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: 2ND MAJOR 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.

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QUESTION NO: 1

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An electron starts from point P (at t = 0) with an initial velocity vo =(8.6*10**5)i m/s in an electric field E =(4.1*10**3)i N/C. Find the time it takes the electron to return to point P.
(i is the unit vector along the positive x-axis.)

A. 1.2*10**(-8) sec
B. 1.2*10**(-9) sec
C. 3.5*10**(-9) sec
D. 2.4*10**(-9) sec
E. 2.4*10**(-8) sec

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QUESTION NO: 2

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A heat engine has a monatomic gas as the working substance and its operating cycle is shown by the P-V diagram in Figure 1. In one cycle, 18.2 kJ of heat energy is absorbed by the engine. Find the efficiency of the heat engine.

A. 0.55
B. 0.44
C. 0.31
D. 0.25
E. 0.22

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QUESTION NO: 3

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A solid conducting sphere of radius R = 5.0 cm has a charge density of 2.0*10**(-6) C/m**2 on its surface. What is the electric potential at the center of the sphere?
(Take V = 0 at infinity.)

A. 3.6*10**4 V
B. 7.2*10**4 V
C. 2.2*10**4 V
D. zero
E. 1.1*10**4 V

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QUESTION NO: 4

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A 2.0 micro-C charge is placed at the origin. An identical charge is placed 2.0 m from the origin on the x-axis, and a third identical charge is placed 2 m from the origin on the y-axis. The magnitude of the force on the charge at the origin is:

A. 9.0*10**(-3) N
B. 1.8*10**(-3) N
C. 2.6*10**(-2) N
D. 6.4*10**(-2) N
E. 1.3*10**(-2) N

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QUESTION NO: 5

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A point charge of 4.0 nano-C is located at a point having coordinates (30.0 cm, 40.0 cm). At what point will the electric field be 72 N/C and pointing in the negative y-direction?

A. (30.0, 70.7) cm
B. (30.0, -30.7) cm
C. (10.0, -89.9) cm
D. (30.0, 49.9) cm
E. (30.0, -49.9) cm

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QUESTION NO: 6

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A container holds 240 g of water at 8 degrees-C. The container is placed in a refrigerator maintained at - 5 degrees-C. Calculate the change in entropy of the water after it is in thermal equilibrium with the refrigerator. C(ice)=2090 J/(kg*K), C(water)=4186 J/(kg*K), Lf=3.33*10**(5) J/Kg.

A. -254 J/K
B. 254 J/K
C. -172 J/K
D. -331 J/K
E. 331 J/K

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QUESTION NO: 7

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Not required for second major 032

A parallel plate capacitor of capacitance C has a charge of magnitude q when connected to a battery of potential difference V. After being fully charged, the capacitor is disconnected from the battery and the separation between the plates is doubled.
Which one of the following statements is TRUE?

A. The magnitude of the charge on the plates doubles.
B. The magnitude of the charge on the plates is halved.
C. The voltage across the plates doubles.
D. The capacitor's capacitance doubles.
E. The voltage across the plates is halved.

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QUESTION NO: 8

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The left-hand side of the container shown in Figure 2 contains 5 moles of nitrogen gas, in thermal equilibrium with the right hand side, which contains 3 moles of hydrogen gas. The two sides are separated by a partition, and the container is insulated. After the partition is broken, what is the change in entropy of the system?

A. 49 J/K
B. 12 J/K
C. zero
D. 58 J/K
E. 34 J/K

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QUESTION NO: 9

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Consider the four charges shown in Figure 5. How much work is required, by an external agent, to move the charge q to infinity. (Take q = 1.0 micro-C.)

A. 0.52 J
B. -0.32 J
C. -0.95 J
D. 0.32 J
E. 0.95 J

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QUESTION NO: 10

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Consider an infinitely long line of charge density 2.0 micro-C/m lying along the x-axis as shown in Figure 4. What is the ratio of electric field strength at point A to that at point B?

