PHY 1120
Exam 3
7/23/2020

Name Alex Yeoh Table #_____

Page 1 6 / 6 pts

Page 2 6 / 6 pts

Page 3 6 / 6 pts

Page 4 2 / 2 pts

Page 5 25 / 25 pts

Page 6 25 / 25 pts

Page 7 20 / 20 pts

Page 8 10 / 10 pts

Total 100 / 100 pts

Useful Information:	$k = 9.0 \times 10^{9}$ N•m²/C²	$\epsilon_o = 8.85 \times 10^{-12}$ C²/N•m²
	$c = 3.0 \times 10^{8}$ m/s	$G = 6.67 \times 10^{-11}$ N•m²/kg²
	$\mu_o = 4\pi \times 10^{-7}$ T•m/A	

Clearly check or fill in the box in front of the answer(s) you are selecting. Each question will have only one **best** answer. <u>You are required to briefly explain each answer to receive credit for your answer</u>. (2 pts each)

1) Which scenario will result in the greatest change in flux through a loop of wire.

- ☐ The magnetic field decreasing from 1.0 Tesla to 0 Tesla
- ☒ The magnetic field very slowly switching from +1.0 Tesla to -1.0 Tesla
- ☐ The magnetic field very quickly switching -0.5 Tesla to +0.5 Tesla
- ☐ The loop slowly rotating 90° in a fixed 1.0 Tesla field

2

Explain: the first and third choices are basically a change in 1 tesla, while the second choice is a change in 2 tesla.

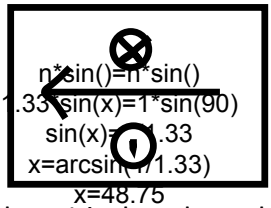
the fourth choice would yield the same results as the first and third choices

2) An East-West facing wire lying on a table produces a North pointing magnetic field above the wire. Which way is the current flowing in the wire?

- ☐ East
- ☒ West
- ☐ There is no current flowing in the wire
- ☐ More information is required

2

Explain:



assuming "above the wire" is above the table, due to right hand rule #1, a north pointing magnetic field would require a west flowing current

3) What is the critical angle at the boundary between water and air?

assuming it starts in water and ends in air

- ☐ 42°
- ☐ 45°
- ☒ 48°
- ☐ There is no critical angle in this situation

2

Explain:

4) Which scenario will result in the greatest EMF in a loop of wire.

2

- ☐ The magnetic field decreasing from 1.0 Tesla to 0 Tesla
- ☐ The magnetic field very slowly switching from +1.0 Tesla to -1.0 Tesla
- ☒ The magnetic field very quickly switching -0.5 Tesla to +0.5 Tesla
- ☐ The loop rotating 90° in a fixed 1.0 Tesla magnetic field

Explain: $emf=\Delta flux/\Delta t$
emf is inversely proportional to time, so if the time changes very quickly the emf would also be greater

5) An electron is moving, in a straight line, through a magnetic field, which of the following is true?

2

- ☒ The electron is moving parallel to the magnetic field lines
- ☐ The electron is moving perpendicular to the magnetic field lines
- ☐ The electron is moving at an increasing velocity
- ☐ More than one answer possible

Explain: $F=qvB\sin()$
the angle has to be parallel to the magnetic fields for F = 0, otherwise there will be some force acting on the electron making the path not a straight line

6) A convex lens produces a 65 cm tall, real, image from a 25 cm tall object. What do we know about d_o and d_i?

2

- ☐ $d_o > d_i$
- ☐ $d_o = d_i$
- ☒ $d_o < d_i$
- ☐ More information needed

Explain: $hi/ho=di/do$
$do(65/25)=di$
$di=2.6do$

7) Two wires emerge from a clock face at 90° from the face. One wire is at 12 o'clock and has current a current of 2.5 A coming out of the clock face. One wire is at 6 o'clock and has current of 5.0 A coming out of the clock face. What can we say about the magnetic field at the center of the clock?

- ☐ The B-field will be zero.
- ☐ The B-field will be point towards 3 o'clock.
- ☒ The B-field will be point towards 9 o'clock.
- ☐ The B-field will point in a number of different directions.

