PHYS 202 Final Exam 5/03/19 Dr. Holmes NAME______**Key**______________

DO ALL THE PROBLEMS. THE WORTH OF EACH PROBLEM IS MARKED NEXT TO THE PROBLEM. SHOW YOUR WORK FOR PARTIAL CREDIT. (For directions, use the six standard directions: ↑N, →E, ↓S, ←W, ⊙up or out, and ⊗down or in.)

1) Consider two charged particles (q_1 = +3 nC, m_1 = 6 grams; q_2 = -2 nC, m_2 = 4 grams) The first particle is 18 cm to the West of the second one. a) What is the magnitude and direction of the electric FORCE on the 1st particle due to the presence of the 2nd particle? [when answering this direction question, answer with North, East, South, West, Up or Down.]

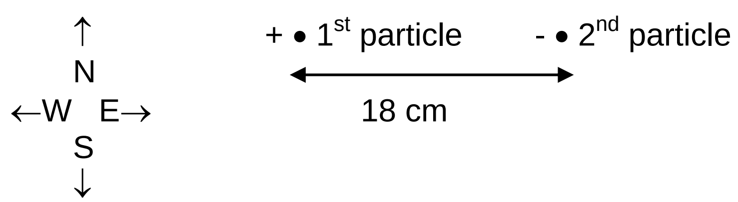
[3] __**1.67 x 10^{-6} Nt**_, [2] _**East**_______.

b) Is the magnitude of the force on the 2nd particle due to the 1st particle [bigger than, the same as, or smaller than] the force on the 1st particle due to the 2nd particle?

[1] ___**same**________.

c) Is the magnitude of the acceleration of the 2nd particle due to the presence of the 1st particle [bigger than, the same as, or smaller than] the acceleration of the 1st particle due to the 2nd particle? (Assume there are no other forces acting on the two particles).

[1] _**bigger**_____.



2) A particular light bulb is rated at 150 Watts when a voltage of 110 volts is placed across it.

a) What is the electric current through this light bulb?

[3] _____**1.36 A**______.

b) What is the resistance of this light bulb?

[3] __**80.9 Ω**______ . c) In designing a new wattage light bulb, should the resistance of the light bulb be raised or lowered from that in part b above if the power of the light bulb is to be **decreased** when using the same 110 volts?

[1] _**raised**__ .

3) Consider three resistors: $R_1 = 15\ \Omega$, $R_2 = 30\ \Omega$, $R_3 = 45\ \Omega$.

a) Connect the three resistors in a circuit (make a circuit drawing) such that the effective resistance is the **smallest** it can be: [2]

b) Are the three resistors above connected in series, parallel, or some other combination?

[1] ___**parallel**______. c) What is the effective resistance of this circuit?

[2] __**8.18 Ω**______.

d) Connect the three resistors in a circuit (make a circuit diagram) such that the effective resistance is between 15 Ω and 30 Ω. [2]

4) Consider an electron moving up ⊙ at a speed of 5×10^6 m/s in a magnetic field of strength 0.0017 T directed West ←. a) What is the magnitude of the magnetic force on the electron?

[2] **1.36×10^{-15} Nt**_. b) What is the direction of the magnetic force on the electron?

[2] ___**North**____.

c) What is the magnitude of the acceleration on the electron due to this force?

[1] **1.49×10^{15} m/s^2**____.

d) Will this magnetic force cause the electron to [speed up, slow down, or change direction]?

[1] _**change direction**_.

5) A certain mass spectrograph is to be designed so that ions (singly charged) of mass 48 amu when accelerated to a speed of $v = 7 \times 10^4$ m/s, go in a semi-circle of **diameter** of 14.0 cm when a magnetic field is applied. a) What is the mass of the 48 amu ions in kg?

[1] **7.97 x 10^{-26} kg** .

b) What should the strength of the magnetic field, B, be in the spectrograph to make the 48 amu ions going at the above speed go in a semi-circle of diameter = 14.0 cm?

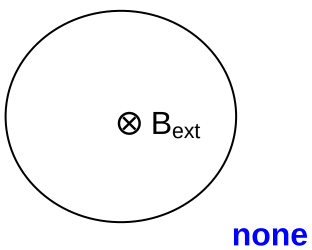
[3] **0.50 T** .

c) Will ions of mass less than 48 amu have diameters of orbit [bigger than, equal to, or smaller than] the 64 amu ion's diameter of orbit?

[1] **smaller** .

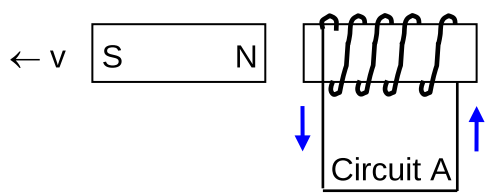
6) In each of the four diagrams below, indicate on the A circuit the direction of the induced current in circuit A due to the situation described (if no current, then write the word NONE on circuit A):

a) the external magnetic field directed DOWN through circuit A is constant in strength:
[2]

