31}\ kg$

$m_p=1.67\times10^{-27}\ kg$

$1\ eV=-1.6\times10^{-19}\ J$

$1\ cal=4.186\ J$

$\mu_0=4\pi\times10^{-7}\ Wb/A.\ m^2$

$k_B=1.38\times10^{-23}\ J/K$

$N_A=6.022\times10^{23}$ molecules/mole

$1\ atm=1.013\times10^5\ N/m^2$

$R=8.31\ J/mol.\ K$

$\rho$(water)=1 $g/cm^3$

$g=9.8\ m/s^2$

milli=$10^{-3}$,micro=$10^{-6}$,nano=$10^{-9}$

$v=v_0+at$; $x=v_0t+\dfrac{1}{2}at^2$

$v^2={v_0}^2+2ax$

May 21, 02

Phys 102 - Final - 092 - p1

**Q1**

$l_f$ = final length
$l_i$ = initial length

$$\Delta l = \alpha l \Delta T$$

$$l_f - l_i = \alpha l_i (T_f - T_i)$$

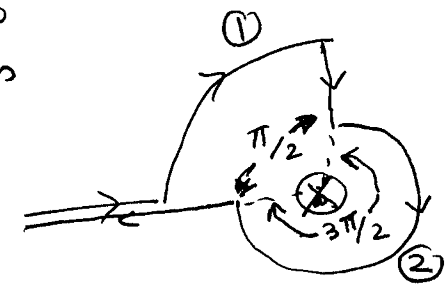
$$l_f = l_i + \alpha l_i (T_f - T_i)$$

$$= 2.168 + 1.42 \times 10^{-5} (2.168)(215 - 15)$$

$$= 2.174 \text{ cm}$$

**Q2**

The magnetic field due to all straight segments is zero, because on these segments, the angle between $\vec{ds}$ and $\vec{r}$ is either $0°$ or $180°$ $\Rightarrow$ $\vec{ds} \times \vec{r} = 0$




$$\vec{B} = \vec{B}_{①} + \vec{B}_{②}$$

due to arc ① ~~segm.~~

$$B = \frac{\mu_0}{4\cancel{\pi}} \frac{i}{2R} \frac{\cancel{\pi}}{\cancel{2}} + \frac{\mu_0}{4\cancel{\pi}} \frac{i}{R} \frac{3\cancel{\pi}}{2}$$ due to Arc ②

$$= \frac{\mu_0 i}{8R} \left( \frac{1}{2} + 3 \right)$$

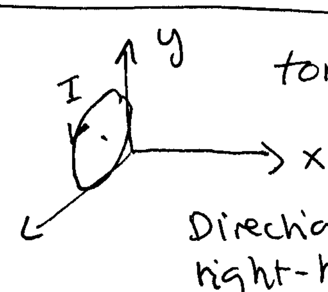
$$= \frac{4\pi \times 10^{-7}}{8(0.1)} (1) \left( \frac{7}{2} \right) = \underline{5.5 \mu T}$$

Right hand rule

if your thumb of your right hand along the direction of the current, then the rest of your fingers point along $\vec{B}$.

According to the right hand rule, $B_{①}$ and $B_{②}$ point into the page.

**Q3**




torque $= \vec{\tau} = \vec{\mu} \times \vec{B}$

magnetic moment. $\mu = AI$

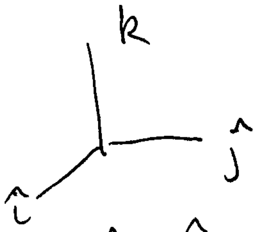
Area of the loop

current

Direction of $\vec{\mu}$ use right-hand rule

- your four straight fingers of your right hand is along I with inner side of your hand facing the loop.
- your thumb points along $\vec{\mu}$.

