Phys2020: Practice Exam 2, Version A, Mar 10, '16. 7:30-9:15 PM

Your Name (please print neatly!) ___________________________

Student ID # ____

TA's name (**Circle one!!**)

Robert Ariniello	Nicholas Kellaris	Prasanth Prahladan
Thomas Gray	Andrew Spott	Shane Rightley

Day your lab meets (**Circle one!!**) Tue Wed Thu

Time your lab starts (**Circle one!!**) 8 10 12 2 4

Please follow these instructions before you start the exam!

☐ Fill in the lines above, and *circle* your TA + the day and time of your lab.

☐ Write in ***and*** *bubble in* your name *and* your ID # on the bubble sheet!

☐ Write ***and*** *bubble* the exam version **(A)** in the space (top left of the bubble sheet.)

Double check all of the above! Then, please wait until a TA announces you may begin.

There are (XX) 24 **multiple choice questions**

Please BUBBLE IN your answer on the bubble sheet. Answers circled on this exam will NOT be used for grading purposes!! Use a #2 pencil. Erase mistakes carefully.
If you can't thoroughly erase, ask for a fresh bubble sheet.
At the end, *check* that you have bubbled in *one* answer only, for all questions.

All questions are weighted the same (so don't let yourself get "stuck" on one problem, move on, come back if you have time!)

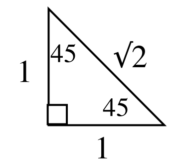
PLEASE turn in your exam in the **proper pile** up front! Ask if it's confusing - thanks!

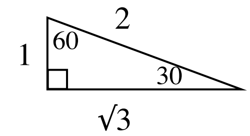
> **"On my honor, as a University of Colorado at Boulder student, I have neither given nor received unauthorized assistance on this work"**

Signature ____

This exam is double sided, please look at the backs of pages!

Useful constants:





k = 9x10^9 N m^2/C^2, μ_0 = 4 π x10^{-7} T m/A
e = 1.6x10^{-19} C,

On this exam, please neglect gravitational forces unless we explicitly say otherwise.

Some Units:
Units of [force] = [N] = [kg*m/s^2],
Units of [energy, or work] = [J] = [N*m] = [kg*m^2/s^2]
Units are Current = C/s, Units of resistance is Ω=Ohm=[J s/C^2] Unit of resistivity is [Ω*m]

Useful Formulas:
Newton's Second Law
$\vec{F}_{net} = m\vec{a}$
Work = $\vec{\mathbf{F}} \cdot \vec{\mathbf{d}}$ = |F||d| cosθ

Coulomb's Law
$|F_{elec}| = \dfrac{k|q_1||q_2|}{r^2}$

Electric Fields
$\vec{E} = \vec{F}/q$
Special cases of the above: $\left|E_{near\ a\ point\ charge}\right| = \frac{k|q|}{r^2}$
For uniform fields (or short distances), $\left|\vec{E}\right| = \left|\frac{\Delta V}{\Delta d}\right|$

Electric Potential (or "Voltage")
$\Delta V = \Delta PE/q$
Special cases of the above: $V_{near\ a\ point\ charge\ q} = \frac{kq}{r}$
For uniform fields (or short distances), $\left|\vec{E}\right| = \left|\frac{\Delta V}{\Delta d}\right|$

Capacitors
$Q = C\Delta V,\ C_{parallel\ plate} = \frac{A}{4\pi k\ d},\ \ |E|_{parallel\ plate} = \frac{4\pi kQ}{A},$
Stored energy in capacitor: $U = \frac{1}{2}C(\Delta V)^2 = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}Q\Delta V$

Currents and circuits
Current is charge passing per second.
Resistance is $R = \rho L/A$, where ρ = resistivity
$\Delta V = IR$ across a resistor, and power dissipated is $P = I\Delta V = I^2R = \Delta V^2/R$
Resistors in series add up, resistors in parallel obey $\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots$

Magnetic fields
Force on a wire in a B-field is $F = I * length * B * \sin\theta$, direction given by a "right hand rule)
Force on a moving charge in a magnetic field is $F = q\ v\ B \sin\theta$ (again, a "right hand rule")
Special case: $\left|B_{near\ a\ long\ wire}\right| = \frac{\mu_0}{2\pi}\frac{I}{r}$

Practice exam. (This older exam may have emphasized Magnetic field questions just a bit more than our 2nd midterm will – we'll see. But, it's all good practice still!)

1. A flashlight has a single 6.0 V battery, which drives current through a single 24 W bulb. How long do you have to wait for 10^{21} electrons to flow through the bulb?

