$$T(^oC) = \frac{5}{9}\left(T(^oF) - 32\right)$$
$$T(K) = T(^oC) + 273.15$$
$$\Delta L = \alpha L_0 \Delta T$$
$$\Delta V = \beta V_0 \Delta T$$
$$Q = mc\Delta T = nC\Delta T$$
$$Q_{F/V} = \pm m L_{F/V}$$
$$H = \frac{dQ}{dt} = k\frac{A}{L}\left(T_H - T_C\right)$$
$$pV = nRT$$
$$K_{tr} = \frac{3}{2}nRT$$
$$C_V = \frac{3}{2}R \quad \text{ideal monatomic gas}$$
$$C_V = \frac{5}{2}R \quad \text{ideal diatomic gas w/o vibration}$$
$$W = \int_{V_1}^{V_2} p\,dV$$
$$\Delta U = Q - W$$
$$e = \frac{W}{Q_H} = 1 - \left|\frac{Q_C}{Q_H}\right|$$
$$e_{Carnot} = 1 - \left|\frac{T_C}{T_H}\right|$$
$$\Delta S = \int_1^2 \frac{dQ}{T}$$
$$S = k\ln w$$
$$R = 8.314\, J/mol\cdot K$$
$$N_A = 6.02\times 10^{23}\, molecules/mole$$
1 atm = 101 325 N / (m^2)

$1/4\pi\varepsilon_0$ = 8.99 x 10^9 Nm^2/C^2

e = -1.602 x 10^{-19} C
$$\vec{F}_E = q\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{qQ}{r^2}\hat{r}$$
$$\Phi_E = \oint \vec{E}\cdot d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$$
$$V_b - V_a = -\int_a^b \vec{E}\cdot d\vec{l}$$
$$\Delta U = q\Delta V$$
$$\vec{E} = -\left(\hat{i}\frac{\partial V}{\partial x} + \hat{j}\frac{\partial V}{\partial y} + \hat{k}\frac{\partial V}{\partial z}\right)$$
$$Q = CV$$
$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots \quad \text{series}$$
$$C_{eq} = C_1 + C_2 + C_3 + \dots \quad \text{parallel}$$
$$U = \frac{1}{2}CV^2$$
$$u_E = \frac{1}{2}\varepsilon_0 E^2$$
$$E = \frac{E_0}{K}$$
$$I = \frac{dq}{dt}$$
$$\vec{J} = nq\vec{v}_d$$
$$\rho = \frac{E}{J}$$
$$V = IR$$
$$P = VI$$
$$R_{eq} = R_1 + R_2 + R_3 + \dots \quad \text{series}$$
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots \quad \text{parallel}$$
$$q = C\mathcal{E}\left(1 - e^{-t/RC}\right) \quad \text{charging}$$
$$q = Q_0 e^{-t/RC} \quad \text{discharging}$$
$$\vec{F} = q\vec{v}\times\vec{B}$$
$$\Phi_B = \int \vec{B}\cdot d\vec{A}$$
$$d\vec{F} = Id\vec{l}\times\vec{B}$$
$$\vec{\tau} = \vec{\mu}\times\vec{B}, \quad \vec{\mu} = NI\vec{A}$$
$$U = -\vec{\mu}\cdot\vec{B}$$
$$\vec{B} = \frac{\mu_0}{4\pi}\frac{q\vec{v}\times\hat{r}}{r^2}$$
$$d\vec{B} = \frac{\mu_0}{4\pi}\frac{Id\vec{l}\times\hat{r}}{r^2}$$
$$\oint \vec{B}\cdot d\vec{l} = \mu_0\left(i_C + i_D\right)$$
$$\oint \vec{\mathrm{E}}\cdot d\vec{l} = \mathcal{E} = -\frac{d\Phi_B}{dt}$$

$$i_D = \varepsilon \frac{d\Phi_E}{dt}$$

$$\mathcal{E}_2 = -M\frac{di_1}{dt} \text{ and } \mathcal{E}_1 = -M\frac{di_2}{dt}$$