A. 4.00
B. 1.00
C. 0.50
D. 0.25
E. 2.00

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QUESTION NO: 11

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Not required for second major 032

In one hour, how many electrons pass between the terminals of a 12-V car battery when a 96 watts headlight is used?

A. 1.8*10**23 electrons
B. 5.0*10**19 electrons
C. 2.8*10**23 electrons
D. 6.6*10**22 electrons
E. 2.6*10**19 electrons

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QUESTION NO: 12

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Not required for second major 032

A 72-V battery is connected across a 0.50 micro-F, air filled, parallel-plate capacitor. With the battery still connected, the space between the plates is filled with a dielectric, whereupon the charge on the capacitor is increased by 90 micro-C. What is the dielectric constant of the dielectric?

A. 3.5
B. 1.5
C. 2.5
D. 4.5
E. 5.0

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QUESTION NO: 13

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Which one of the following statements is WRONG?

A. After a system has gone through a reversible cyclic process, its total entropy does not change.
B. The total entropy of a system increases only if it absorbs heat.
C. Thermal energy cannot be transferred spontaneously from a cold object to a hot object.
D. No heat engine has higher efficiency than Carnot efficiency.
E. A heat pump works like a heat engine in reverse.

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QUESTION NO: 14

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Which one of the following statements is CORRECT?

A. In a solid conductor, electrons do not move freely.
B. Halfway between two point charges of equal magnitude and opposite sign, the net electric field is zero.
C. Electric field lines are closer together when the electric field is weak, and are far apart when the electric field is strong.
D. Electric charge is not quantized.
E. The direction of an electric field does not change whether a positive or negative test charge is used in calculating the electric field.

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QUESTION NO: 15

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Not required for second major 032

A wire having a resistance of 3 Ohms is stretched so that its length is tripled while its volume remains unchanged. The resistance of the stretched wire is:

A. 9 Ohms
B. 1 Ohm
C. 1/3 Ohm
D. 3 Ohms
E. 27 Ohms

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QUESTION NO: 16

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Which one of the following statements is TRUE?

A. The electric flux through an equipotential surface is always zero.
B. The magnitude of the electric flux through a surface enclosing a charge depends on the size and shape of the surface.
C. The electric field lines are always perpendicular to the associated equipotential surfaces.
D. For a spherically symmetric charge distribution, the equipotentials nearby the charge are parallel planes.
E. If the electric potentials at points A and B are different, then the electric field strength at A and B must be different.

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QUESTION NO: 17

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An infinitely long line has a charge density of 7.6 nano-C/m. Calculate the electric flux through a spherical surface of radius R = 7.7 cm whose center, C, lies on the line charge as shown in Figure 3.

A. 610 (N*m**2)/C
B. 92.0 (N*m**2)/C
C. zero
D. 415 (N*m**2)/C
E. 132 (N*m**2)/C

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QUESTION NO: 18

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A spherical conducting shell of inner radius r1 and outer radius r2 has a net charge of 2 micro-C. If a point charge of -4.0 micro-C is placed at the geometrical center of the spherical shell, what is the charge on the outer surface of the spherical shell?

A. +4.0 micro-C
B. +2.0 micro-C
C. -4.0 micro-C
D. zero
E. -2.0 micro-C

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QUESTION NO: 19

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Not required for second major 032

A 9.0-V battery is connected to three capacitors as shown in Figure 6. What is the energy stored in the 6 micro-F capacitor?

A. 27 micro-J
B. 62 micro-J
C. 53 micro-J
D. 12 micro-J
E. 35 micro-J

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QUESTION NO: 20

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Two large parallel plates are connected to a 100 V power supply. An electron starts from rest at one plate and accelerates toward the other. The speed of the electron when it hits the second plate is:

A. 6.0*10**5 m/s
B. 5.9*10**6 m/s
C. 2.1*10**7 m/s
D. 3.5*10**6 m/s
E. 7.8*10**6 m/s

Physics 102
Formula Sheet for 2nd Major Exam
Second Semester 1999-2000 (Term 992)

$$Q = mc\Delta T, \quad Q = mL$$

$$Q = nc_p\Delta T, \quad Q = nc_v\Delta T$$

$$W = Q_h - Q_c$$

$$e = \frac{W}{Q_h} = 1 - \frac{Q_c}{Q_h}$$

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

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

$$\frac{Q_c}{Q_h} = \frac{T_c}{T_h}, \quad \Delta S = \int \frac{dQ_r}{T}$$

$$\Delta S = nC_v \ln\left(\frac{T_f}{T_i}\right) + nR \ln\left(\frac{V_f}{V_i}\right)$$

$$F = \frac{kq_1q_2}{r^2}, \quad \Phi = \int_{Surface} \vec{E}.d\vec{A}$$

$$E = \sigma/2\varepsilon_o, \quad E = \sigma/\varepsilon_o$$

$$E = \frac{kQ}{r^2}, \quad E = \frac{kQ}{R^3}r, \quad E = \frac{2k\lambda}{r}$$

$$\Phi_c = \oint \vec{E}.d\vec{A} = \frac{q_{in}}{\varepsilon_0}$$

$$E_x = -\frac{\partial V}{\partial x}, \quad E_y = -\frac{\partial V}{\partial y}, \quad E_z = -\frac{\partial V}{\partial z}$$

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

$$V = \frac{kQ}{r}$$

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

$$C = \frac{Q}{V}, \quad C = \kappa C_0$$

$$I = n q v_d A = J A, \quad J = \sigma E$$

$$P = I V, \quad U = \frac{1}{2}CV^2$$

$$I = \frac{dQ}{dt}; \quad I = \frac{\Delta Q}{\Delta t}$$

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

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

$$v = v_o + at$$

$$x - x_o = v_o t + \frac{1}{2} a t^2$$

$$v^2 = v_o^2 + 2a(x - x_o)$$

Constants:

$k = 9.0 \times 10^9$ N.m^2/C^2
$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N.m^2
$e = 1.6 \times 10^{-19}$ C
$m_e = 9.11 \times 10^{-31}$ kg
$m_p = 1.67 \times 10^{-27}$ kg
$k_B = 1.38 \times 10^{-23}$ J/K
$N_A = 6.022 \times 10^{23}$ molecules/mole
$R = 8.314$ J/mol. K
1 atm $= 1.013 \times 10^5$ N/m^2
$g = 9.8$ m/s^2

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micro $= 10^{-6}$
nano $= 10^{-9}$
pico $= 10^{-12}$