A) 1.6E-19 sec B) 4.0 sec C) 1.0E21 sec D) 160 sec E) 40.0 sec

2. You have two identical resistors. If you connect just *one* of them to a battery, there is 16 W of heat dissipated in the resistor. If you connect both of them in *series* to the same battery, what total heat will be dissipated? (Hint: Draw a picture, work it out!)

A) 16 W
B) 32 W
C) 8 W
D) 64 W
E) 4 W

3. A wire of resistance R is stretched to four times its original length. What happens to its resistance?
HINT: When you stretch wire, you do not remove any material, you do not change the density, you do not even change the total volume of the material...

A) 32 times as large
B) 16 times as large
C) 4 times as large
D) twice as large
E) Stays the same

For the next 2 problems, you are buying copper wire for speakers.
(The resistivity of copper is 2.0E-8 Ω*m.)

4. You choose wire with a diameter of 0.50 mm. You measure the resistance and it comes out to be 2.0Ω. What is the length of the wire you bought?

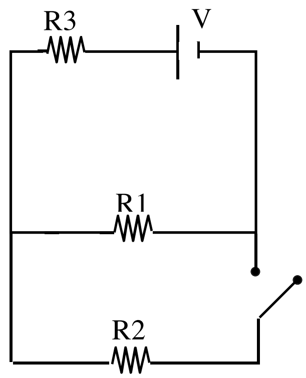
A) 310 m
B) 12.0 m
C) 6.3 m
D) 20.0 m
E) 1.0 m

5. If you get new wire of *twice* the diameter, but the *same* length as above, how does the power dissipated in your new, fatter, speaker wire compare with the power dissipated above?

(Note: Your speakers draw the same amount of current no matter what wire you use)

A. The new wire dissipates one-half as much.
B. One-quarter as much.
C. Exactly the same.
D. Two times as much.
E. Four times as much

For the 3 questions below, consider the circuit shown below:



6. When the switch is closed, what happens to the current through the battery (labelled "V")?

A) It suddenly increases
B) It suddenly decreases
C) It stays unchanged
D) Not enough information is given to decide.

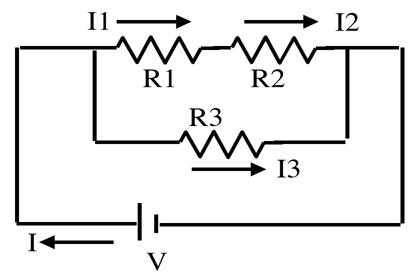
7. Suppose all 3 resistors are light bulbs, and have the SAME resistance, R1 = R2 = R3.
After the switch is closed, how do the brightnesses of the bulbs compare?
(Let "P1" = "brightness of bulb R1", etc.)

A) P1 = P2 =P3 (i.e. they are all equally bright)
B) P1 = P2 < P3 (i.e. bulbs 1 and 2 are the same, but 3 is BRIGHTER than either one)
C) P3 < P1 = P2 (i.e. 1 and 2 are the same, but 3 is DIMMER than either one)
D) P1 < P2 < P3 (i.e. 1 is dimmest, 2 is brighter, 3 is brightest)
E) None of the above is correct.

8. Instead of being the same, now assume R1 = 4 Ω , R2 = 4 Ω , and R3 = 5 Ω .
What is the total equivalent resistance of the circuit, **after the switch is closed**?

A) 9 Ω
B) 5.5 Ω
C) 3 Ω
D) 13 Ω
E) 7 Ω

THE NEXT *THREE* PROBLEMS REFER TO THE CIRCUIT SHOWN HERE TO THE RIGHT:



9. Three normal resistors are hooked up to an ideal battery as shown. What can you conclude?

A) I + I1 + I3 = 0
B) I + I1 + I2 + I3 = 0
C) I1 + I2 - I3 = 0
D) I + I1 + I2 = 0
E) I2 + I3 - I = 0

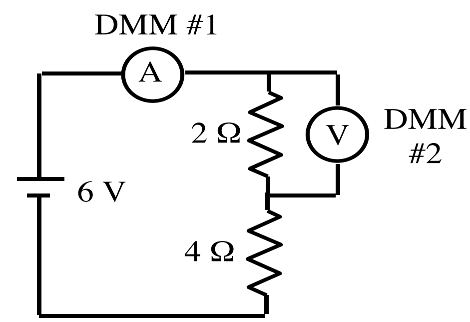
10. In the above circuit, if you suddenly increase resistance R1 (holding the other resistors, and the voltage V, constant), what happens to the current I3?