2

Explain: 

because right hand rule #1, the magnetic field would be pointing in opposite directions, but because the strength of the magnetic field is proportional to current, the lower magnetic field would win leading to an overall charge towards 9 o'clock at the center of the clock face

8) In a power transformer the primary coil has 145 loops and the secondary coil has 82 loops. What is true about the voltages involved with this transformer?

- ☒ $V_{in} > V_{out}$
- ☐ $V_{in} = V_{out}$
- ☐ $V_{in} < V_{out}$
- ☐ More information is required

2

Explain:

$Vs/Vp=Ns/Np$
$Vs=82/145*Vp$
$Vs=0.5655*Vp$

9) In a power transformer the primary coil has 145 loops and the secondary coil has 82 loops. What is true about the power involved with this transformer?

- ☐ $P_{in} > P_{out}$
- ☒ $P_{in} = P_{out}$
- ☐ $P_{in} < P_{out}$
- ☐ More information is required

2

Explain:

$Is/Ip=Np/Ns$
$Is=145/82*Ip$

multiplying in voltage from q8

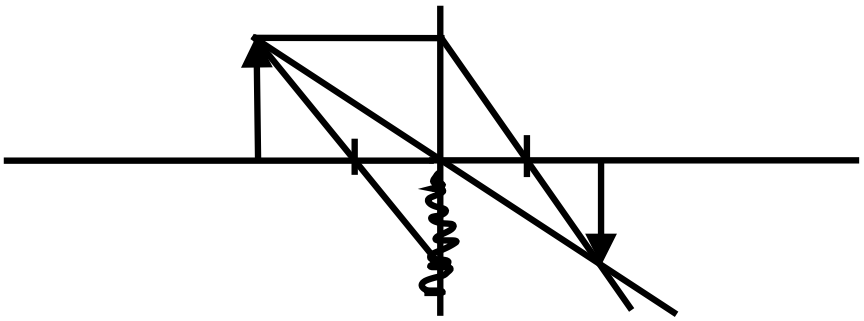
$Vs*Is=(82/145*Vp)*(145/82*Ip)$
$Ps=(82/145)*(145/82)*Pp$
$Ps=1Pp$
$Pp=Ps$

10) A lens produces focused image of a physicist on a screen. If you take the lens and cover half of the lens with tape, what happens to your image?

2

- [x] The image is still produced, but it's not as bright.
- [ ] The image is still produced, but it's out of focus.
- [ ] Only part of the image is produced, but it's in focus.
- [ ] The lens will no longer produce an image.

Explain: light is being reflected by all parts of the object.If you block half the lens, all parts of the object still has light reachign the lens, there are just fewer rays of light that reach the lens



PSP Style: Solve the problem. Make sure to show all your work. (25 pts each)

11) Two, 12.5 cm (0.125m) long, 1.00 gram (0.001kg), wires (1) and (2) are to be held 3.0 cm (0.03m) apart. One wire is hanging horizontally from strings. The other wire is to be held parallel and below the first. How much current and in what direction should the current flow to make the second wire **hover below** the first? (You may assume both wires are carrying the same amount of current)

- Determine the magnitude and direction of the magnetic field caused by each wire at the location of the other (B-field of (1) @ (2) and B-field of (2) @ (1))
- Determine the magnitude and direction of the force on each wire caused by the other wire.

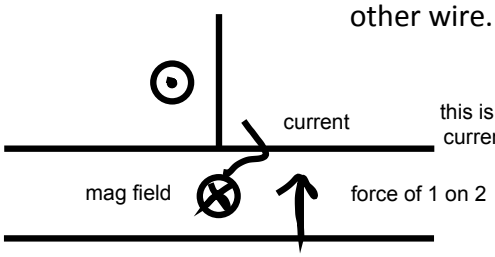
$f=(\mu o/(2\pi))*(I^2*L/r)=2e\text{-}7*I^2*L/r=mg$

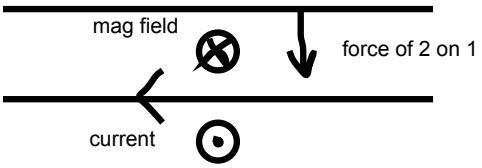
this simplification can be made because the currents are equal