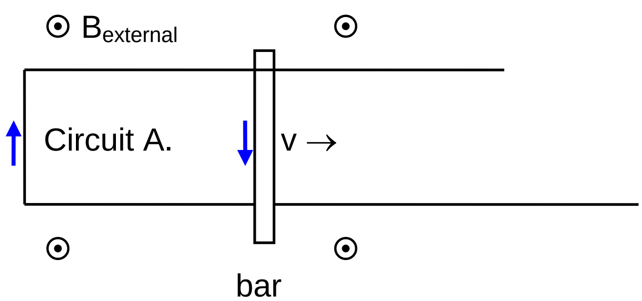


Circuit A is the loop of wire

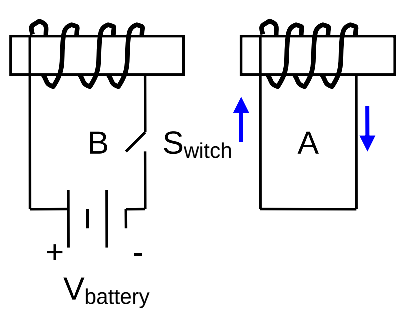
b) the North pole of the bar magnet is pointing toward the solenoid in circuit A and is moving away from it: [2]



c) The bar is moving to the right: [2]



d) The switch in circuit B is being OPENED (it was closed): [2]



7) A person is **farsighted** and can see things clearly only if they are 60 cm away or farther.
a) What focal length should the person's glasses (lenses) have if they are designed to let the person see something at the near viewing distance of 25 cm clearly?

[3] ___**42.9 cm**____.

b) Draw a diagram showing the position of the eye, the lens, the object and the image. [2]

c) Design a lens that has the above focal length from part a), that is, specify n_{glass}, R_1 and R_2 and draw a picture of the lens: [3]

n_{glass} ____________ R_1 __________ R_2 __________ . picture:

FOR PROBLEMS 8 AND 9 USE THE FOLLOWING INFORMATION: A 35 mm camera (film size is 24 mm x 36 mm) uses a lens with a focal length of 120 mm and the f-stop setting is 2 (which means the diameter of the opening to the lens is 1/2 the focal length or 60 mm). You take a picture of a newspaper located 50 meters away. The size of the print on the page is 8 mm. For purposes of calculation assume that the wavelength of the light is one in the middle of the visible spectrum. [If you do not know what wavelength this is, you may ask and I will give it to you but you will be marked down one point.]

8) a) What is the object distance?

[1] ____**50 m**_______

b) What is the image distance?

[3] _**120.3 mm**_.

c) Given that the print size on the paper is 8 mm in height, what is the image height on the film?

[2] _**1.92 x 10^{-5} m**___.

d) Is the image upside down or right-side-up?

[1] _**upside down**__.

9) a) What is the smallest angle that this camera can resolve based on the Rayleigh criterion?

[3] ____**6.41 x 10^{-4} degrees**_.

b) What angle does the print size (8 mm on the paper) make when viewed from 50 meters away?

[3] __**9.17 x 10^{-3} degrees**_.

c) Assuming the camera has quality lenses and a fine grain film, can the picture the camera takes be enlarged big enough and clearly enough so that you can read what the newspaper said (definitely, just barely, not quite, definitely not) ?

[1] _**definitely**________.

10) a) List two experiments that indicate light behaves as a wave and not as a particle:

(1) [1]

(2) [1]

b) List two experiments that indicate light behaves as a particle and not as a wave:

(1) [1]

(2) [1]

11) a) What is the energy of a photon given off by a hydrogen atom in going from the n=3 state to the n=2 state?

[3] ____**1.89 eV**_____. b) What is the wavelength of light from this transition?

[2] ____**659 nm**_____. c) What type (or if visible, what color) is this photon?

[1] _____**red**___.

12) a) What is the speed of an electron accelerated through 150 volts?

[2] __**7.26×10^{6} m/s**__.

b) What is the momentum of this electron (at the above speed)?

[2] __**6.61×10^{-24} kg*m/s**__.

c) What is the wavelength of this electron (at the above momentum)?

[2] __**1.00×10^{-10} m**__.

d) What is the wavelength of a **photon** that has an energy of 150 eV ?

[2] __**8.29×10^{-9} m**__.

13) Fill in the missing particle(s):

[1] $_{90}Th^{232}$ goes to **$_{88}X^{228}$** + alpha + energy

[2] $_{53}I^{122}$ goes to **$_{52}X^{122}$** + **$_{+1}\beta^{o}$** + **ν**

[2] $_{53}I^{131}$ goes to **$_{54}X^{131}$** + **$_{-1}\beta^{o}$** + anti- **ν**

(There is one stable isotope of $_{53}I$ at a mass of 127.)

14) a) Given that the half life of $_{53}I^{131}$ is 8.05 days, what is the decay constant for this isotope?

[2] __**9.97 x 10^{-7} / sec**___. b) How many atoms of I^{131} are there in 1 gram?

[1] ___**4.58 x 10^{21}**__.

c) What is the activity of 1 gram of I^{131} in dis/sec? In Curies ?

[2] _**4.56 x 10^{15} Bq**_. [1] _**1.23 x 10^{5} Ci**_.

d) What will be the activity of this one gram after 1 year (in dis/sec) ?

[2] ___**102 Bq**_____.

15) C^{14} has a half life of 5,730 years, and the ratio of C^{14} to C^{12} is 1.3×10^{-12}. a) What is the decay constant, λ, for C^{14} ?

[1] _**3.84 x 10^{-12} /sec**_. b) How many atoms of C^{14} are there in **9 grams** of carbon, assuming the ratio given above?

[1] __**5.85 x 10^{11}**__. c) What is the present activity of **9 grams** of carbon taken from a modern "bone" (this assumes the present ratio of C^{14} to C^{12}) ? Express your answer in two forms: in dis/sec: and in Curies:

[2] _**2.25**____ [1] _**6.08 x 10^{-11}**_ .

d) Assuming the ratio of C^{14} to C^{12} in the atmosphere has remained the same, what should the age of a bone be if 9 grams of carbon taken from the bone have an activity of 0.40 counts/sec ?

[2] ___**14,300 years**.