A) It stays the same
B) It increases
C) It decreases
D) You cannot possibly decide without knowing the numerical values of the symbols.

11. In the above circuit, suppose R1=R2=R3=12.0 Ohm, and V= 24.0 V, what is I?

A) 24. A   B) 0.667 A   C) 6.0 A   D) 3.0 A   E) 192. A

12. The circuit to the right has two "digital multimeters", or DMM's (that's the device you used in the lab to read current and/or voltage in circuits). As shown:
DMM #1 is set to read "amps", it's an ammeter.
DMM #2 is set to read "volts", it's a voltmeter.



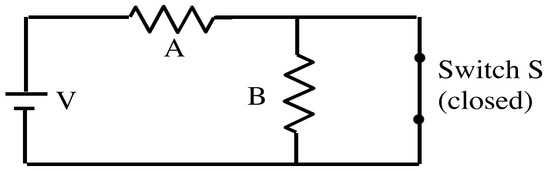
What should the two devices read?

	"DMM #1",	"DMM #2"
A)	1 A,	2 V
B)	1 A,	3 V
C)	4.5 A,	3 V
D)	4.5 A,	6V
E)	None of the above combinations is correct.	

13. In the previous problem, if you take DMM #2 and flip the switch that reads "volts" to now read "amps" (i.e., if DMM #2 is now *also* an ammeter), what happens? (Assume 20 Amp fuses)

A) DMM #1 is o.k., but the fuse in DMM #2 blows out - too much current!
B) The fuses in both DMM #1 and DMM #2 blow out - too much current!
C) No fuses blow, and DMM #1's reading goes down.
D) No fuses blow, and DMM #1's reading goes up.
E) No fuses blow, and DMM #1's reading stays the same.

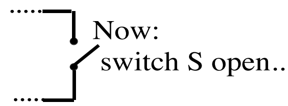
THE NEXT TWO PROBLEMS REFER TO THE CIRCUIT SHOWN BELOW.
The circuit has two light bulbs, A and B, of *equal resistance*.



Switch S starts off closed,

Bulb A starts off glowing brightly.

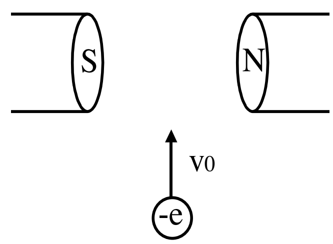
14. If you now *open* the switch S,



what happens to the brightness (which really means the power) of bulb A?
A) Bulb A stays exactly the same
B) Bulb A increases power, by a factor 2
C) Bulb A increases power, by a factor 4
D) Bulb A goes down in power, by a factor 1/2
E) Bulb A goes down in power, by a factor 1/4

15. In the previous problem, what happens to bulb B when you open the switch S?
A) Bulb B does not change at all.
B) Bulb B turns off.
C) Bulb B turns on.
D) Bulb B goes from bright to brighter.
E) Bulb B goes from bright to dimmer.

16. An electron (which has negative charge!) flies (in the plane of the paper) up towards a region of magnetic field between the poles of a big horseshoe magnet, as shown.

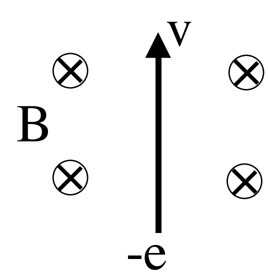


Which of the following best describes its trajectory?
(Neglect gravity)

A) It continues in a straight line(upwards) with constant speed v0.
B) It curves to the left (in the plane of the page)
C) It curves to the right (in the plane of the page)
D) It curves out of the plane of the page, towards you.
E) It curves into the plane of the page, away from you.

An electron (negative charge) moves up the page through a uniform magnetic field which points into the page, as shown.

17. What direction is the magnetic force on the electron?
   A. Into the page
   B. To the right
   C. To the left
   D. Along the direction of travel (i.e. it gets accelerated)
   E. There is no force.

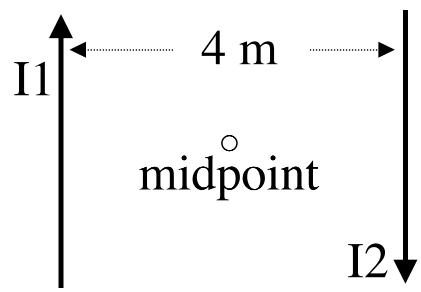


18. Suppose the particle in the previous problem had been a proton (positive charge)
(It is also going up the page, in the same B field, just as shown)
How would the acceleration of this proton compare with the acceleration of the electron from the previous question?

