YOUR NAME _____

Sample Final Physics 1404 (Dr. Huang)), Correct answers are underlined.

Useful constants: $e=1.6\times10^{-19}$C, $m_e=9.1\times10^{-31}$ kg, $m_p=1.67\times10^{-27}$ kg, $\varepsilon_0=8.85\times10^{-12}$ C^2/N·m^2, $c=3\times10^8$m/s
$k_e=8.99\times10^9$ N·m^2 /C^2, $\mu_0=4\pi\times10^{-7}$ Wb/A·m, $h=6.63\times10^{-34}$ J·s, 1au$=1.66\times10^{-27}$ kg.

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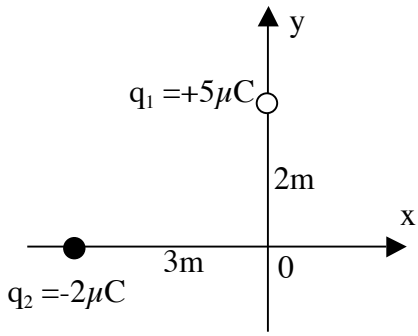
***** Problems 1-32 carry equal credit of 5 points *****

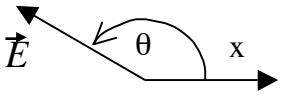
Problem 1,2,3 Two point charges are arranged as shown in the figure.



What is the magnitude of electric field at the origin?

a) 3.49×10^4 N/C
b) 6.33×10^4 N/C
c) $\underline{1.14\times10^4\text{ N/C}}$
d) 2.11×10^4 N/C
e) 2.66×10^4 N/C
f) 6.04×10^4 N/C

What is the angle between the electric field and the x-axis at the origin?



a) 153°
b) 289°
c) 67°
d) 127°
e) $\underline{260°}$
f) 321°

What is the electric potential at the origin?

a) $\underline{1.65\times10^4\text{ Volts}}$
b) 2.25×10^4 Volts
c) -4.22×10^3 Volts
d) 1.19×10^4 Volts
e) 2.86×10^4 Volts
f) None of above

Problem 4,5 Two parallel metal plates are separated by 2 mm. A 120 V potential difference is maintained between those plates. If an electron is released from the negative plate,

What is the electrostatic force on the electron?

a) $\underline{9.6\times10^{-15}\text{ N}}$
b) 7.8×10^{-15} N
c) 2.3×10^{-15} N
d) 3.8×10^{-15} N
e) 1.2×10^{-15} N

What is the speed of the electron when it reaches the positive plate?

a) 3.2×10^6 m/s
b) 5.4×10^6 m/s
c) 8.7×10^6 m/s
d) 1.3×10^5 m/s
e) 1.7×10^6 m/s
f) $\underline{6.5\times10^6 \text{ m/s}}$

Problem 6,7 When an air-filled parallel-plate capacitor is connected to a 15 V source, it contains 90 μC of charge. After disconnecting the capacitor from the source, the distance between two parallel plates is now reduced to half.

What is its new capacitance?

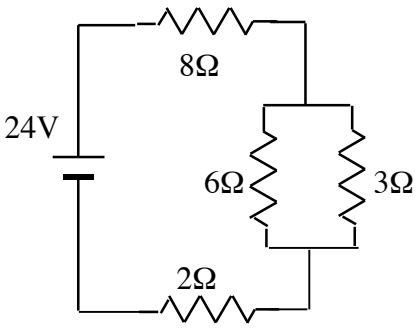
a) 4 μF
b) 10 μF
c) 6 μF
d) 1 μF
e) 3 μF
f) 12 μF

What happen to the potential difference between two plates?

a) Doubled
b) Halved
c) No change
d) No potential difference
e) Quadrupled

Problem 8,9 In the circuit on the right,

What is the equivalent resistance of the entire network?



a) 10 Ω
b) 10.6 Ω
c) 12 Ω
d) 19 Ω
e) 16 Ω

What is the power dissipated on the 8Ω resistor?

a) 32 W
b) 40 W
c) 8.0 W
d) 16 W
e) 20 W
f) 48 W
g) None of above

Problem 10 Two parallel wires carry currents of 40 and 80 A, respectively, in opposite directions. The wires are separated by 1.0 cm. What is the force on a 0.80 m long segment of the wire carrying the larger current?

a) 0.125 N
b) 0.0512 N
c) 1.85 N
d) 0.321 N
e) 0.064 N
f) None of above

Problem 11,12 A circular coil with 500 turns and radius 5.0 cm is placed in a spatially uniform magnetic field of 0.10 T. The field is parallel to the axis of the coil.

