PHYS1220, Practice Exam 1

1) A closed loop conductor that forms a circle with a radius of 2.0 m is located in a uniform but changing magnetic field. If the maximum emf induced in the loop is 5.0 V, what is the maximum rate at which the magnetic field strength is changing if the magnetic field is oriented perpendicular to the plane in which the loop lies?

A) 0.40 T/s B) 2.5 T/s C) 5.0 T/s D) 0.080 T/s

2) A point charge *Q* moves on the *x*-axis in the positive direction with a speed of 280 m/s. A point *P* is on the *y*-axis at $y = +70\ \text{mm}$. The magnetic field produced at the point *P*, as the charge moves through the origin, is equal to $-0.30\ \mu\text{T}\ \hat{k}$. What is the charge *Q*?

A) +39 μC B) -39 μC C) +53 μC D) -53 μC E) +26 μC

3) If a certain sample of an ideal gas has a temperature of 109°C and exerts a pressure of $1.2 \times 10^4\ \text{Pa}$ on the walls of its container, how many gas molecules are present in each cubic centimeter of volume? The ideal gas constant is 8.314 J/mol • K and Avogadro's number is $6.022 \times 10^{23}$ molecules/mol.

A) $2.3 \times 10^{22}$ molecules B) $4.6 \times 10^{19}$ molecules C) $8.7 \times 10^{16}$ molecules
D) $7.1 \times 10^{22}$ molecules E) $2.3 \times 10^{18}$ molecules

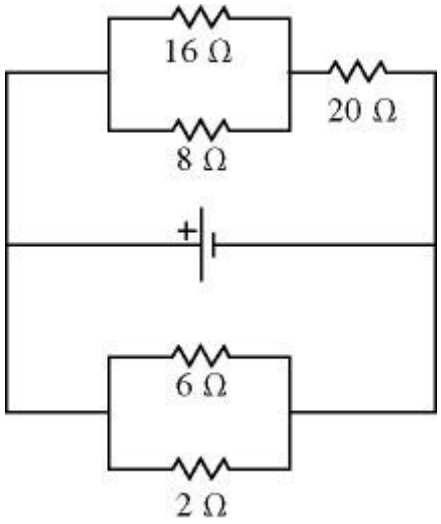
4) A solenoid having *N* turns and carrying a current of 2.000 A has a length of 34.00 cm. If the magnitude of the magnetic field generated at the center of the solenoid is 9.000 mT, what is the value of *N*?

A) 1591 B) 2318 C) 1218 D) 3183 E) 860.0

5) An electron enters a magnetic field of $0.75\ \text{T}$ with a velocity perpendicular to the direction of the field. At what frequency does the electron traverse a circular path?

A) $2.1 \times 10^{14}$ Hz B) $2.1 \times 10^{10}$ Hz
C) $4.8 \times 10^{-7}$ Hz D) $4.8 \times 10^{-11}$ Hz

6) For the circuit shown in the figure, the current in the 8-Ω resistor is 0.50 A, and all quantities are accurate to 2 significant figures. What is the current in the 2-Ω resistor?




A) 2.25 A B) 4.5 A C) 6.4 A D) 0.75 A E) 9.5 A

7) A parallel-plate capacitor has a capacitance of 10 mF and is charged with a 20-V power supply. The power supply is then removed and a dielectric material of dielectric constant 4.0 is used to fill the space between the plates. What is the voltage now across the capacitor?

A) 20 V B) 80 V C) 10 V D) 5.0 V E) 2.5 V

8) Benzene can be modelled as a circular ring of orbiting electrons. We make an NMR measurement of benzene by slowly increasing the magnetic field. The measured resonance of benzene occurs at $B_0$. What is the true resonance field?

A) Smaller than $B_0$ B) $B_0$ C) Larger than $B_0$ D) Cannot be determined with this information

9) A loop of radius $r$ = 3.0 cm is placed parallel to the $xy$-plane in a uniform magnetic field $\vec{B}$ = 0.75 T $\hat{k}$. The resistance of the loop is 18 Ω. Starting at $t$ = 0, the magnitude of the field decreases uniformly to zero in 0.15 seconds. What is the magnitude of the electric current produced in the loop during that time?

A) 1.7 mA B) 0.79 mA C) 3.9 mA D) 2.1 mA E) 0.20 mA

10) Two long parallel wires carry currents of 20 A and 5.0 A in opposite directions. The wires are separated by 0.20 m. What is the magnitude of the magnetic field midway between the two wires?