$\sqrt{(mgr/(2e\text{-}7*L))}=I$

$I=\sqrt{(0.001*9.8*0.03/(2e\text{-}7*0.125))}=108.44A$ to the right

this is because the force needs to be upwards, so according to right hand rule #2 current will be to the right and the magnetic field will go inwards (towards wire 2)

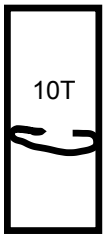




25

because the the wires need to pull on each other for wire 2 to levitate, and because of right hand rule #2, the magnetic field goes inwards towards wire 1 and the current goes to the left

12) Wonder Woman's Lasso of Truth is made of silver and has a resistance of 0.1000Ω. As she is lassoing Magneto the diameter of the lasso is reduced from 2.00 m to 0.5 m in 0.75 seconds. Assuming Magneto is creating a 10 T magnetic field (Which is uniform and extends from his head to his toes) when caught, how much current is induced in the lasso? Draw pictures and show ALL work.



diameter = 2m, B = 10T

diameter = 0.5m, B = 10T

$v=-n*\Delta\Phi/\Delta t=-n*(BA-BA)/t=-n*B(A-A)/t=-n*B(\pi*(d/s)^2-\pi(d/s)^2)/t$
$=-1*10(\pi*(0.5/2)^2-\pi*(2/2)^2)/0.75=39.27V$

$V=IR$
$I=V/R=39.27/0.1=392.7A$

25

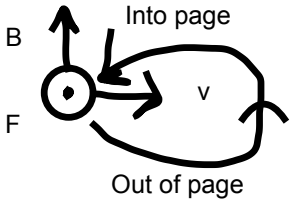
Complete the short-answer question below. Be aware the question may have multiple parts. You must answer all parts to receive full credit. Show all work. Partial credit may be given for partially correct or complete answers. (10 points each)

13) An proton (m_{p+} = 1.67 x10^{-27} kg) is fired through a 12.5 T magnetic field. If the field is moving from the floor to the ceiling and the particles have an initial velocity of 15% of the speed of light, to the right, answer the following questions.

- What is the force on the proton?
- What is the radius of the path the proton takes? Draw a picture showing this situation.
- How would your answers change if the proton was replaced by an electron (m_{e-} = 9.11 x10^{-31} kg) (increase/decrease/stay the same)?

F=qvBsin()=1.6e-19*0.15*3e8*12.5*sin(90)=9e-11N

r=(mv)/(qBsin())=(1.67e-27*0.15*3e8)/(1.6e-19*12.5*sin(90))=0.037575m



10

The force would stay the same but the radius would decrease because mass is lower, and the path would reverse

14) A circular loop of wire is connected to a battery and experiences a rapidly increasing current in the counter-clockwise direction. What is the direction of the induced current in the square loop. **Explain** your answer thoroughly.

The counter-clockwise current in the loop would generate a magnetic field pointing outwards in the center and pointing inwards outside the loop because of right hand rule #1. Because of this inward pointing magnetic field, the square wire outside would have a clockwise current because of right hand rule #1

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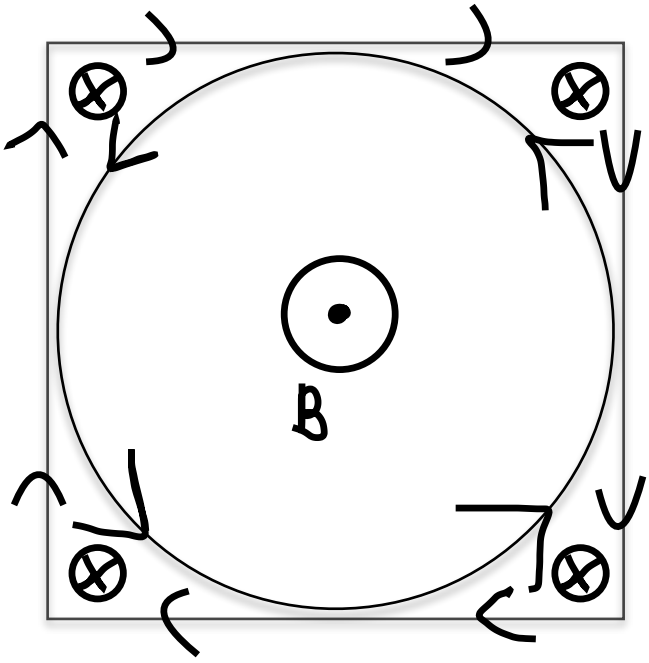