$$M = \frac{N_2\Phi_{B2}}{i_1} = \frac{N_1\Phi_{B1}}{i_2}$$

$$\mathcal{E} = -L\frac{di}{dt},$$

$$L = \frac{N\Phi_B}{i}$$

$$U = \frac{1}{2}LI^2, \qquad u_E = \frac{1}{2\mu_0}B^2$$

$$\frac{di}{dt} = \frac{\mathcal{E}}{L}e^{-Rt/L}$$

$$\omega = \frac{1}{\sqrt{LC}}$$

$$I_{RMS} = \frac{1}{\sqrt{2}}I \quad \text{for } i = I\cos(\omega t)$$

$$V_{RMS} = \frac{1}{\sqrt{2}}V \quad \text{for } v = V\cos(\omega t)$$

$$V_R = IR$$

$$V_L = IX_L, \quad \text{where } X_L = \omega L$$

$$V_C = IX_C, \quad \text{where } X_C = \frac{1}{\omega C}$$

$$V = IZ, \quad \text{where } Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$P_{\text{Avg}} = \frac{1}{2}VI\cos\varphi, \quad \tan\varphi = \frac{X_L - X_C}{R}$$

$$V_s = V_p\frac{N_s}{N_p}$$

$$\varepsilon_0 = 8.85 \text{ x } 10^{-12}\ \frac{\text{C}^2}{\text{Nm}^2}$$

$$\mu_0 = 4\pi \times 10^{-7}\ \text{T·m/A}$$

Calculus

Derivatives:

$$\frac{d}{dx}x^n = nx^{n-1} \qquad \frac{d}{dx}\ln ax = \frac{1}{x} \qquad \frac{d}{dx}e^{ax} = ae^{ax}$$

$$\frac{d}{dx}\sin ax = a\cos ax \qquad \frac{d}{dx}\cos ax = -a\sin ax$$

Integrals:

$$\int x^n\,dx = \frac{x^{n+1}}{n+1} \quad (n \neq -1) \qquad \int\frac{dx}{x} = \ln x \qquad \int e^{ax}\,dx = \frac{1}{a}e^{ax}$$

$$\int \sin ax\,dx = -\frac{1}{a}\cos ax \qquad \int \cos ax\,dx = \frac{1}{a}\sin ax \qquad \int\frac{dx}{\sqrt{a^2 - x^2}} = \arcsin\frac{x}{a}$$

$$\int\frac{dx}{\sqrt{x^2 + a^2}} = \ln\left(x + \sqrt{x^2 + a^2}\right) \qquad \int\frac{dx}{x^2 + a^2} = \frac{1}{a}\arctan\frac{x}{a} \qquad \int\frac{dx}{(x^2 + a^2)^{3/2}} = \frac{1}{a^2}\frac{x}{\sqrt{x^2 + a^2}}$$

$$\int\frac{x\,dx}{(x^2 + a^2)^{3/2}} = -\frac{1}{\sqrt{x^2 + a^2}}$$

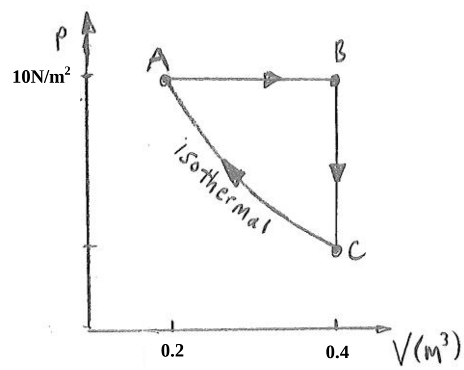
Physics 161-001 Spring 2014 Final Exam

Name: ___________________________________ Box#_____________

1) Heat is added to a 6 kg piece of ice at a rate of 25 kW. How long will it take for the ice to melt if it was initially at -100.00°C? (The heat capacity of ice is 2.11 kJ/kg/K, the latent heat of fusion for water is 334 kJ/kg and its latent heat of vaporization is 2260 kJ/kg.)

A) 10 s
B) 35 s
C) 60 s
D) 80 s
E) 95 s
F) 110 s
G) 130 s
H) 155 s
I) 170 s
J) 190 s

2) Consider a monatomic ideal gas taken around the thermodynamic cycle shown, traversed in the clockwise direction. This cycle is:

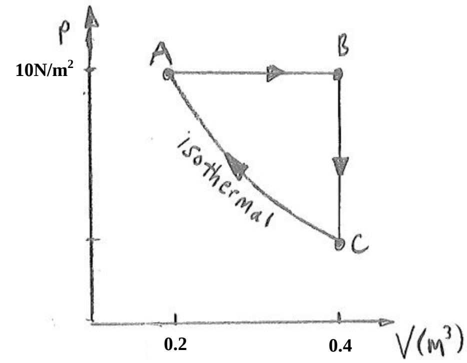


A) a refrigerator
B) an engine
C) neither
D) need more information to determine

3) Along which path segment(s) is work done on the gas?

A) AB
B) BC
C) CA
D) AB & BC
E) AB & CA
F) BC & CA

4) Along which path segment(s) is heat added to the gas?