A) $4.0 \times 10^{-5}$ T
B) $3.0 \times 10^{-5}$ T
C) $1.0 \times 10^{-5}$ T
D) $5.0 \times 10^{-5}$ T
E) $2.0 \times 10^{-5}$ T

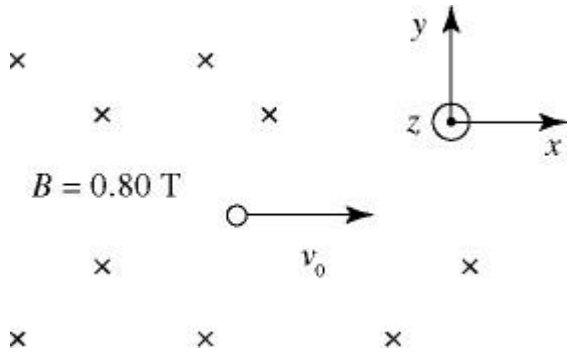
11) An electric field of $10^6$ V/m exists in a capacitor with plate radius of 1 mm. During discharge, the field is decreased to 0 in 1 ms. What is the value of the magnetic field between the plates a distance 1 mm from the capacitor axis during this discharge?

A) 0 T B) 0.15 T C) 0.56 T D) 2.2 T E) 5.6 T

12) A substance has a melting point of 20°C and a heat of fusion of $3.9 \times 10^4$ J/kg. The boiling point is $150°C$ and the heat of vaporization is $7.8 \times 10^4$ J/kg at a pressure of 1.0 atm. The specific heats for the solid, liquid, and gaseous phases are $600\ \text{J/(kg} \cdot \text{K)}$, $1000\ \text{J/(kg} \cdot \text{K)}$, and 400 J/(kg • K), respectively. The quantity of heat required to raise the temperature of $3.80$ kg of the substance from $-6°C$ to $128°C$, at a pressure of 1.0 atm, is closest to

A) 620 kJ. B) 560 kJ. C) 210 kJ. D) 770 kJ. E) 470 kJ.

13) A uniform magnetic field of magnitude 0.80 T in the negative $z$ direction is present in a region of space, as shown in the figure. A uniform electric field is also present and is set at 76,000 V/m in the +$y$ direction. An electron is projected with an initial velocity $v_0 = 9.5 \times 10^4$ m/s in the +$x$ direction. The $y$ component of the initial force on the electron is closest to which of the following quantities?

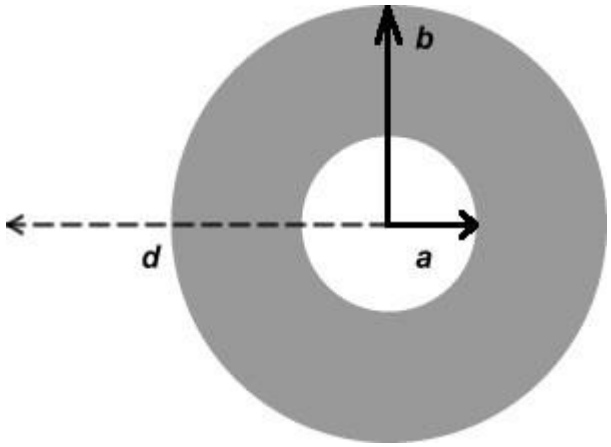


A) $+1.0 \times 10^{-14}$ N
B) $-1.0 \times 10^{-14}$ N
C) zero
D) $+2.4 \times 10^{-14}$ N
E) $-2.4 \times 10^{-14}$ N

14) A -3.0-μC point charge and a -9.0-μC point charge are initially extremely far apart. How much work does it take to bring the -3.0-μC charge to $x = 3.0\ \text{mm}$, $y = 0.00\ \text{mm}$ and the -9.0-μC charge to $x = -3.0\ \text{mm}$, $y = 0.00\ \text{mm}$? $(k = 1/4\pi\varepsilon_0 = 8.99 \times 10^9\ \text{N} \cdot \text{m}^2/\text{C}^2)$

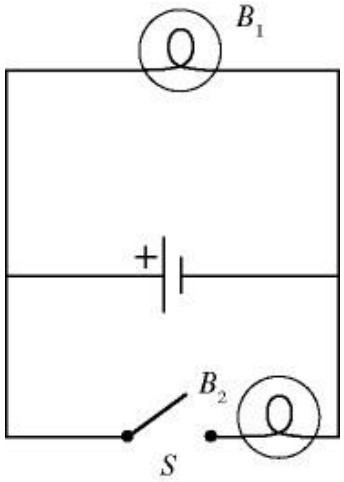
A) 6.8 J B) 27 J C) 40 J D) 81 J

15) The figure shows the cross-section of a hollow cylinder of inner radius *a* = 5.0 cm and outer radius *b* = 7.0 cm. A uniform current density of 1.0 A/ $\text{cm}^2$ flows through the cylinder parallel to its axis. Calculate the magnitude of the magnetic field at a distance of *d* = 10 cm from the axis of the cylinder.



