Physics 2 Final Exam

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Problem One:

$$\begin{aligned} W &= F_g \\ F_g &= (4 \cdot 10^{-3})(1000) + 3 + 4 \\ &= 11[\text{N}] \end{aligned} \tag{1}$$

Because total weight is ball plus fluid plus beaker

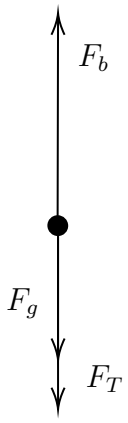

Figure 1: Free Body Diagram of Rubber Ball

$$\begin{aligned} F_b - F_g - F_T &= 0 \\ F_b &= F_T + F_g \\ 4 + 6 &= 10[\text{N}] \end{aligned} \tag{2}$$

$$\begin{aligned} P &= \rho g h \\ 1000 \cdot 10 \cdot .15 &= 1500[\text{Pa}] \end{aligned} \tag{3}$$

The ball will displace less fluid, so lower (4)

Problem Two:

$$A_1 v_1 = A_2 v_2$$
$$\frac{v_2}{v_1} = \frac{A_1}{A_2} \tag{5}$$

Velocity is greater, and is inversely related to pressure, so pressure decreases (6)

Problem Three:

$$\begin{aligned} \Delta U &= \frac{3}{2}\Delta(PV) \\ \frac{3}{2} \cdot -2000 \cdot \frac{1}{2} &= -1500[\mathrm{J}] \end{aligned} \tag{7}$$

$$\begin{aligned} \Delta U &= Q + W \\ Q &= 1000[\mathrm{J}] \\ W &= P\Delta V \\ \Delta V &= 0 \\ \Delta U &= 1000[\mathrm{J}] \end{aligned} \tag{8}$$

Problem Four:

$$\begin{aligned} Q(6) &\approx 400 \\ Q(3) &\approx 200 \\ \frac{Q(6)-Q(3)}{6-3} = \frac{200}{3} &= 66.7 \left[\frac{\mathrm{J}}{\mathrm{s\,K}}\right] \end{aligned} \tag{9}$$

$$\begin{aligned} 2[\mathrm{cm}] &= .02[\mathrm{m}] \\ 6[\mathrm{cm}^2] &= .0006[\mathrm{m}^2] \\ \frac{Q}{\Delta t} &= k\frac{A\Delta T}{L} \\ k\frac{A}{L} &= 66.7 \\ k = \frac{.02}{.0006} \cdot 66.7 &= 2222.2 \left[\frac{\mathrm{J}}{\mathrm{s\,K\,m}}\right] \end{aligned} \tag{10}$$

Problem Five:

Diagrams on next two pages

$$
\begin{aligned}
E_6 &= k\frac{Q}{r^2} \\
9 \cdot 10^9 \cdot \frac{6 \cdot 10^{-6}}{5^2} &= 2160 \left[\frac{\mathrm{N}}{\mathrm{C}}\right] \\
E_4 &= k\frac{Q}{r^2} \\
9 \cdot 10^9 \cdot \frac{4 \cdot 10^{-6}}{4^2} &= 2250 \left[\frac{\mathrm{N}}{\mathrm{C}}\right] \\
\tan^{-1}\left(\frac{4}{3}\right) &= 53^\circ \\
2 \cdot 2160 \cdot \cos(53) &= 260 \left[\frac{\mathrm{N}}{\mathrm{C}}\right] \\
2600 - 2250 &= 350 \left[\frac{\mathrm{N}}{\mathrm{C}}\right] \text{ up}
\end{aligned}
\tag{11}
$$

$$
\begin{aligned}
V &= k\frac{Q}{r} \\
V_t = k\left(\frac{6 \cdot 10^{-6}}{5} + \frac{6 \cdot 10^{-6}}{5} - \frac{4 \cdot 10^{-6}}{4}\right) &= 12600[\mathrm{V}]
\end{aligned}
\tag{12}
$$

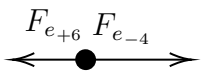

Figure 2: Free Body Diagram for left particle

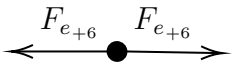

Figure 3: Free Body Diagram for center particle

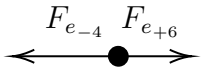

Figure 4: Free Body Diagram for right particle

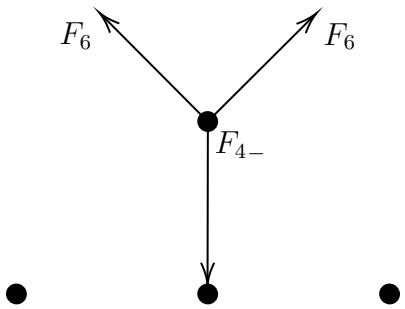

Figure 5: Electric Field Vectors at point P

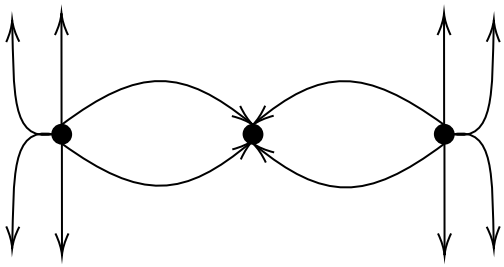

Figure 6: Electric Field Drawing

Problem Six:

Positive (lines are moving out) (13)

0[J] (14)

10[J] (15)

Problem Seven:

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1. This means the current needs to be doubled. Initially, the capacitor may be neglected, so the identical resistor needs to be placed in parallel with the first one, which would make the total resistance, half, and, assuming voltage is kept constant, the current would be doubled.

2. This would mean that the voltage would need to be doubled. This would be done by adding another battery in series, while placing a resistor in series. By doubling the resistance, while also doubling the voltage, the current remains the same.

3. This would mean that current and voltage would need to be doubled. This may be done by simply placing an additional battery in series. By doubling the voltage, and keeping resistance the same, current would be doubled as well.

Problem Eight:

Circuit on Next Page

$$\frac{108}{6} = 18[\Omega] \tag{16}$$

$$18 \cdot 120 = 2160[\mathrm{W}] \tag{17}$$

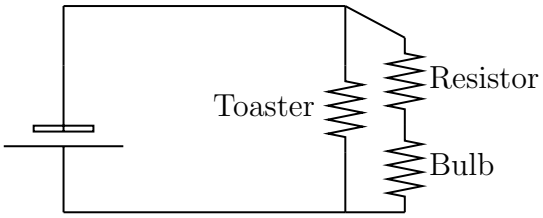

Figure 7: Circuit For Problem 8