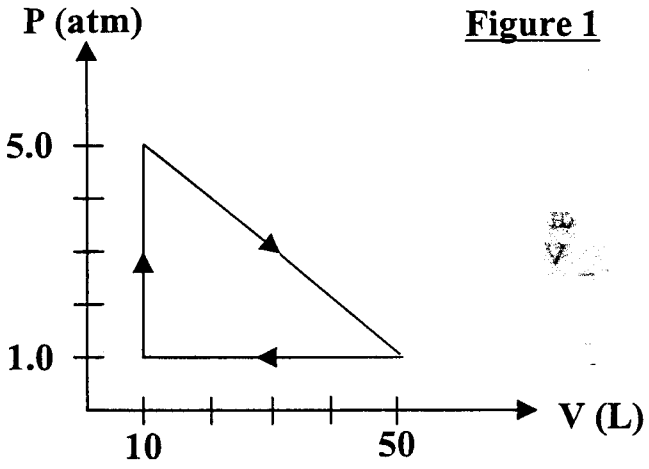


Figure 1

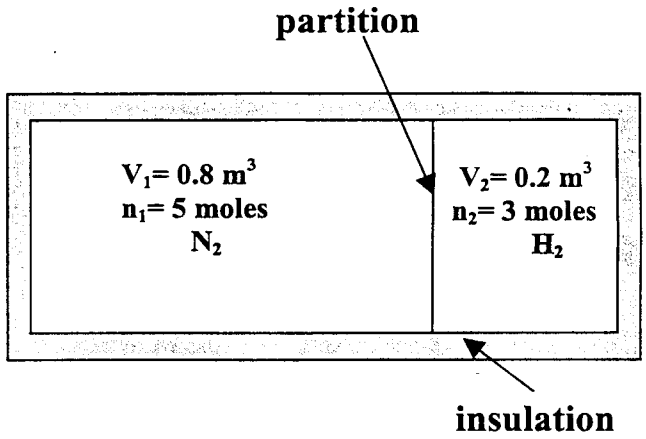


Figure 2

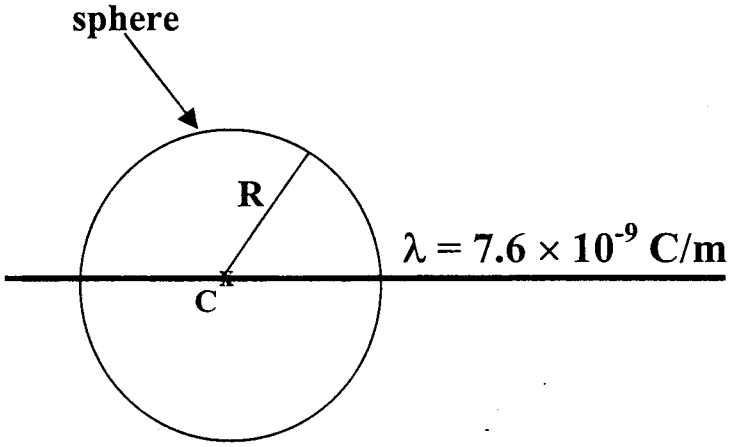


Figure 3

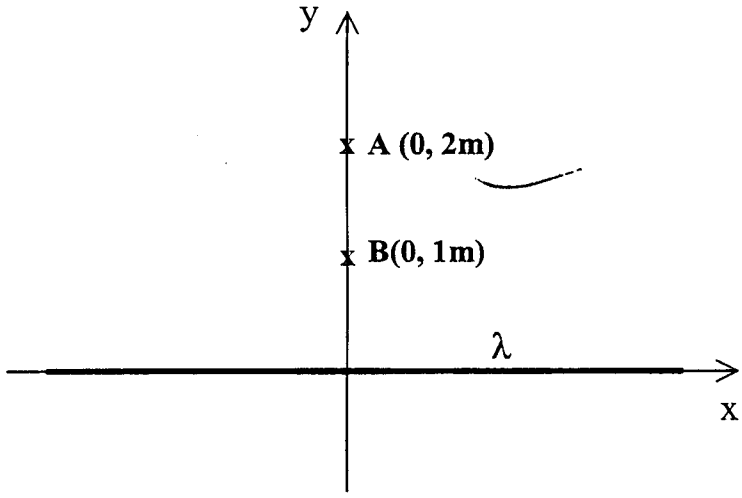


Figure 4

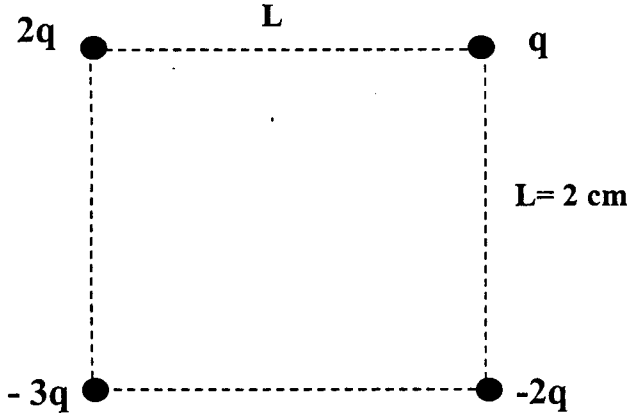


Figure 5

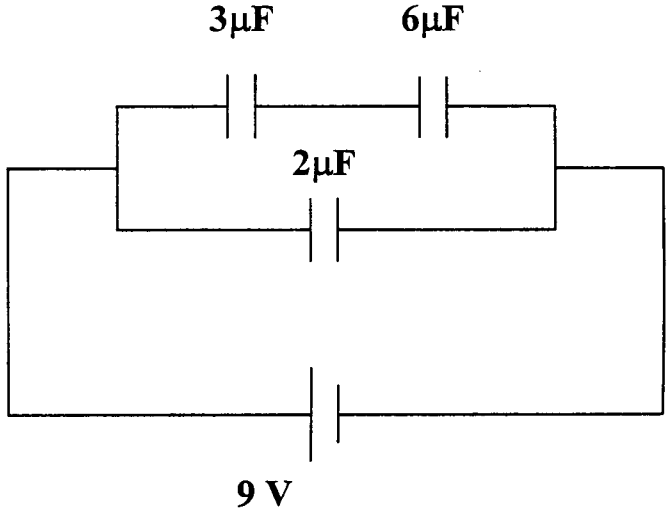
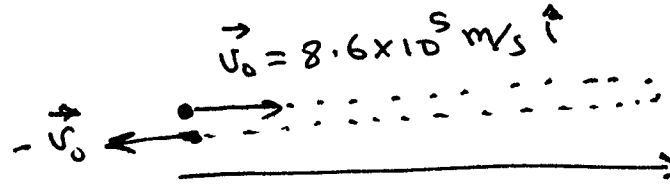


Figure 6

Phys-102
Second major exam
Term 992

Q1



$$v_f = v_0 + at \qquad a = \frac{F}{m} = \frac{-eE}{m}$$

$$-v_0 = v_0 - \frac{eE}{m}t \Rightarrow t = \frac{2v_0 m}{eE} = \frac{2(9.1\times10^{-31})(8.6\times10^5)}{(1.6\times10^{-19})(4.1\times10^3)}$$