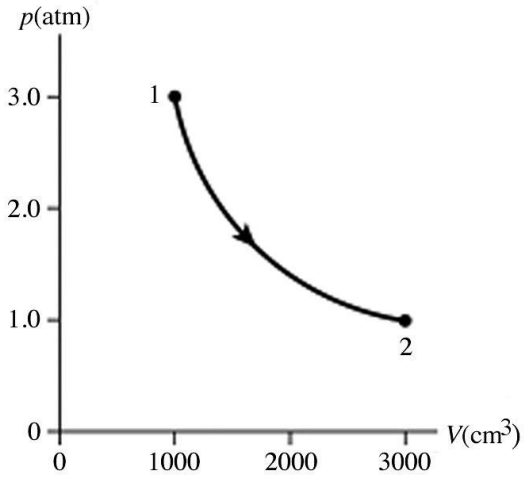

A) $4.5 \times 10^{-4}$ T
B) 0.00 T
C) $0.50 \times 10^{-4}$ T
D) $2.5 \times 10^{-4}$ T
E) $1.5 \times 10^{-4}$ T

16) Two light bulbs, $B_1$ and $B_2$, are connected to a battery having appreciable internal resistance as shown in the figure. What happens to the brightness of bulb $B_1$ when we close the switch $S$?




A) The brightness of $B_1$ decreases temporarily but gradually increases back to its original brightness.
B) The brightness of $B_1$ decreases permanently.
C) The brightness of $B_1$ increases temporarily but gradually decreases back to its original brightness.
D) The brightness of $B_1$ does not change.
E) The brightness of $B_1$ increases permanently.

17) The figure shows a $pV$ diagram for 0.95 mol of gas that undergoes the process 1 → 2. The gas then undergoes an isochoric heating from point 2 until the pressure is restored to the value it had at point 1. What is the final temperature of the gas? The ideal gas constant is $R$ = 8.314 J/mol • K = $0.0821\ \text{L} \cdot \text{atm/mol} \cdot \text{K}$.



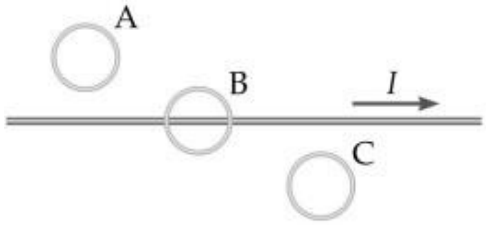

A) 390°C B) -160°C C) 120°C D) 15°C

18) An ideal gas is at a pressure $1.00 \times 10^5\ \text{N/m}^2$ and occupies a volume 2.00 m$^3$. If the gas is compressed to a volume 1.00 m$^3$ while the temperature remains constant, what will be the new pressure in the gas?
A) $1.00 \times 10^5$ N/m$^2$
B) $2.00 \times 10^5$ N/m$^2$
C) $4.00 \times 10^5$ N/m$^2$
D) $0.500 \times 10^5$ N/m$^2$
E) The answer depends on the mass of the gas particles.

19) An electric dipole is made of two charges of equal magnitudes and opposite signs. The positive charge, $q$ = 1.0 μC, is located at the point ($x$, $y$, $z$) = (0.00 cm, 1.0 cm, 0.00 cm), while the negative charge is located at the point ($x$, $y$, $z$) = (0.00 cm, -1.0 cm, 0.00 cm). How much work will be done by an electric field $\vec{E}$ = (3.0 × $10^6$ N/C) $\hat{i}$ to bring the dipole to its stable equilibrium position?

A) 0.030 J B) 0.12 J C) 0.060 J D) 0.020 J E) 0.00 J

20) The long straight wire in the figure carries a current $I$ that is decreasing with time at a constant rate. The circular loops A, B, and C all lie in a plane containing the wire. The induced emf in each of the loops A, B, and C is such that

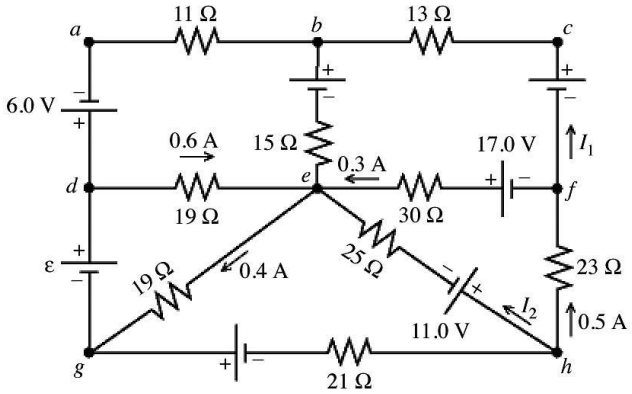



A) a counterclockwise emf is induced in all the loops.
B) loop A has a clockwise emf, loop B has no induced emf, and loop C has a counterclockwise emf.
C) loop A has a counter-clockwise emf, loops B and C have clockwise emfs.
D) no emf is induced in any of the loops.
E) loop A has a counter-clockwise emf, loop B has no induced emf, and loop C has a clockwise emf.