What is the magnetic flux through the coil?

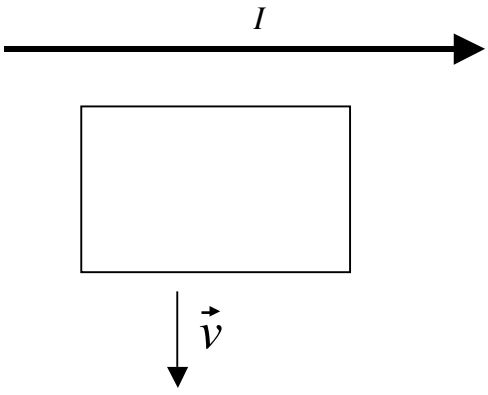
a) 1.23×10^{-4} Wb
b) 9.45×10^{-4} Wb
c) 7.41×10^{-4} Wb
d) 5.39×10^{-4} Wb
e) 7.85×10^{-4} Wb

In order to have an induced emf in the coil of 100 V, the time during which this field must be linearly reduced to zero is

a) 0.039 ms
b) 0.079 ms
c) 0.008 ms
d) 3.9 ms
e) 1.87 ms
f) None of the above

Problem 13,14 A closed rectangular conducting loop is moving away from a long straight wire carrying current *I*.

What is the direction of the induced current in the loop?



a) Clockwise
b) Counterclockwise
c) No induced current

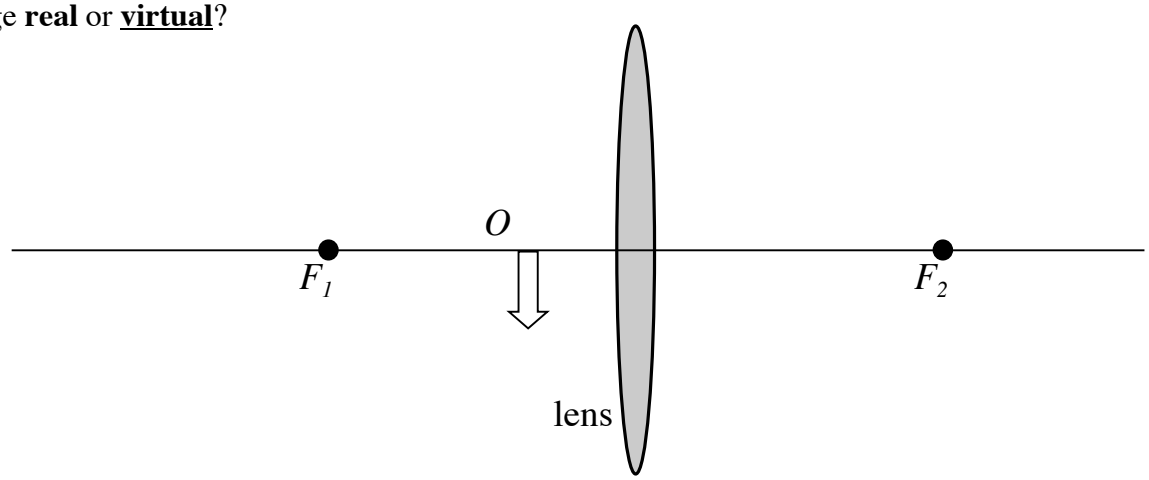
What is the direction of *net* magnetic force on the loop?

a) Up
b) Down
c) Left
d) Into the paper
e) Out of Paper
f) None of above

Problem 15 The magnitude of the Poynting vector for solar radiation at the top of the earth's atmosphere is 1350 W/m^2. The distance earth-sun is 150 million kilometers. Calculate the total radiative output from the sun.

a) 3.82×10^{26} Watts
b) 0.96×10^{26} Watts
c) 0.30×10^{26} Watts
d) 1.91×10^{26} Watts
e) 7.36×10^{26} Watts
f) None of above

Problem 16 Draw ray diagram to find the image of the object *O* formed by the thin converging lens. Is the image **real** or **virtual**?



