SHOCK VALUE

Pembroke Hill Invitational
December 7, 2013

ANSWER KEY

NOTES ON THE ANSWER KEY

- An illegible response anywhere on the exam was counted as incorrect.
- In Section 2, terms needed to be *exactly* as they are given on the answer key. For example, putting "Amp" instead of "Ampere" resulted in no credit (unless the Event Supervisor decided to award credit for these responses).
- Specific parts of each of the Free Response answers are given specific point values. Points will be awarded based on each of these broken down components and how many points they are worth. "PC" stands for Partial Credit, and PC points will *only* be considered if the final answer (i.e., the final, calculated number) is incorrect. If the final number is correct, PC points will not be considered and full points will simply be awarded.
- Section IV was graded in the same way as Section III. Each of the two questions had specific concepts, each worth one point, which needed to be mentioned for that point to be awarded.

WE WERE GOING TO USE THE TIME MACHINE TO PREVENT THE ROBOT APOCALYPSE, BUT THE GUY WHO BUILT IT WAS AN ELECTRICAL ENGINEER.

SECTION 1: MULTIPLE CHOICE

1. B	11. C	21. B
2. B	12. A	22. B
3. E	13. A	23. A
4. C	14. A	24. A
5. C	15. B	25. C
6. B	16. E	26. B
7. C	17. C	27. A
8. D	18. B	28. D
9. C	19. B	29. C
10. A	20. D	30. B

FOR EVENT SUPERVISOR ONLY
SECTION 1 SCORE
30 Points Possible
30

SECTION 2: FILL-IN

1. **Ampere**
2. **Repel**
3. **Resistance**
4. **Ferromagnetism**
5. **Electromagnet**
6. **Negative**
7. **Lodestone**
8. **Current**
9. **Insulators**
10. **Open**

FOR EVENT SUPERVISOR ONLY
SECTION 2 SCORE
10 Points Possible
10

SECTION 3: FREE RESPONSE

FOR EVENT SUPERVISOR ONLY
SECTION 3 SCORE
30 Points Possible
30

1, (A): *1 point.*

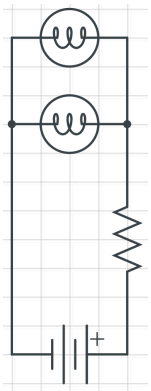
Current flow (1 point)

1, (B): *2 points.*

Double (1/2 point) the amount of current flows through the 2Ω resistor than the 4Ω resistor – More current flows through 2Ω resistor than 4Ω resistor (1/2 point)

Current takes the path of least resistance (1 point)

1, (C): *2 points.*



1/2 point: Proper light bulb symbol

1/2 point: Proper resistor AND battery symbol

1/2 point: Parallel light bulbs represented correctly

1/2 point: Series resistor represented correctly

1, (D): *2 points.*

Total current flow through both light bulbs: 1.09 A (PC: 1/2 point)

Use of the same voltage (1.45 V) on both of the light bulbs (PC: 1/2 point)

Correct set-up of both equations with right numbers and V=IR (PC: 1/2 point)

2Ω Resistor = <u>0.725</u> A (1 point) / 4Ω Resistor = <u>0.3625</u> A (1 point)

1, (E): *3 points.*

Current takes the path of least resistance, current flow is "slowed" too much for the 4Ω light bulb (1 point)

Total I flow of 0.6 A (PC: 1/2 point) from a total R of 3.33Ω (PC: 1/2 point)

V of 4Ω resistor is <u>0.798</u> V (1 point) b/c I for the parallel section is 0.6 A and R is 1.33 V, thus V=IR, and V=0.798 for both of the parallel resistors

I of 4Ω resistor is <u>0.1995</u> A (1 point) b/c V=0.798 and R=4Ω and V=IR

2, (A): *2 points.*

ρ = resistivity (1/2 point)

Resistivity = How much a material resists the flow of current (1/2 point)

High resistivity results in low conductivity (1 point)
--Insulators have high resistivity

2, (B): *1 point.*

The area of the wire must increase (1 point)

2, (C): *2 points.*

1.45 cm^2 for the initial area (PC: 1/2 point)

(1.45 cm^2)(1/100)(1/100) = 0.000145 set-up for calculation (PC: 1/2 point)

$A=\pi r^2$ = 0.000145 m^2 set-up for area equation (PC: 1/2 point)

Radius = 0.0068 m (2 points)

3, (A): *1 point.*

Red arrow represents the MAGNITUDE (1/2 point) and DIRECTION (1/2 point) of the electric field acting on the E-Field Sensor at its given location

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3, (B): *3 points.*

(Specific answers will vary! Because of this, grading will be mainly no technique, not the final answer. No "PC" for specific steps.)