Q3 cont. $\vec{\mu}$ points along positive x-axis




$\hat{i} \times \hat{k} = -\hat{j}$

$$\vec{\tau} = AI\,\hat{i} \times (-0.8\,\hat{k})$$
$$= AI(0.8)\,\hat{j}$$
$$= \pi R^2 I(0.8)\,\hat{j}$$
$$= \pi\left(\frac{2}{2\pi}\right)^2 17\times10^{-3}(0.8)\,\hat{j}$$
$$= 4.33\times10^{-3}\,\hat{j}$$

Circumference $= 2\pi R$

---

Q4

$$\beta = 10\log\frac{I}{I_0}$$

sound level

$$\beta_f - \beta_i = 10\log\frac{I_f}{I_0} - 10\log\frac{I_i}{I_0}$$
$$= 10\log\frac{I_f}{\cancel{I_0}}\cdot\frac{\cancel{I_0}}{I_i} = 10\log\frac{I_f}{I_i}$$
$$\Rightarrow \frac{I_f}{I_i} = 10^{\frac{\beta_f-\beta_i}{10}} = 10^{3/10} = 2.$$

---

Q5 is the area under the curve of a PV diagram

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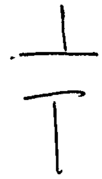
Q6

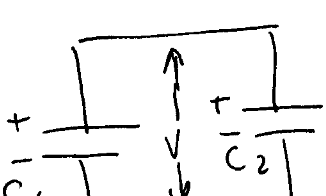
$Q_{01} = C_1 V_{01}$
$= (30\mu)(3)$
$= 90\,\mu C$



$Q_{02} = C_2 V_{02}$
$= (50\mu)4$
$= 200\,\mu C$

$V = \frac{Q_1}{C_1} = \frac{Q_2}{C_2}$ but charge is conserved $\Rightarrow$

$Q_{01} + Q_{02} = Q_1 + Q_2$
$90C + 200C = Q_1 + Q_2$
$Q_1 = 290\mu C - Q_2$




$$\frac{290\mu C - Q_2}{30\mu F} = \frac{Q_2}{50\mu F}$$

$$50(290\mu C - Q_2) = 30\,Q_2$$
$$50(290\mu C) = (30+50)Q_2 \Rightarrow Q_2 = \frac{50(290)}{80}\mu C = 181\,\mu C$$

May 21, 02

Phys102-Final-092-p3

**Q.7**

$$\vec{F} = q\,\vec{v}\times\vec{B}$$

$1.6\times10^{-19}C$

$$= -e(3\times10^{4}\,\hat{i} + 2\times10^{5}\,\hat{j}) \times 0.4\,\hat{i}$$

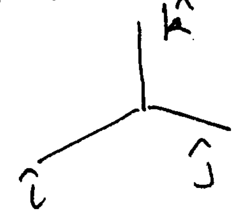
$$= -e(2\times10^{5})(0.4)(-\hat{k})$$

$$= (1.6\times10^{-19})(2\times10^{5})(0.4)\,\hat{k}$$

$$= 1.3\times10^{-14}\,\hat{k}$$

$\hat{i}\times\hat{i} = 0$

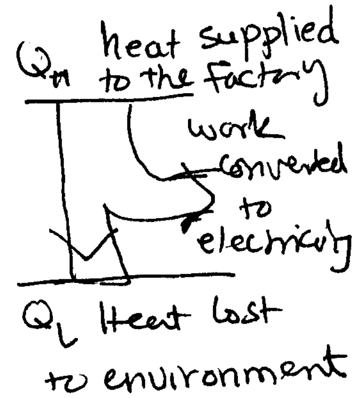
$\hat{j}\times\hat{i} = -\hat{k}$




**Q8**

$$\varepsilon = \frac{\overbrace{W}^{\text{work (electricity produced)}}}{\underbrace{Q_H}_{\text{Heat energy supplied}}} = \frac{W}{Q_L + W}$$

heat lost




$$\varepsilon(Q_L + W) = W$$

$$\varepsilon Q_L + \varepsilon W = W$$

$$Q_L = \frac{W(1-\varepsilon)}{\varepsilon} = \frac{800\,(1-0.31)}{0.31}$$

$$= 1781\ \text{MJ}$$

**Q9**

$$P = IV = \frac{V}{R}V = \frac{V^2}{R} \Rightarrow R = \frac{V^2}{P} = \frac{(12)^2}{300} = 0.48\,\Omega$$