A) AB
B) BC
C) CA
D) AB & BC
E) AB & CA
F) BC & CA

5) What is the magnitude of the work along path segment AB?

A) 0.2 J
B) 0.4 J
C) 1.0 J
D) 1.2 J
E) 1.4 J
F) 2.0 J
G) 3.0 J
H) 3.4 J
I) 4.0 J
J) 5.0 J

6) To the nearest Pascal (N/m^2) , what is the pressure at C?

A) 1 Pa
B) 2 Pa
C) 3 Pa
D) 4 Pa
E) 5 Pa
F) 6 Pa
G) 7 Pa
H) 8 Pa
I) 9 Pa
J) 10 Pa

7) If the temperature of the gas at A is 300K, what is the temperature at B?

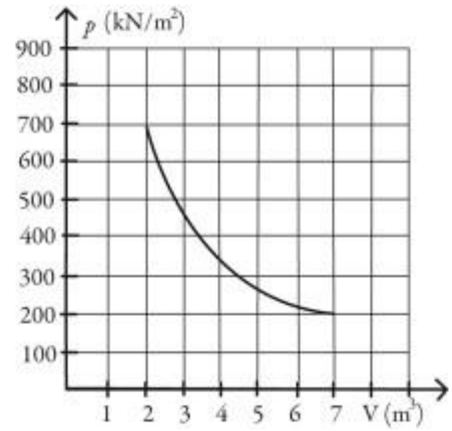
A) 400 K
B) 500 K
C) 600 K
D) 700 K
E) 800 K
F) 900 K
G) 1000 K
H) 1100 K
I) 1200 K
J) 1400 K

8) Heat is added to some unknown gas. The amount that the average molecular kinetic energy increases depends upon:

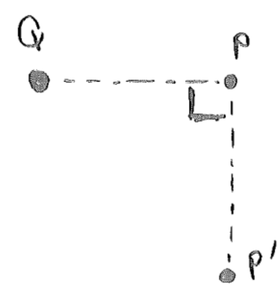
A) if the volume changes.
B) if the pressure changes.
C) if the gas is monatomic or diatomic.
D) both A) and B)
E) both A) and C)
F) both B) and C)
G) all three (A, B and C)
H) It doesn't depend on any A), B) or C).

9) What is the change in entropy of 11.6 moles of *ideal* monatomic gas that reversibly undergoes the isothermal expansion shown in the figure? The ideal gas constant is R = 8.314 J/(mol·K).

A) 84 J/K
B) 60.4 J/K
C) 70.7 J/K
D) 90.8 J/K
E) 0 J/K
F) 23.1 J/K
G) 40.6 J/K
H) 29.2 J/K
I) 105 J/K
J) 10.3 J/K

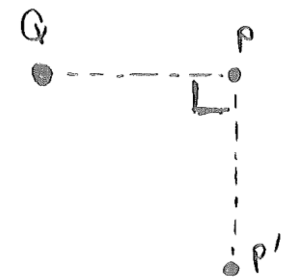


10) The magnitude of the electric field at point P, 2m from a charge Q is 8.5 N/C. If a second charge of opposite sign but same magnitude is placed an equal distance away, at point P', what is the magnitude of the total electric field at P?



A) 0 N/C
B) 3 N/C
C) 8.5 N/C
D) 9 N/C
E) 9.5 N/C
F) 10 N/C
G) 10.5 N/C
H) 11 N/C
I) 11.5 N/C
J) 12 N/C

11) The electric potential at point P from a point charge Q is 4 V. If a second charge of opposite sign but same magnitude is placed an equal distance away, at point P', what is the new electric potential at point P?



A) 0.0 V
B) 2.8 V
C) 4.2 V
D) 5.6 V
E) 6.8 V
F) 7.2 V
G) 8.0 V
H) 10 V
I) 12 V
J) 16 V

12) A circular parallel plate capacitor has plate area 0.1 m^2 and separation distance between the plates of 1mm. It is charged with 4 nC. What is the electric field in the space between the capacitor plates?

A) 0 V/m
B) 4.5×10^3 V/m
C) 7.3×10^3 V/m
D) 2.1×10^4 V/m
E) 4.9×10^4 V/m
F) 8.7×10^4 V/m
G) 1.9×10^5 V/m
H) 3.7×10^5 V/m
I) 5.5×10^5 V/m
J) 4.5×10^6 V/m

13) If a 1 μC charge is released from rest in a region where the electric field is 1.0×10^4 V/m. What is its kinetic energy after it travels a distance of 1mm?