15) An small, toy tree is placed at 1.75 times the focal length away from the mirror. Draw the complete ray diagram for this situation. State whether the image is real/virtual, upright/inverted, and bigger/smaller.

See on next page

10

If the tree is 4.5 cm tall and the focal length of the mirror is 20 cm, calculate d_i, h_i, magnification.

di

(1/do)+(1/di)=(1/f)

di=1/((1/f)-(1/do))=1/((1/20)-(1/(1.7

di=46.67cm

hi

hi/ho=di/do

hi=ho*di/do=4.5*46.67/(1.75*20)

hi=6cm

10 10

magnification

by distance

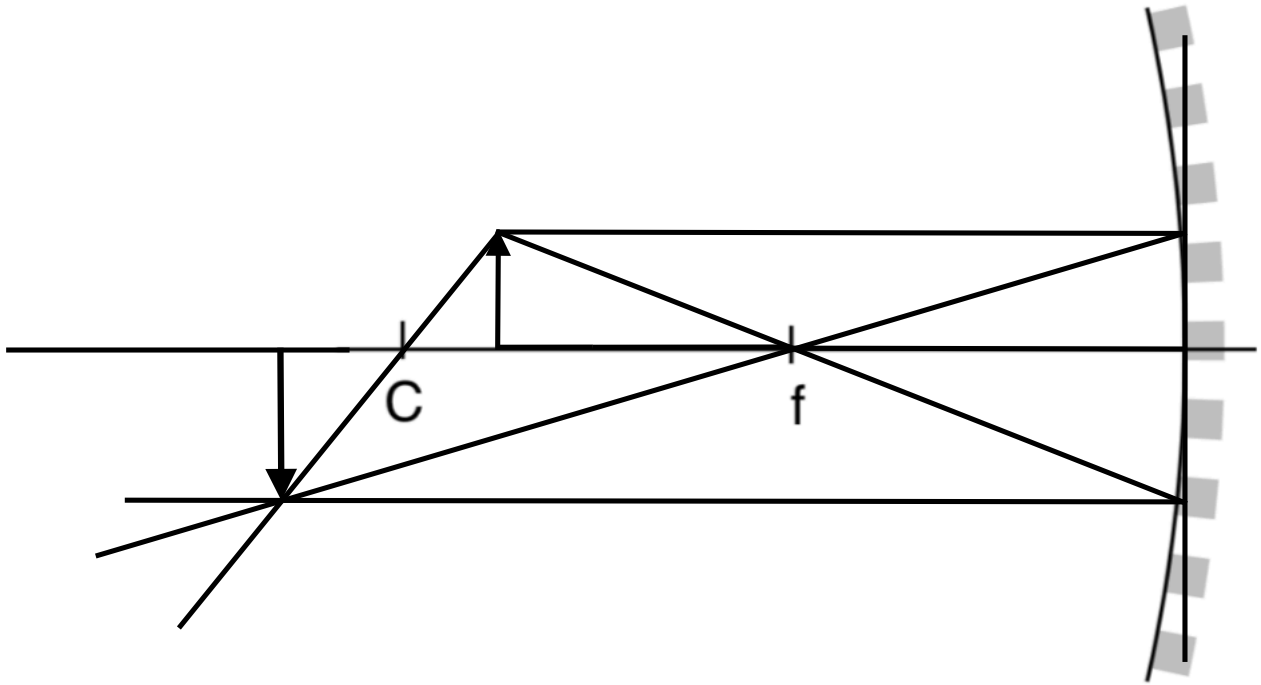
magnification=di/do=46.67/(1.75*20)

magnification=1.33

by height

magnification=hi/ho=6/4.5

magnification=1.33


C
f