Problem 17,18 A 631 nm laser beam (measured in air) is introduced into an optical fiber with an index of refraction of 1.52, which is submerged in water (n_w = 1.33).

The critical angle for total internal reflection under water is

a) 41°
b) 49°
c) 61°
d) 56°
e) 74°

What is the wavelength of the light in the optical fiber?

a) 474 nm
b) 839 nm
c) 959 nm
d) 631 nm
e) 415 nm
f) 779 nm

Problem 19 The magnification produced by a converging lens is found to be -3.5 for an object placed 0.185 m from the lens. What is the focal length of the lens?

a) 0.35 m
b) 0.31 m
c) 0.26 m
d) 0.22m
e) 0.19 m
f) 0.14 m

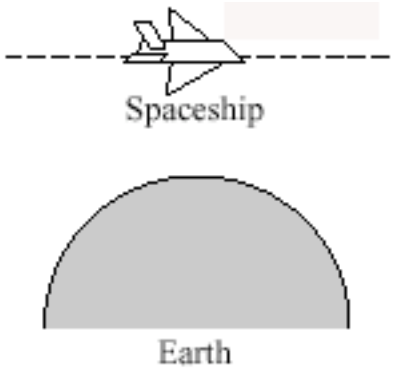
Problem 20 A camera lens is made of a glass with index of refraction of 1.50. A 100 nm thick anti-reflection coating made of MgF_2 (n = 1.38) is deposited on the surface of the lens. Calculate the wavelength (in air) of the visible light for which this coating works best.

a) 552 nm
b) 600 nm
c) 400 nm
d) 276 nm
e) 345 nm
f) 476 nm

Problem 21 A circular radar antenna on a ship has a diameter of 2.8 m and radiates at a frequency of 12×10^9 Hz. Two small boats are located 11 km away from the ship. How close could the boats be and still be detected as two objects?

a) 112 m
b) 76 m
c) 98 m
d) 120 m
e) 89 m
f) 32 m

Problem 22 A spaceship travels with a speed of 0.441c as it passes by the Earth, as shown in the figure. The pilot of the spaceship measures the length of the moving ship as 42.8 m. Determine its length as measured by a person on the Earth.



a) 39.6 m
b) 41.1 m
c) 38.4 m
d) 45.8 m
e) 32.1 m
f) 25.9 m

Problem 23 Calculate the total energy of a proton if it is accelerated to a speed of 0.41c.

a) 1.99×10^{-10} J
b) 2.35×10^{-10} J
c) $3.22\text{x}10^{-10}$ J
d) $\underline{1.65\text{x}10^{-10}\text{ J}}$
e) $1.11\text{x}10^{-10}$ J
f) $4.91\text{x}10^{-10}$ J

Problem 24 A proton has a mass that is 2.5 times of its rest mass. What is its speed?

a) 0.84c
b) 0.89c
c) <u>0.92c</u>
d) 0.75c
e) 0.95c
f) 0.97c

Problem 25 A metal has a work function of 3.5 eV. What is the cut-off wavelength of the illuminating light, above which no photoelectron is emitted from the surface?

a) 239 nm
b) 299 nm
c) <u>355 nm</u>
d) 412 nm
e) 576 nm
f) 642 nm

Problem26 What is the minimum energy of a photon that can produce an electron-positron pair?

a) <u>1.02 MeV</u>
b) 2.33 MeV
c) 1.69 MeV
d) 0.78 MeV
e) 2.77 MeV
f) 3.92 MeV

Problem 27 The uncertainty in the position of a proton is 0.053 nm. What is the uncertainty in its speed?