**Q10** The temperature of the gas decreases

T

$$T_i V_i^{\gamma-1} = T_f V_f^{\gamma-1}$$

$$T_f = T_i\left(\frac{V_i}{V_f}\right)^{\gamma-1}$$

$$= T_i\left(\frac{V_i}{V_f}\right)^{5/3-1}$$

smaller than 1

**Q11**

uniform B and flat A

$$\varepsilon = \frac{d\phi}{dt} = \frac{d}{dt}BA = A\frac{dB}{dt}$$

constant

ignore sign. we are interested in magnitudes

$$\varepsilon = IR$$

$$\Rightarrow IR = A\frac{dB}{dt}$$

convert to m

$$R = \frac{A}{I}\frac{dB}{dt} = \frac{(40\times10^{-4})(5.5-0.5)}{(1\times10^{-3})\ (2)} = 10\,\Omega$$

**Q12**

$$\frac{\phi}{2\pi} = \frac{\Delta x}{\lambda} \Rightarrow \phi = 2\pi\,\frac{5}{4}\,\text{rad}\left(\frac{180^\circ}{\pi\,\text{rad}}\right) = 450^\circ$$

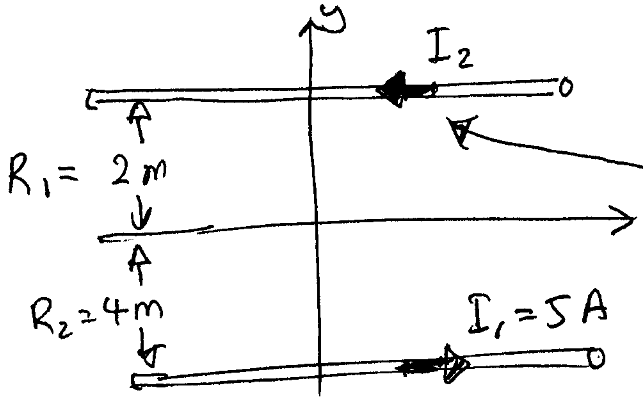
to convert from rad to degrees

This statement is WRONG

**Q13** "A magnetic force acting on a moving negatively charged particle is always anti-parallel to its direction of motion"

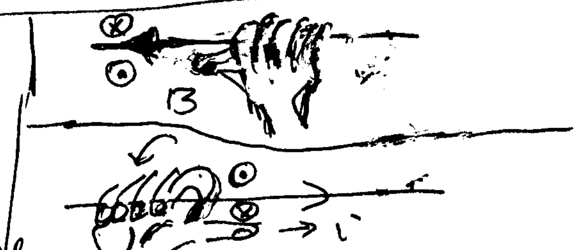
---

**Q14**




assume direction

positive z - axis out of the page




note when $I_2$ moves to the left, ~~the~~ the magnetic field it produces points out of the page

$$\vec{B} = \vec{B}_1 + \vec{B}_2$$

$$(0.35\mu T)\hat{k} = \left(\frac{\mu_0}{2\pi}\frac{I_1}{R_1}\right)\hat{k} + \boxed{\left(\frac{\mu_0}{2\pi}\frac{I_2}{R_2}\right)\hat{k}}$$

$$0.35\times10^{-6} = \frac{4\pi\times10^{-7}}{2\pi}\frac{5}{4} + \frac{4\pi\times10^{-7}}{2\pi}\frac{I_2}{2}$$

