Physics 202 Midterm Exam 2, Solution
1) E

\[ R = \frac{\rho L}{A}, \]

\[ \frac{R_1}{R_2} = \left(\frac{\rho L \times 1.2}{(A/1.2)}\right) / \left(\frac{\rho L}{A}\right) = 1.44 = 1.4 \]

Area divided by 1.2 to keep constant volume

2) E

\[ R = \frac{V^2}{P} = \frac{6 \times 6}{48} = \frac{3}{4} \Omega \]

3) B

Resistance of the 36 and 18 resistors in parallel: \( \frac{1}{1/(36 + 1/18)} = 12 \ \Omega \)

Resistance of the entire circuit: 72 \( \Omega \)

Total current: \( I = \frac{V}{R} = \frac{252}{72} = 3.5 \) A

Voltage drop over 12 \( \Omega \) equivalent resistance: \( V = IR = 3.5 \times 12 = 42 \) V

Power = \( \frac{V^2}{R} = \frac{42^2}{18} = 98 \) W

4) A

\( I_1 = I_2 \) since they are in series

5) E

After a long time the capacitor is charged and no current runs in the resistor and so there is no voltage drop.

\[ Q = CV = (0.120 \ \mu F) \times 12.0 = 1.44 \ \mu C \]

6) B

\[ F = I \times L \times B \]

The angle is 90 degrees so: \( B = F/LI = 0.18/(0.30 \times 3) = 0.20 \) T north

7) E

Electrons are deflected upward indicating a downward electric field

Into the page creates a downward magnetic force.
8) D
the magnetic force is the source of the centripetal acceleration
\[ a = \frac{v^2}{r} = \frac{F}{m} = \frac{qvB}{m} \]
\[ r = \frac{mv}{qB} \]
9) A

\[ U = -\mu \cdot B \]
Only the Z component of the magnetic field is aligned along the dipole and contributes to the potential energy.
\[ U = -IAB = -5(\pi \times 0.05^2) \times 0.12 = -4.7 \text{ mJ} \]
10) B

\[ F = q(v \times B) \]
\( V \) is opposite the direction of the current. \( v \times B \) gives to the left (opposite surface 2) by the right hand rule. However q is negative reversing the direction. Note you get the same answer for positive charges so you need another experiment (the Hall effect) to distinguish whether electric current is carried by positive or negative charge carriers.
The magnetic force is toward surface 2.
11) A

\[ B = (\mu_0 q v / 4\pi \times \text{rhat}/r^2), \text{ where rhat is the direction of } r \text{ (which points from the charge back to the origin)} \]
\[ B = ((\mu_0 q v / 4\pi) \times (1/r^2)) \times \sin(\theta) \]
\[ B = (1 \times 10^{-7} \times 3.6 \times 10^{-9} \times 4.5 \times 10^7 / 5^2) \times 3/5 = 3.9 \text{ nT positive } z \text{ direction} \]
12) A
The velocity of the electron and the magnetic field are parallel so the force is zero
13) B
For an infinitely long wire \( B = (\mu_0 I) / (2\pi r) \)
\[ B = (2 \times 10^{-7} \times 1.5) / (0.02) - (2 \times 10^{-7} \times 1.5) / (0.04) = 7.5 \times 10^{-6} \text{ T} \]
The contribution of the top wire is larger so into the page
14) C
The field is zero at the origin and rises toward R. Outside the wire it goes as $B = (\mu_0 I)/(2\pi r)$

15) C

Multiply by the proportion of the area inside 3.35mm

$\left(\pi (3.23*3.25 - \pi 3*3) / (\pi (3.5*3.5 - \pi 3*3)\right) \times 15 = 7.8A$

16) A

For the wire: $B = (\mu_0 I)/(2\pi r)$

Flux = integral from a to b $[BdA]$

Integral of $1/r = \ln(r)$

Therefore: $= (\mu_0 I)/(2\pi r))\times l \times (\ln(b) - \ln(a)) = (2\mu_0 Il)/(4\pi)\times \ln(b/a)$

17) C

EMF = N*Flux/time = NBA/time = 200(3.0)/0.05/5 = 6.0V

18) B

By lenz’s the induced current creates a magnetic field that opposes the original change in magnetic flux.

The field caused by the current is in the positive x direction. The flux would be increasing in the negative x direction if the magnet is moving toward the ring

19) C

By lenz’s the induced current creates a magnetic field that opposes the original change in magnetic flux.

As the ring enters the area of the magnetic field the flux in the direction out of the page is increasing. Thus the current in the ring will be clockwise to create a downward magnetic field. The effect of the original magnetic field on a clockwise current is a net of zero on the upper and lower segments and to the left on the rightmost segment of the loop which is entering the field.

20) D

At terminal velocity the magnetic force will equal the gravitational force

$F = ma = 0.07*9.81 = 0.69N$