a) <u>1192 m/s</u>
b) 600 m/s
c) 972 m/s
d) 312 m/s
e) 882 m/s
f) 789 m/s

Problem 28 Determine the wavelength of light emitted when a hydrogen atom makes a transition from the n = 6 to the n = 3 energy level according to the Bohr mode. The Rydberg constant $R = 1.097 \times 10^7\ m^{-1}$.

a) 388 nm
b) 723 nm
c) 987 nm
d) 755 nm
e) 678 nm
f) 1094 nm

Problem 29 Which of the following electron configurations is a possible *ground state*?

a) $1s^2 2s^1 2p^5\ 3s^3$
b) $1s^2 2s^2 2p^6\ 2d^1$
c) $1s^2 2s^2 2p^6\ 3s^2$
d) $1s^2 2s^2 2p^7\ 3s^2$
e) $1s^2 1d^2 2s^2 2p^7\ 3s^2$
f) None of these is possible

Problem 30 What is the approximate radius of a $^{64}_{29}\mathbf{Cu}$ nucleus?

a) 3.3×10^{-15} m
b) 1.9×10^{-15} m
c) 4.8×10^{-15} m
d) 3.6×10^{-15} m
e) 2.7×10^{-15} m

Problem 31 Complete the following nuclear reaction: $^{38}_{19}\mathbf{K} + {}^{1}_{1}\mathbf{H} \rightarrow$ _____ $+ {}^{38}_{20}\mathbf{Ca}$

a) p
b) n
c) $^{2}_{1}\mathbf{H}$
d) $^{3}_{1}\mathbf{H}$
e) β^-

Problem 32 The mass of tritium ($^{3}_{1}T$) is 3.016049 au. Based on $m_H = 1.007825$ au and $m_n = 1.008665$ au, calculate its binding energy per nucleon. (1 au = 931.5 MeV/c^2)

a) 3.045 MeV
b) 2.83 MeV
c) 3.33 MeV
d) 3.78 MeV
e) 1.55 MeV

Problem 33-52: (2 points each) Fill in a T/F answer for each statement below:

33. [ ] The force on a negative charge is in the opposite direction of the electric field.
34. [ ] Electric field vector is perpendicular to the electric field line at each point.
35. [ ] A 10 μF capacitor can store 50 μC of charge if the potential difference between the two conducting plates is 5 volts.
36. [ ] All materials follow the Ohm's law.
37. [ ] The equivalent capacitance of a series combination is always less than any individual capacitance in the combination.

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38. [ ] If a current carrying wire does not experience any magnetic force, the magnetic field must be zero in that area.
39. [ ] Parallel conductors carrying currents in the same direction attract each other.
40. [ ] A large, steady magnetic flux through a circuit induces a large emf.
41. [ ] Lenz's law states that the induced current and induced emf in a conductor are in such a direction as to enhance the magnetic flux change that produced them.
42. [ ] The electric and magnetic components of a plane EM wave are always perpendicular to each other.

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43. [ ] In Young's double-slit experiment, the condition for constructive interference is that the path difference of two waves must be either zero or some integer multiple of the wavelength.
44. [ ] If the incident angle of a light equals Brwester's angle, the reflected beam would be partially polarized.
45. [ ] To improve the resolution of a lens, one can either increase the diameter of the lens or decrease the frequency of the light.
46. [ ] The principle of the constancy of the speed of light states that the speed of light in empty space has the same value in all inertial reference frames, independent of the speed of the source or observer.
47. [ ] In a pair production, a photon disappears and an electron pair is created.

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48. [ ] If an electron jumps from the ground state to an excited state, it absorbs a photon whose energy equals (E_e-E_g).
49. [ ] Heisenberg uncertainty principle states that both the energy and momentum of an object cannot be measured precisely at the same time.
50. [ ] For each orbital quantum number l, the magnetic quantum number can take 2(l+1) possible values.
51. [ ] Pauli exclusion principle states that no two electrons in an atom can occupy the same quantum state.
52. [ ] The four known type of forces are strong nuclear force, weak nuclear force, gravitational force and electromagnetic forces.