$$0.35\times10^{-6} = \frac{5}{2}\times10^{-7} = 10^{-7}I_2$$

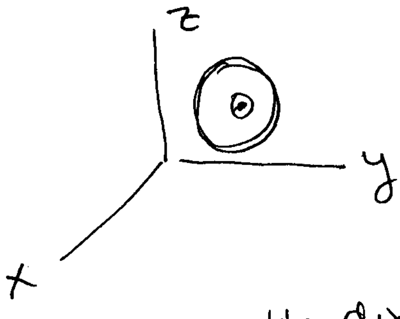
$$3.5 - 2.5 = I_2$$

$$I_2 = 1\ A$$

since it is positive our assumption is right and $I_2$ points towards left

---

**Q15**




$$\phi = \int \vec{B}\cdot d\vec{A}$$

since B is constant

$$\phi = \vec{B}\cdot\vec{A}$$

$\hat{i}\cdot\hat{i} = 1$
$\hat{i}\cdot\hat{j} = 0$
$\hat{i}\cdot\hat{k} = 0$

$$= (2\hat{i} + 4\hat{j} + 5\hat{k})\cdot \pi r^2\hat{i}$$

the direction of $\vec{A}$ is perpendicular to the surface

$$= 2(\pi(0.02)^2)$$

$$= 2.5\times10^{-3}\ Tm^2$$

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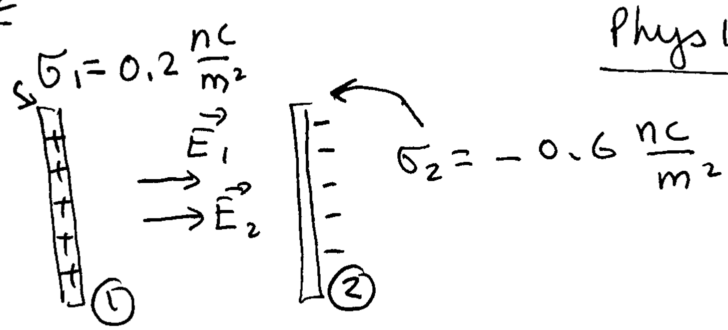
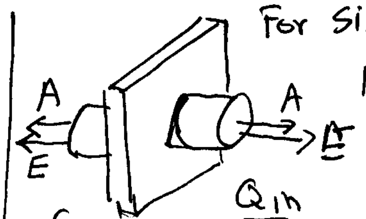
## Q16




For single plate




$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{in}}{\varepsilon_0}$$

$$EA + EA = \frac{\sigma A}{\varepsilon_0}$$

$$E = \frac{\sigma}{2\varepsilon_0}$$

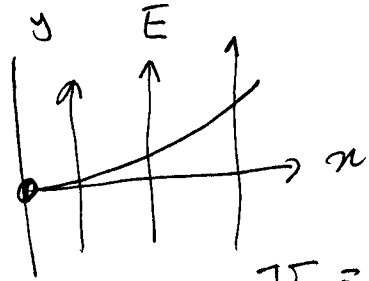
$$\vec{E} = \vec{E}_1 + \vec{E}_2$$

$$E = \frac{\sigma_1}{2\varepsilon_0} + \frac{|\sigma_2|}{2\varepsilon_0}$$

between the plates $\vec{E}_1$ and $\vec{E}_2$ point right

$$= \frac{1}{2(8.85\times10^{-12})}\left\{0.2\times10^{-9} + 0.6\times10^{-9}\right\} = 45 \frac{N}{C}$$

## Q17




$$a_y = \frac{F_y}{m} = \frac{qE}{m}$$

$$a_x = 0 \Rightarrow v_x = v_{x0}$$

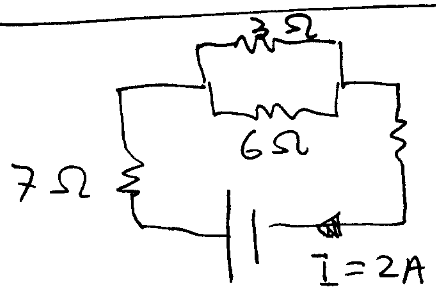
$$v_y = v_{oy} + a_y t = 0 + \frac{qE}{m}t = \frac{1.6\times10^{-19}}{1.7\times10^{-27}} 80\times2\times10^{-6}$$