Use of Coulomb's Law: $F=k\frac{|q_1|}{r^2}$ (1 point)

q = $2x10^{-9}$ C (1/2 point—for conversion to Coulombs)
r = given in meters (1/2 point)

Magnitude: Away from the charge (1 point)

3, (C): *2 points.*

Lines represent the equipotential surfaces / an area with the same voltage (1 point)

Equipotential: Where the electric potential/voltage of a field is the same (1 point)

4, (A): *1 point*.

Cations are the white OR black ions – either black/white acceptable (1 point)

4, (B): *4 points*.

Electrolyte: A solution that consists of dissolved ions in water (1 point)

The ions in the solution carry the charge around the solution (1/2 point)

A negative ion cloud forms around the cathode, and a positive ion cloud forms around the anode, and electrons flow between these ion clouds (1/2 point)

In an electrolyte, the ions move around freely to carry the charge while in a metal wire the electrons move around freely to conduct a charge (1 point)

As the concentration increases, the conductivity increases (1 point)

5, (A): *2 points*.

Domain: A region in a material where there is a net magnetic field (1 point)

When a majority of the domains within a material point in the same direction, a net magnetic field results and the material is magnetic.

-- (1/2 point) for domains pointing in the same direction

-- (1/2 point) for net magnetic field

5, (B): *1 point.*

A Ferromagnetic material can be placed near a magnetic material (an external magnetic field) (1/2 point)

The dipoles within the nonmagnetic material will align themselves with the magnetic field, thus creating a magnetic material (1/2 point)

5, (C): *1 point*.

For video at 1:10: <u>Down</u> **For video at 1:45: <u>Down</u>**

SECTION 4: DOCUMENT-BASED SHORT ANSWER

FOR EVENT SUPERVISOR ONLY
SECTION 4 SCORE
10 Points Possible

10

1: *5 points.*

Need to have five of the following six ideas to get full points:

(1 point) **Description of the triboelectric effect (don't need to use term): Materials with weakly bound electrons tend to lose them while materials with empty valence shells tend to gain them.**

(1 point) **The rubbing of the balloon pulls electrons off of the hair onto the balloon.**

(1 point) **The additional electrons make the balloon slightly negative, and the loss of electrons make the hair slightly positive.**

(1 point) **The negative charge on the balloon then attracts the positive charge on the hair, and the two items cling together (the balloon pulling the hair out).**

(1 point) **The positively charged hair strands repel each other, and that is why the hair "spreads out."**

(1 point) **The hair eventually fell back into place by "taking" electrons from the molecules in the air because of the natural conductivity of the air.**

2: *5 points.*

Need to have five of the following seven ideas to get full points:

(1 point) **When a (metamorphic or igneous) rock forms, the iron in the rocks align their domains with the magnetic field of the Earth.**

(1 point) **Thus, rocks preserve the location of the poles when they form.**

(1 point) **The magnetic poles of the planet reverse every hundred thousand years or so.**

(1 point) **Because rocks form continuously at the mid-ocean ridge, the band of rocks near the ridge record the current location of the poles when they formed.**

(1 point) **When the poles reverse, the new rocks formed at the ridge preserve the new location of the poles.**

(1 point) **Thus, the symmetric banding of the rocks preserves the continuing reversal of the poles. Each band (color) represents one of the pole locations.**

(1 point) **The symmetric banding of paleomagnetic evidence shows the seafloor must be spreading because the banding could not form (with the alternating magnetic orientations) if the seafloor didn't continue to spread as the poles kept reversing.**