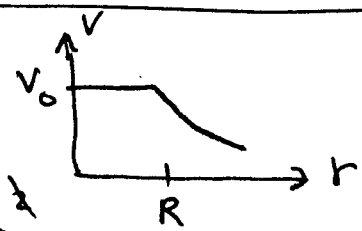
$$= 2.4\times10^{-9}\ s$$

Q2

$$e = \frac{W}{Q_H} = \frac{\frac{1}{2}(5-1)(50-10)\ \text{Atm}\cdot\text{L}}{Q_H}$$ ← work is the area of the closed loop.

$$= \frac{80\ \text{Atm}\cdot\text{L}\left(\frac{1.01\times10^5\ \text{Pa}}{1\ \text{Atm}}\right)\left(\frac{10^{-3}\ m^3}{1\ \text{L}}\right)}{18.2\times10^3\ \text{J}} = 0.44$$

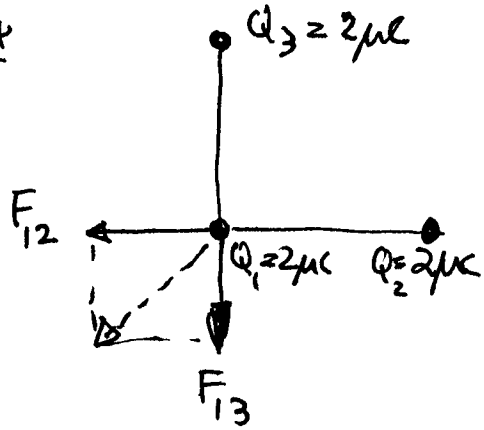
Q3 The electric Potential at the center is the same at the surface of the sphere