$$= 15.3 \text{ km/s}$$

$$\text{Speed} = \sqrt{v_y^2 + v_x^2} = \sqrt{15.3^2 + 20^2} \text{ Km/s}$$

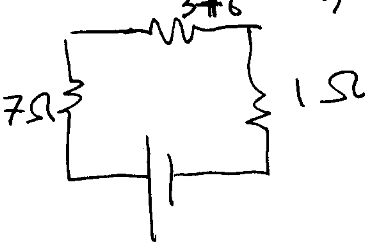
$$= 25 \text{ Km/s}$$

## Q18



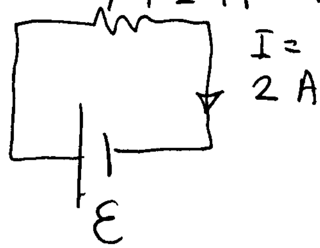

$$\Rightarrow$$

$$\frac{(3)(6)}{3+6} = \frac{18}{9} = 2\Omega$$




$$7 + 2 + 1 = 10\,\Omega$$

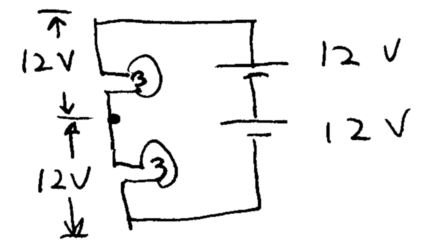
$$\Rightarrow$$




$$\varepsilon = IR$$

$$= 2(10) = 20 \text{ V}$$

Q19 nothing changes to the intensity of the light bulbs. beforce closing the switch voltage across bulb A = 12V and across bulb B = 12V. No voltage changes across the bulbs after closing the switch

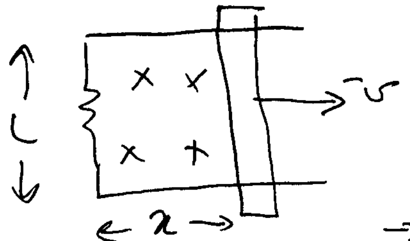



Q20 $TV^{\gamma-1}$ = const for an ideal gas undergoing adiabatic process.

$$T_i V_i^{\gamma-1} = T_f V_f^{\gamma-1}$$

$$T_f = T_i \left(\frac{V_i}{V_f}\right)^{\gamma-1} = 20\left(\frac{200}{20}\right)^{1.4-1} = 20(10)^{0.4}$$
$$= 50\ ^\circ c$$

Q21




$$\mathcal{E} = -\frac{d}{dt}\phi = -\frac{d}{dt}\int \vec{B}\cdot d\vec{A}$$

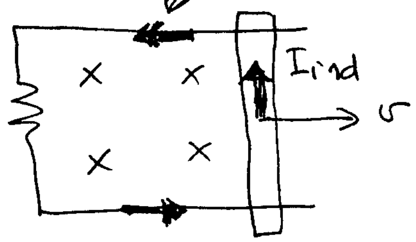
$d\vec{A}$ is a vector perpendicular to the area of the loop. We may choose it to point upward or downward. Let us choose it downward. This means, according to the right-hand rule, current produced from positive $\mathcal{E}$ will flow clockwise.

$$\mathcal{E} = -\frac{d}{dt}\int B\,dA = -\frac{d}{dt}\int BL\,dx = -BL\frac{d}{dt}\int dx$$
$$= -BL\frac{dx}{dt} = -BLv$$

since $\mathcal{E}$ is negative, the induced current flows counterclockwise.