Note: protons are 2000 times more massive than electrons.
Be careful: I'm asking about the acceleration of the particles, not the force, in this question.

A. $\vec{\mathbf{a}}_{\text{proton}} = 0$
B. $\vec{\mathbf{a}}_{\text{proton}} = \vec{\mathbf{a}}_{\text{electron}}$
C. $\vec{\mathbf{a}}_{\text{proton}} = -\vec{\mathbf{a}}_{\text{electron}}$
D. $\vec{\mathbf{a}}_{\text{proton}} = -\vec{\mathbf{a}}_{\text{electron}} / 2000$
E. $\vec{\mathbf{a}}_{\text{proton}} = -\vec{\mathbf{a}}_{\text{electron}} * 2000$

Two long straight wires are lined up on the page as shown. The wires are 4 m apart. The magnetic field midway between the wires is $\mathbf{B}_0$.



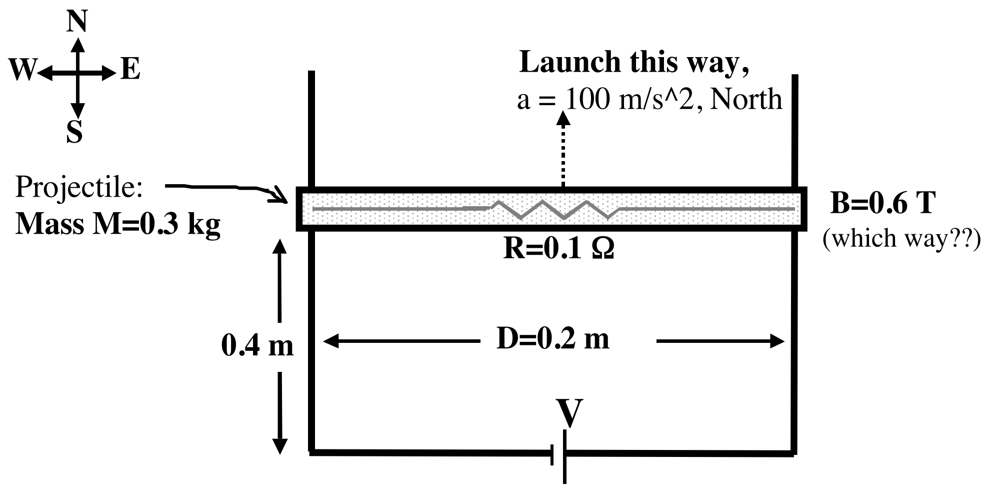
19. If I1=10 A, and I2=0 (no current in wire 2), what is the direction of $\mathbf{B}_0$?
A. It points to the right
B. It points to the left
C. It points into the page
D. It points out of the page
E. it points in the same direction as I1 does.

20. Suppose |I1|=10 A, and |I2|=20 A. (I1 flows up the page, I2 flows *down* the page, as shown!)
How does the new magnetic field $\mathbf{B}_0$(new), compare with the value from the previous problem?
A. Twice as big. i.e. $\mathbf{B}_0$ (when |I2|=20) = 2 * $\mathbf{B}_0$ (when I2 was 0)
B. The exact same as it was.
C. Three times as big.
D. Half as big.
E. Exact same magnitude, but opposite in direction.

21. An alpha particle (mass = 4*m(proton), charge = +2*e) sits in a magnetic field |**B**| = 4.0 T. What is the magnitude of the force the alpha particle feels?

A) 0 N
B) 4.0 N
C) 8.0 N
D) 6.4E-19 N
E) 1.3E-18 N

The next two problems refer to the follow circuit. *Ignore friction and gravity*.



A battery (voltage "V") drives a large current around a closed metal loop composed of fixed rails and a conducting bar (that's the projectile, it has length D=0.20 m, and mass M=0.30 kg) which rests on the rails a distance 0.40 m from the battery.
You have a huge magnet which provides a uniform magnetic field B= 0.60 T everywhere.
The rails have zero resistance, but the projectile has a finite resistance R= 0.10 Ω

22. If you want acceleration a=100.0 m/s^2, find the voltage V required.
(Assume B is oriented in the optimal direction)

A) 50.0 V
B) 25.0 V
C) 12.5 V
D) 1.25 V
E) None of the above is correct.

23. In which direction should the B field point, to *most effectively* launch the projectile in the direction shown?

A) North (launch direction)
B) South (opposite launch direction)
C) West (perpendicular to launch direction, in the plane of the circuit)
D) Into the page, away from you.
E) None of the above is correct.
(Such "electromagnetic launchers" exist in real life, by the way!)