CC

Physics 161
Makeup Exam
WEDNESDAY, DECEMBER 4, 2013

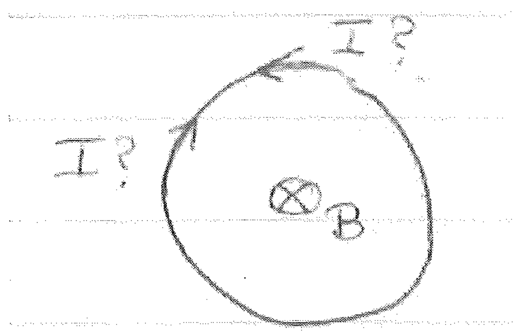
Directions: The exam consists of 25 multiple choice questions. Each question carries equal weight. Please record your answers on the computer-scannable sheets provided. Be sure to record the version (AA, BB, or CC) by filling in the bubbles in the appropriate row in the leftmost column.

Useful equations and constants:

$$R = 8.314\ \frac{\mathrm{J}}{\mathrm{mole\cdot K}} = 0.082\frac{\mathrm{ltr\text{-}atm}}{\mathrm{mole\cdot K}}$$
$$1\ \mathrm{atm} = 1.01\times10^5\ \mathrm{Pa}$$
$$k = 1.38\times10^{-23}\frac{\mathrm{J}}{\mathrm{K}}$$
$$C_p = C_V + nR$$
$$T(^\circ\mathrm{C})+273.15=T(\mathrm{K})$$
$$\Delta U = Q - W$$
$$dU = TdS - PdV$$
$$H = U + PV$$
$$dH = TdS + VdP$$
$$A = U - TS$$
$$G = H - TS$$
$$S = k\ln W;$$
$$W_{\mathrm{monatomic\ gas}} = \left(T^{3/2}V\cdot\mathrm{const.}\right)^N/N!$$
$$\mu_0 = 4\pi\times10^{-7}\ \mathrm{Ns^2/C^2}$$
$$\epsilon_0 = 8.84\times10^{-12}\ \mathrm{C^2/Nm^2}$$

(1-4pts) A circular wire loop lies in the plane of the page, as shown in the figure. A uniform magnetic field B is directed into the page. What happens as the loop is gradually squashed into the shape of an ellipse?

(a) A current is induced in the loop in the counter clockwise direction.
(b) A current is induced in the loop in the clockwise direction.
(c) A current is not induced.



(2-4pts) The following equations describing all of the laws of electricity and magnetism are known as "Maxwell's equations":

(a)

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\epsilon_0}$$
$$\oint \vec{E} \cdot d\vec{s} = -\frac{d}{dt} \int \vec{B} \cdot d\vec{A}$$
$$\oint \vec{B} \cdot d\vec{A} = 0$$
$$\oint \vec{B} \cdot d\vec{s} = \mu_0 I + \mu_0 \epsilon_0 \frac{d}{dt} \int \vec{E} \cdot d\vec{A}$$

(b)

$$\oint \vec{E} \cdot d\vec{A} = 0$$
$$\oint \vec{E} \cdot d\vec{s} = -\frac{d}{dt} \int \vec{B} \cdot d\vec{A}$$
$$\oint \vec{B} \cdot d\vec{A} = \frac{Q}{\epsilon_0}$$
$$\oint \vec{B} \cdot d\vec{s} = \mu_0 I + \mu_0 \epsilon_0 \frac{d}{dt} \int \vec{E} \cdot d\vec{A}$$

(c)

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\epsilon_0}$$
$$\oint \vec{E} \cdot d\vec{s} = 0$$
$$\oint \vec{B} \cdot d\vec{A} = 0$$
$$\oint \vec{B} \cdot d\vec{s} = \mu_0 I$$

(d)

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q}{\epsilon_0}$$
$$\oint \vec{E} \cdot d\vec{s} = -\frac{d}{dt} \int \vec{B} \cdot d\vec{A}$$
$$\oint \vec{B} \cdot d\vec{A} = \mu_0 I$$
$$\oint \vec{B} \cdot d\vec{s} = \mu_0 \epsilon_0 \frac{d}{dt} \int \vec{E} \cdot d\vec{A}$$

(3-4pts) A straight segment of wire carrying current of 1 Ampere in the $\hat{y}$ direction is placed in a uniform magnetic field of 1 Tesla in the $-\hat{z}$ direction. What is the force on the segment if it has a length of 1 meter?