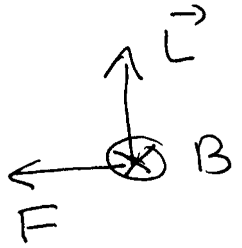
Q21 cont.

induced current = $I_{ind}$




$$I_{ind} = \frac{|\mathcal{E}|}{R} = \frac{BLv}{R}$$

Force on the bar $\vec{F} = I_{ind}\,\vec{L} \times \vec{B}$




$$F = I_{ind} L B = \frac{B^2 L^2 v}{R}$$

$$= \frac{(3.5)^2 (0.2)^2\, 5}{5} = 0.49 \text{ N to Left.}$$

Note you will get the same direction of the induced current if you choose $d\vec{A}$ to point upward

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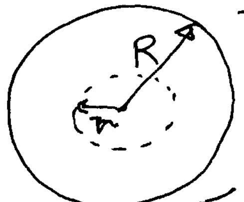
Q22 Ampere's law $\oint \vec{B}\cdot d\vec{s} = \mu_0 I_{inc}$

Inside wire

let $I$ total current through the wire




$$\oint \vec{B}\cdot d\vec{s} = B_{in}\, 2\pi r = \mu_0 I_{inc}$$

$I_{inc} = JA = \frac{I}{\pi R^2}\pi r_{in}^2$

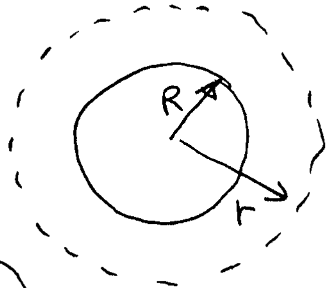
current density

area enclosed by Ampere's loop

$$B_{in}(2\pi r) = \mu_0 \frac{I}{R^2} r_{in}^2$$

$$B_{in} = \frac{\mu_0}{2\pi} I \frac{r}{R^2}$$

outside wire




$$\oint \vec{B}\cdot d\vec{s} = B_{out}\, 2\pi r_{out} = \mu_0 I$$

$$B_{out} = \frac{\mu_0}{2\pi} I \frac{1}{r_{out}}$$

magnetic field at 2 cm inside wire

$$\frac{\cancel{\mu_0}}{\cancel{2\pi}} \cancel{I} \frac{(2)}{R^2} = 3 \frac{\cancel{\mu_0}}{\cancel{2\pi}} \cancel{I} \frac{1}{(8)}$$

magnetic field at 8 cm outside wire

$$\frac{2}{R^2} = \frac{3}{8} \Rightarrow R^2 = \frac{16}{3} \Rightarrow R = 2.3 \text{ cm}$$

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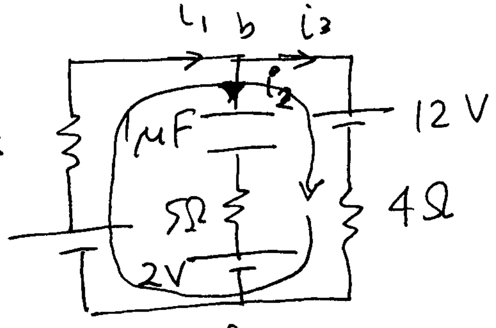
Q23




Since the circuit is connected for a long time, there is no current flowing through the capacitor.

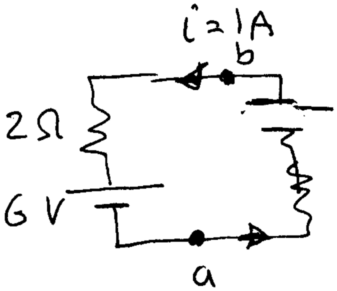
$i_2 = 0$

$i_1 = i_3 = i$

$6 - 2i - 12 - 4i = 0$

$-6i - 6 = 0 \Rightarrow i = -1\,A$

the correct current is in the opposite direction




$V_a + 6 + 2(1) = V_b \Rightarrow V_b - V_a = 8\,V$

---

Q24

$\Delta E = Q - W$

$W \approx 0$ we ignore the change in volume

$\Delta E = c\, m\, \Delta T$

$= (4186)(1 \times 10^{-3})(80 - 0)$

$= (4.186)(80)\,J \, \dfrac{1\,cal}{4.186\,J}$

$= 80$ cal.