$$V_0 = K\frac{Q}{R} = K\frac{5\ 4\pi R^2}{R}$$

$$= (8.99\times10^9)(4\pi)(2\times10^{-6})(0.05) = 1.1\times10^4\ V$$

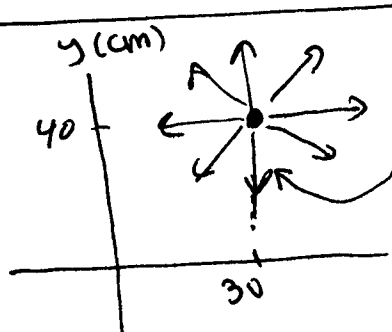
Q4



$$F = \sqrt{F_{12}^2 + F_{13}^2} = \sqrt{2}\,K\frac{q^2}{d^2}$$

$$= \sqrt{2}\,(8.99\times10^9)\frac{(2\mu)^2}{2^2} = 1.3\times10^{-2}\ N$$

Q5



$$E = K\frac{q}{r^2} \Rightarrow r = \sqrt{\frac{Kq}{E}}$$

distance from charge particle

$$r = \sqrt{\frac{8.99\times10^9\times4\times10^{-9}}{72}} = 0.707\ m$$

$$y = y_0 - r = -30.7\ cm$$

Q6 water (T_8) → water (T_0) → ice (T_0) → ice (T_{-5})

heat absorbed by water

$$\Delta S = mc_w \ln\frac{T_0}{T_8} - \frac{mLF}{T_0} + mc_i \ln\frac{T_{-5}}{T_0}$$

$$= (0.24)\left\{186 \ln\frac{273}{281} - \frac{3.33\times10^5}{273} + 2090 \ln\frac{268}{273}\right\}$$

$$= -331 \text{ J/K}$$

Q7 The voltage across the plate is doubled.

$$V = \frac{Q}{C} = \frac{Q}{\frac{\varepsilon_0 A}{d}} = \frac{dQ}{\varepsilon_0 A}$$

$$V_{new} = \frac{2dQ}{\varepsilon_0 A} = 2V_{old}$$

Q8

$$\Delta S = \Delta S_1 + \Delta S_2$$

$$= n_1 R \ln\frac{V_f}{V_1} + n_2 R \ln\frac{V_f}{V_2}$$

$$= 8.314\left(5 \ln\frac{1}{0.8} + 3 \ln\frac{1}{0.2}\right) = 49 \text{ J/K}$$

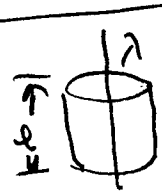
Q9

$$W_{app} = q\Delta V = q(V_f - V_i) = q\left(0 - \left(K\frac{2q}{L} - K\frac{3q}{\sqrt{2}L} - K\frac{2q}{L}\right)\right)$$

$$= K\frac{q^2}{L}\frac{3}{\sqrt{2}} = \frac{8.99\times10^9 (10^{-6})^2}{0.02(\sqrt{2})} = 0.95 \text{ J}$$

Q10

$$E' 2\pi r \ell = \frac{\ell\lambda}{\varepsilon_0} \Rightarrow E = \frac{\lambda}{2\pi\varepsilon_0}\frac{1}{r}$$



Gauss' Law $\Phi = \frac{Q_{in}}{\varepsilon_0}$

$$\frac{E_A}{E_B} = \frac{r_B}{r_A} = 0.5$$

Q11

$$P = IV \Rightarrow I = \frac{P}{V} = \frac{96}{12} = 8 \text{ A}$$

$$I = \frac{\Delta Q}{\Delta t} = \frac{e(\#\text{ of electrons})}{\Delta t} \Rightarrow \#\text{ of electrons} = \frac{I\Delta t}{e}$$

1 hour

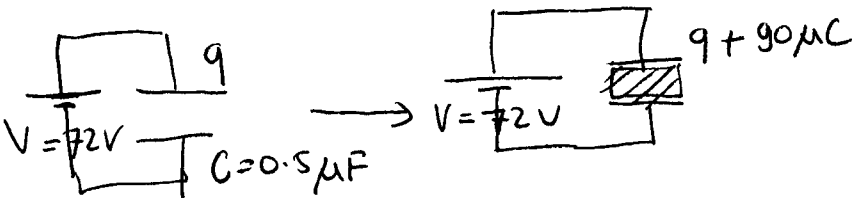
$$= \frac{8(3600)}{1.6\times10^{-19}}$$

$$= 1.8\times10^{23} \text{ electrons}$$

Apr 26, 02

Phyp102 - major 2 - 992 - p3

Q12



$$q = CV$$
$$q' = C'V \Rightarrow q + 90\mu C = KCV$$
$$K = \frac{CV + 90\mu}{CV} = 3.5$$