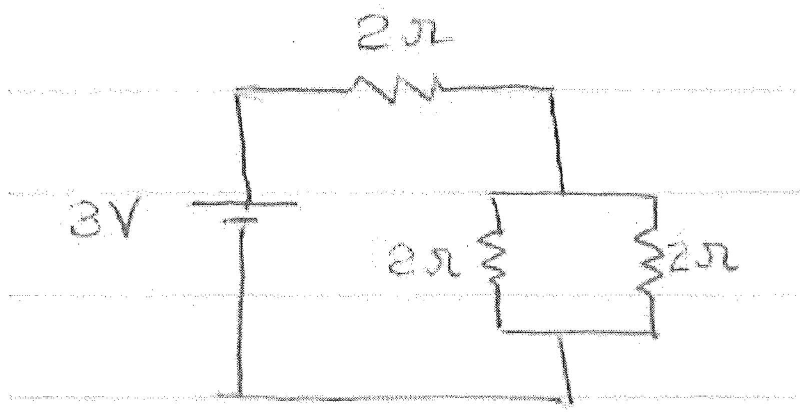
(a) -1 N $\hat{z}$
(b) 0 N
(c) -1 N $\hat{x}$
(d) -1 N $\hat{y}$

(4-4pts) Two infinitely long straight wires each carry a steady current. One wire carries a current of 1 Ampere in the $\hat{x}$ direction, and the other wire carries a current of 1 Ampere in the $-\hat{x}$ direction. If the distance between the two wires is 1 meter, the magnetic force (per meter) between them is

(a) 1.4×10^{-7} (attractive).
(b) 0 N
(c) 2×10^{-7} N/m (attractive).
(d) 2×10^{-7} N/m (repulsive).

(5-4pts) Consider the circuit shown below, consisting of three 2 Ω resistors and a 3 V battery. At what rate is work done by the battery? (Assume that the battery has no internal resistance.)

(a) 4 W
(b) 3 W
(c) 6 W
(d) 5 W



(6-4pts) A long solenoid with length 1 meter has a diameter of 2 cm and a winding density of 5000 turns per cm. If the solenoid supports a current of 24 mA, what is the energy stored in the magnetic field?

(a) 19.3 mJ.
(b) 22.1 mJ.
(c) 28.4 mJ.
(d) 35.2 mJ.

(7-4pts) An 0.5 μF capacitor consists of two concentric metal spheres which are separated from one another by an insulator. When a charge of 1 μC is removed from one of the spheres and place on the other sphere, the potential between them is

(a) 1 V
(b) 2 V
(c) 0.1 V
(d) 0.5 V

(8-4pts) A parallel plate capacitor is given a charge Q when connected across a battery with voltage V. If an insulator having dielectric constant of 4 is inserted between the plates, the charge

(a) Decreases by a factor of 8
(b) Increases by a factor of 8
(c) Decreases by a factor of 4
(d) Increases by a factor of 4

(9-4pts) How much work must be performed to give a 0.5 μF capacitor a charge of 1 μC?

(a) 1.0 μJ
(b) 1.6 μJ
(c) 0.5 μJ
(d) 0.3 μJ

(10-4pts) A 5 V battery is connected to two different capacitors in parallel in a closed loop circuit. How is the voltage divided between the two?

(a) The largest voltage drop is across the largest capacitor.
(b) The largest voltage drop is across the smallest capacitor.
(c) Half the voltage is dropped across one capacitor and half the voltage is dropped across the other.
(d) The voltage across each capacitor is 5 V.

(11-4pts) Which is a statement of Ohm's law?

(a) The current in a conductor is proportional to the voltage across the conductor.
(b) The current in a conductor decreases exponentially with time due to resistance.
(c) The current in a conductor is proportional to the square of the voltage.
(d) The voltage across a battery is always slightly smaller than the ideal voltage.

(12-4pts) A 5 V battery drives a current through a circuit, delivering 5 mW of power. What is the current?

(a) 25 mA
(b) 1 mA
(c) 0.2 mA
(d) Cannot be determined unless the resistance, inductance, and capacitance are specified.

(13-4pts) How long does it take for charge build up on an initially uncharged 1 μF capacitor which is placed in a series circuit with a 10 kΩ resistor and a 5 V battery? (order of magnitude)

(b) 10 ms ← Note (a) or (b) acceptable on scantron
(c) 50 μs
(d) 20 s
(a) 5 s

(14-4pts) What is a possible trajectory for a charged particle moving in a uniform magnetic field?