**Q25** $v = f\lambda$

$= \frac{20}{60}(12) = 4$ m/s

accurate way

20 crests per minute

= 19 periods per minute

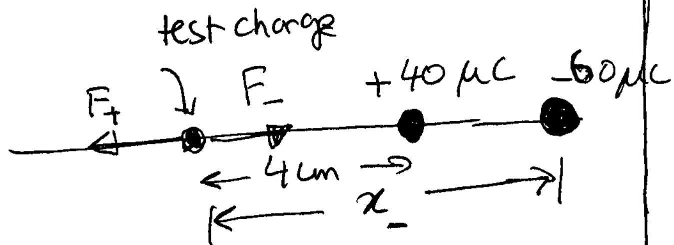
$\Rightarrow f = \frac{20-1}{60}$ Hz

$v = \frac{19}{20} 12 = 3.8$ m/s

simple example If you have two crests coming per second you have one period passing.

key

**Q26**

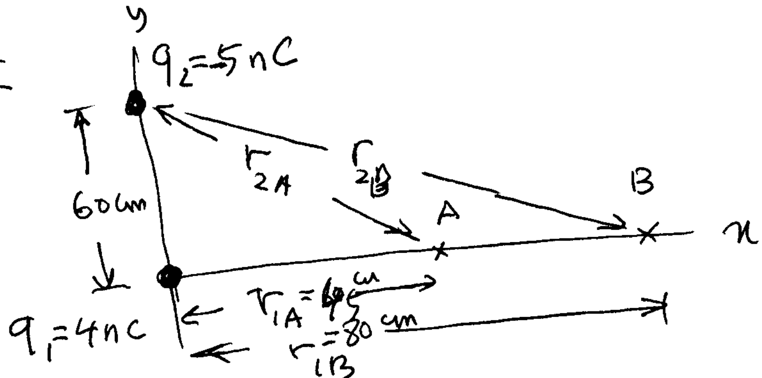



$\cancel{k}\frac{q_+}{x_+^2} = \cancel{k}\frac{q_-}{x_-^2}$

$x_- = x_+\sqrt{\frac{q_-}{q_+}}$

$= 4\sqrt{\frac{60}{40}} = 4.9$ cm

**Q27**




$V_A = k\frac{q_1}{r_{1A}} + k\frac{q_2}{r_{2A}}$ ; $V_B = k\frac{q_1}{r_{1B}} + k\frac{q_2}{r_{2B}}$

$V_A - V_B = kq_1\left(\frac{1}{r_{1A}} - \frac{1}{r_{1B}}\right) + kq_2\left(\frac{1}{r_{2A}} - \frac{1}{r_{2B}}\right)$

$= 9\times10^9(4\times10^{-9})\left(\frac{1}{0.45} - \frac{1}{0.8}\right)$

$+ 9\times10^9(-5\times10^{-9})\left(\frac{1}{\sqrt{0.45^2+0.6^2}} - \frac{1}{\sqrt{0.8^2+0.6^2}}\right)$

$= 20$ V

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Q28

$$r = \frac{mv}{qB} \Rightarrow T = \frac{2\pi r}{v} = 2\pi \frac{m}{qB}$$

period

$$T = 2\pi \frac{9.1\times10^{-31}}{1.6\times10^{-19}\ 50\times10^{-6}} = 715\times10^{-9}\,s$$
$$= 715\ ns$$

Q29

$$B = \mu_0 I n = 4\pi\times10^{-7}(2)\frac{500}{0.3} = 4.2\ mT$$
$$= 4.2\times10^{-3}\,T$$

Q30

$$q = q_0 e^{-t/RC}$$
$$= CV e^{-t/RC}$$
$$= (4\times10^{-6})(24)\ e^{-\frac{4\times10^{-6}}{(200)(4\times10^{-6})}} = 0.647$$