Q13 The total entropy of a system increases only if it absorbs heat. WRONG - Free Expansion

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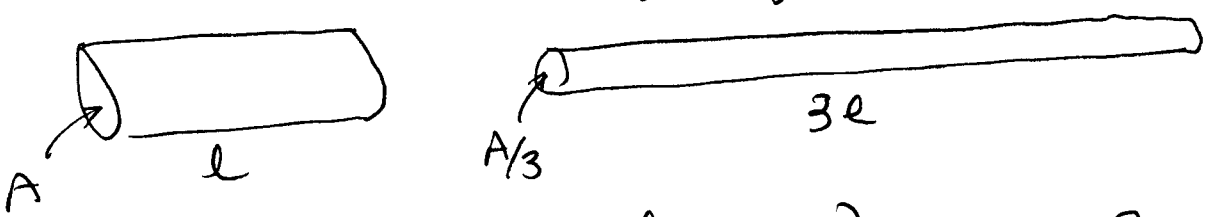
Q14 The direction of an electric field does not change whether a positive or negative test charge is used in calculating the electric field TRUE

Q15 V = length · Area = constant



$$R_{new} = \rho \frac{3\ell}{A/3} = 9\rho\frac{\ell}{A} = 9R_{old} = 27\,\Omega$$

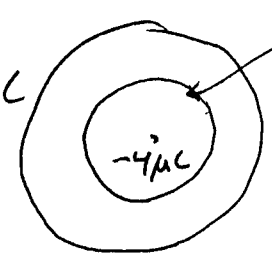
Q16 The electric field lines are always perpendicular to the associated equipotential surfaces TRUE

Q17 flux through a closed surface $= \frac{\text{charge inside the surface}}{\varepsilon_0}$

$$= \frac{\lambda(2R)}{\varepsilon_0} = \frac{7.6\times10^{-9}(2\,0.077)}{8.85\times10^{-12}}$$
$$= 132\ Nm^2/C$$

Q18 q_{out} = net charge − q_{in}

$= 2\mu - 4\mu = -2\mu C$

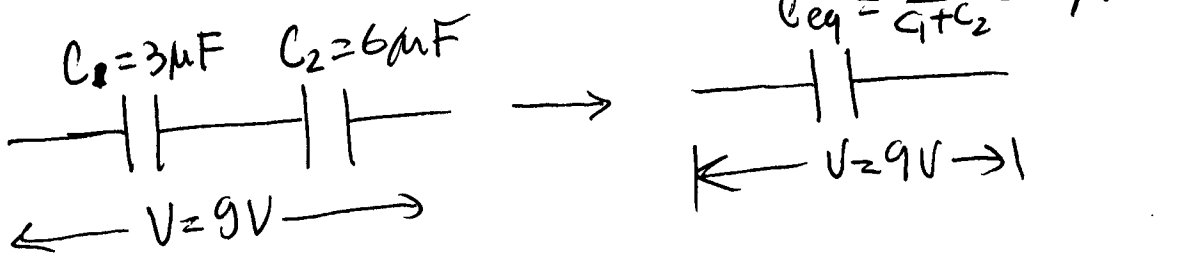


on inner surface, there should be +4μC so that the charge enclosed by any surface in the shell is zero.

Apr 26, 02

Phyp102 – major 2 – 992 – P4

Q19



$Q_{eq} = C_{eq} V = 18\mu C = Q_2$ since Q_1 and Q_2 are connected in series

$$U = \frac{1}{2}\frac{Q_2^2}{C_2} = \frac{1}{2}\frac{(18\mu)^2}{6\mu} = \frac{18}{12}\,18\mu = 27\mu J$$

Q20 Mechanical energy is conserved

$K_i + U_i = K_f + U_f$

$0 + 0 = \frac{1}{2}mv_f^2 + (-e)V_f$

$$v_f = \sqrt{\frac{2eV_f}{m}}$$

$$= \sqrt{\frac{2(1.6\times10^{-19})(100)}{9.1\times10^{-31}}}$$

$$= 5.9\times10^{6}\ m/s$$