21) Suppose that a steel bridge, 1000 m long, was built without any expansion joints and that only one end of the bridge was held fixed. What would the difference in the length of the bridge be between winter and summer, taking a typical winter temperature as 0.00°C, and a typical summer temperature as 40°C? The coefficient of thermal expansion of steel is $10.5 \times 10^{-6}\ \mathrm{K}^{-1}$.

A) 0.11 m B) 0.11 mm C) 0.42 m D) 0.37 cm E) 0.42 mm

22) A multiloop circuit is shown in the figure. Some circuit quantities are not labeled. It is not necessary to solve the entire circuit. The current $I_1$ is closest to




A) +0.4 A. B) -0.4 A. C) +0.2 A. D) zero. E) -0.2 A.

23) An infinitely long non-conducting cylinder of radius $R$ = 2.00 cm carries a uniform volume charge density of $18.0\ \mu\mathrm{C/m}^3$. Calculate the electric field at distance $r$ = 1.00 cm from the axis of the cylinder.

A) 2.00 × $10^3$ N/C
B) 2.50 × $10^3$ N/C
C) 5.10 × $10^3$ N/C
D) 10.2 × $10^3$ N/C
E) zero

24) If we use 67 W of power to heat 148 g of water, how long will it take to raise the temperature of the water from 15°C to 25°C? The specific heat of water is $4190\ \text{J/kg} \cdot \text{K}$.

A) 93 s B) 5.3 s C) 114 hours D) 22 s

25) What is the net power that a person loses through radiation if her surface area is 1.20 $m^2$, if her emissivity is 0.895, if her skin temperature is 300 K, and if she is in a room that is at a temperature of 17°C?
A) 68.4 W B) 60.3 W C) 62.6 W D) 64.8 W E) 65.7 W

26) When an ideal gas increases in volume at constant pressure, the average kinetic energy of the gas molecules

A) decreases.
B) increases.
C) does not change.
D) may either increase or decrease, depending on whether or not the process is carried out adiabatically.
E) may or may not change, but insufficient information is given to make such a determination.

27) A wire carries a 4.0-A current along the +*x*-axis through a magnetic field $\vec{B} = (5.0\,\hat{i} + 7.0\,\hat{j})\ \text{T}$. If the wire experiences a force of 30 N $\hat{k}$ as a result, how long is the wire?

A) 0.87 m B) 1.5 m C) 1.1 m D) 0.63 m

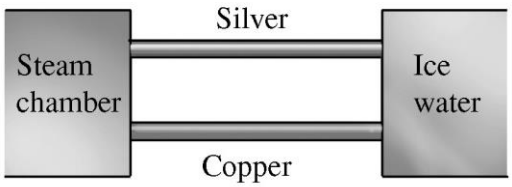
28) At what distance from the central axis of a long straight thin wire carrying a current of 5.0 A is the magnitude of the magnetic field due to the wire equal to the strength of the Earth's magnetic field of about $5.0 \times 10^{-5}$ T?

A) 1.0 cm B) 2.0 cm C) 3.0 cm D) 4.0 cm E) 5.0 cm

29) What length of a certain metal wire of diameter 0.15 mm is needed for the wire to have a resistance of 15 Ω? The resistivity of this metal is $1.68 \times 10^{-8}\ \Omega \cdot \text{m}$.

A) 16 cm B) 16 m C) 160 m D) 1.6 m E) 16 mm

30) Two metal rods, one silver and the other copper, are both attached to a steam chamber as shown in the figure, with a temperature of 100°C, at one end, and an ice water bath, with a temperature of 0°C, at the other. The rods are 5.0 cm long and have a square cross-section, $2.0\ \text{cm}$ on a side. When steady state has been reached, how much heat flows through the two rods in 1.0 min? The thermal conductivity of silver is $417\ \text{W/(m} \cdot \text{K)}$, and that of copper is $395\ \text{W/(m} \cdot \text{K)}$. No heat is exchanged between the rods and the surroundings, except at their ends.




A) 11 kJ B) 49 kJ C) 20 kJ D) 39 kJ E) 47 kJ

1) A
2) D
3) E
4) C
5) B
6) E
7) D
8) C
9) B
10) D
11) C
12) A
13) E
14) C
15) E
16) B
17) B
18) B
19) C
20) E
21) C
22) C
23) D
24) A
25) C
26) B
27) C
28) B
29) B
30) D