(a) an ellipse
(b) a hyperbola
(c) a circle
(d) a straight line

(15-4pts) The cyclotron is a device that

(a) accelerates charged particles to high energies with an ac electric field by taking advantage of the fact that the orbital period of a particle in a uniform magnetic field remains constant as its energy increases.

(b) measures the strength of a magnetic field by looking at the deflection of a galvanometer caused by changes in magnetic flux in a coil.

(c) allows one to determine the chemical composition of a substance by sorting ions by their charge to mass ratio.

(d) determines the sign of the charges that move in a conductor by measuring the transverse voltage that develops in a magnetic field.

(16-4pts) The discovery that an electric field is generated by a changing magnetic flux is attributed to

(a) Biot and Savart.
(b) Oersted.
(c) Faraday.
(d) Ampere.

(17-4pts) Two electrons are at rest. Assuming that they are initially far from one another, what is the minimum amount of work that must be performed to bring the electrons together to a separation of 2 nm? (1 eV = 1.6×10^{-19} J)

(a) 1.8 eV
(b) 2.1 eV
(c) 0.4 eV
(d) 0.7 eV

(18-4pts) At a particular point just above the surface of a conductor, the electric field is found to be directed towards the surface, having a magnitude of 57 N/C. What is the charge density on the conducting surface at this point?

(a) -0.3 nC/m^2
(b) 0.2 nC/m^2
(c) -0.5 nC/m^2
(d) -0.4 nC/m^2

(19-4pts) A uniform magnetic field has a strength $\vec{B}$ = 2 T $\hat{x}$+1 T $\hat{y}$. Consider a square surface with area vector $\vec{A}$ = 3 m^2 $\hat{x}$ - 2 m^2 $\hat{y}$. What is magnitude of the magnetic flux through this surface?

(a) 4 Tm^2
(b) 5 Tm^2
(c) 0 Tm^2
(d) 1 Tm^2

(20-4pts) The electric flux through a spherical Gaussian surface having a 5 m radius is -100 Nm^2/C. Which of the following *must* be true?

(a) The magnitude of the electric field at the Gaussian surface is -0.3 N/C
(b) The charge enclosed by the Gaussian surface is -0.9 nC
(c) The total charge enclosed by the Gaussian surface is zero.
(d) The charge enclosed by the Gaussian surface is located at the center of the sphere.

(21-4pts) An ideal gas is expanded isothermally and reversibly, from $P = 2$ atm and $V = 1$ liter, to $P = 1$ atm and $V = 2$ liters, at 273 K. How much work is performed on the surroundings?

(a) $2 \ln 2$ liter-atm.
(b) $8.02 \ln 2$ liter-atm.
(c) $80.2 \ln 2$ liter-atm.
(d) $0.082 \ln 2$ liter-atm.

(22-4pts) An ideal gas Carnot engine has

(a) the same efficiency as a non-ideal gas Carnot engine
(b) a lower efficiency than a Carnot engine for which working fluid changes phase.
(c) a higher efficiency than the non-ideal gas Carnot engine
(d) a lower efficiency than a non-ideal gas Carnot engine

(23-4pts) If 600 kJ of heat is transferred from a system to the surroundings at 300 K, the change in entropy of the surroundings is

(a) -18 kJ/K
(b) 18 kJ/K
(c) -2 kJ/K
(d) 2 kJ/K

(24-4pts) Two glass bulbs having the same volume are connected to one another by a stopcock. Initially, one bulb is filled with helium gas at 1 atm, and the other bulb is filled with xenon gas at 1 atm. The bulbs are in thermal contact with the surroundings at 298 K. When the stopcock is opened, the gases mix. Assuming ideal gas behavior, which of the following statements is true?

(a) $\Delta S_{\text{universe}} > 0$
(b) $Q > 0$
(c) $\Delta U < 0$
(d) $\Delta S_{\text{surroundings}} > 0$

(25-4pts) When combined with Boltzmann's postulate, the second law of thermodynamics implies that

(a) entropy increases with the logarithm of a system's weight.
(b) an increase in entropy represents an increase in disorganization.
(c) the energy of the universe remains constant.
(d) an increase in entropy may always be associated with a transfer of heat.

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