A) 0 J
B) 1.0×10^{-5} J
C) 3.2×10^{-4} J
D) 5.6×10^{-3} J
E) 1.7×10^{-2} J
F) 8.9×10^{-1} J
G) 1.0×10^{-1} J
H) 4.5 J
I) 1.0×10^6 J
J) It depends upon the mass of the charge.

14) Consider the following two statements: a) Electric field lines can cross, and b) Electric field lines curl back on themselves. Classify these statements as true or false.

A) a) Always true, b) Always true
B) a) Always true, b) Always false
C) a) Always true, b) Sometimes true
D) a) Always false, b) Always true
E) a) Always false, b) Always false
F) a) Always false, b) Sometimes true
G) a) Sometimes true, b) Always true
H) a) Sometimes true, b) Always false
I) a) Sometimes true, b) Sometimes true

15) A non-conducting sphere of radius R carries a uniform volume charge density ρ. The electric field at distance r < R from the center of the sphere is given by:

A) $\left|\vec{E}\right| = \frac{\rho r}{\varepsilon_0}$

B) $\left|\vec{E}\right| = \frac{\rho r}{2\pi r \varepsilon_0}$

C) $\left|\vec{E}\right| = \frac{\rho R^2}{2r\varepsilon_0}$

D) $\left|\vec{E}\right| = \frac{\rho r}{2\varepsilon_0}$

E) $\left|\vec{E}\right| = \frac{\rho R^2}{2\pi r \varepsilon_0}$

F) $\left|\vec{E}\right| = \frac{\rho r}{3\varepsilon_0}$

G) $\left|\vec{E}\right| = \frac{\rho r^3}{2R\varepsilon_0}$

H) $\left|\vec{E}\right| = \frac{\rho r^3}{2R^2\varepsilon_0}$

I) $\left|\vec{E}\right| = \frac{\rho r^3}{3R^2\varepsilon_0}$

J) $\left|\vec{E}\right| = \frac{\rho R^3}{3r^2\varepsilon_0}$

16) A non-conducting sphere of radius R carries a uniform volume charge density ρ. The electric field at distance r > R from the center of the sphere is given by:

A) $\left|\vec{E}\right| = \dfrac{\rho r}{\varepsilon_0}$

B) $\left|\vec{E}\right| = \dfrac{\rho R}{2\pi r \varepsilon_0}$

C) $\left|\vec{E}\right| = \dfrac{\rho R^2}{2r\varepsilon_0}$

D) $\left|\vec{E}\right| = \dfrac{\rho r}{2\varepsilon_0}$

E) $\left|\vec{E}\right| = \dfrac{\rho R^2}{2\pi r \varepsilon_0}$

F) $\left|\vec{E}\right| = \dfrac{\rho r}{3\varepsilon_0}$

G) $\left|\vec{E}\right| = \dfrac{\rho r^3}{2R\varepsilon_0}$

H) $\left|\vec{E}\right| = \dfrac{\rho r^3}{2R^2\varepsilon_0}$

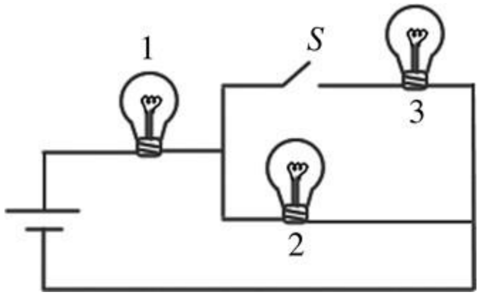
I) $\left|\vec{E}\right| = \dfrac{\rho r^3}{3R^2\varepsilon_0}$

J) $\left|\vec{E}\right| = \dfrac{\rho R^3}{3r^2\varepsilon_0}$

17) Suppose you have two point charges of the opposite sign. As you move them farther and farther apart, the potential energy of this system

A) increases.
B) decreases.
C) stays the same.

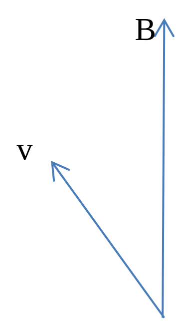
18) The figure shows three identical light bulbs connected to a battery having a constant voltage across its terminals. What happens to the brightness of light bulb 1 when the switch S is closed?



A) The brightness remains the same as before the switch is closed.
B) The brightness decreases permanently.
C) The brightness will decrease momentarily then return to its previous level.
D) The brightness will increase momentarily then return to its previous level.
E) The brightness increases permanently.

19) An electron moves with velocity v in a magnetic field B, the directions of v and B both lie in the plane of the paper and are shown below. What is the direction of the magnetic force on the electron?

A) Into page.
B) Out of page.
C) Down, and to the right.
D) Into the page and to the left.
E) Out of the page and to the left.
F) Up and to the right.
G) In the same direction as v.
H) In the same directions as B.
I) Down and to the left.
J) Up and to the left.



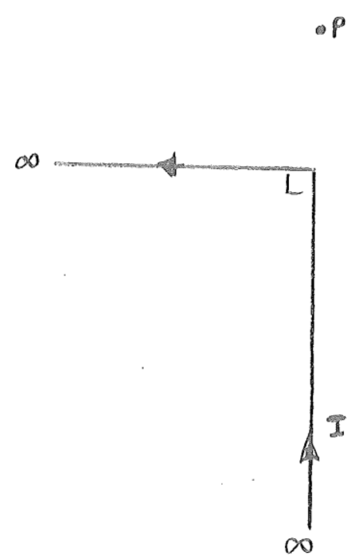
20) An electric field is given by $\vec{E} = \left(1.5\frac{\text{N}}{\text{Cm}}\right)\cdot x^2 \cdot \hat{i}$. If the potential is zero at x = 0, what is the magnitude of the potential at x=2 m?

A) 0 V
B) 2 V
C) 4 V
D) 6 V
E) 8 V
F) 10 V
G) 12 V
H) 14 V
I) 16 V
J) 18 V

21) Where is the potential higher in the previous problem?

A) At x = 0 m
B) At x = 2 m
C) They have the same potential.
D) It's relative.

22) Use Ampere's law & symmetry (not complicated integration) to find the magnitude of the magnetic field at the point P shown, to the nearest microTesla. I = 1 A, and P is 1.25 cm above the vertex, in line with the incoming wire.

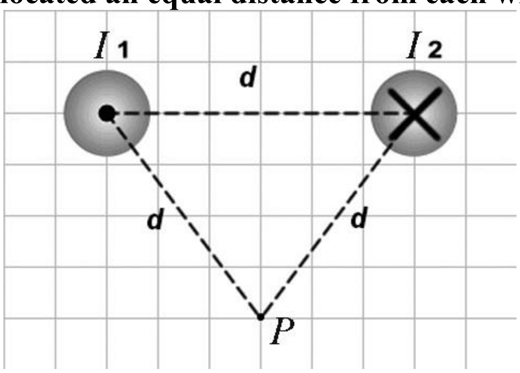


A) 0 μT
B) 1 μT
C) 2 μT
D) 3 μT
E) 4 μT
F) 5 μT
G) 6 μT
H) 7 μT
I) 8 μT
J) 9 μT

23) A 2.0-μF capacitor that is initially uncharged is connected in series with a 8.0-kΩ resistor and an ideal 34.0 V battery. How much energy is stored in the capacitor 16 ms after the battery has been connected?

A) 2.3×10^{-4} J
B) 3.6×10^{-4} J
C) 4.6×10^{-4} J
D) 1.2×10^{-3} J
E) 2.3×10^{-3} J
F) 3.6×10^{-3} J
G) 4.6×10^{-3} J
H) 1.2×10^{-2} J
I) 3.6×10^{-2} J
J) 4.6×10^{-2} J

24) The figure shows two long, parallel current-carrying wires. The wires carry equal currents $I_1 = I_2 = 6$ A in the directions indicated and are located a distance d = 0.1 m apart. Calculate the magnitude of the magnetic field at the point that is located an equal distance from each wire. ($\mu_0 = 4\pi \times 10^{-7}$ T · m/A)



A) 4.0×10^{-6} T
B) 1.2×10^{-5} T
C) 5.5×10^{-5} T
D) 7.3×10^{-5} T
E) 1.0×10^{-4} T
F) 3.4×10^{-4} T
G) 5.0×10^{-4} T
H) 7.2×10^{-4} T
I) 9.8×10^{-4} T
J) 1.0×10^{-3} T

25) A large number of very long wires of diameter 2mm are laid side-by-side to form an infinite plane. If 1.0 A of current is passed through each wire (in the same direction), what is the magnitude of the magnetic field 10 cm above the plane?

A) 1.6×10^{-5} T
B) 2.1×10^{-5} T
C) 4.2×10^{-5} T
D) 6.3×10^{-5} T
E) 7.2×10^{-5} T
F) 9.4×10^{-5} T
G) 1.3×10^{-4} T
H) 2.0×10^{-4} T
I) 2.6×10^{-4} T
J) 3.1×10^{-4} T

Have a great summer!