1. (a) $v = \frac{dx}{dt} = 3(0.5)t^2 + 2 = 1.5t^2 + 2$

At t = 0: $v = 1.5(0)^2 + 2$

$\boxed{v = 2}$

(b) i. $KE = \frac{1}{2}mv^2 = \boxed{\frac{1}{2}m(1.5t^2 + 2)^2 = KE}$

ii. $F = ma$ $\qquad a = \frac{dv}{dt} = 2(1.5)t + 0 = 3t$

$F = m(3t)$

$\boxed{F = 3mt}$

iii. $P = \frac{W}{t} = \frac{F \cdot d}{t} = Fv = 3m(1.5t^2 + 2)$

$\boxed{P = 4.5\ mt^2 + 6}$

9c) $P = 4.5\ (100\ kg)(2\ s)^2 + 6 - [4.5(100\ kg)(0\ s)^2 + 6] = 1800\ W + 6 - 6$

$\boxed{P = 1800\ W}$

(d)

_**X**_ Greater than ___Less Than ___ Equal to

The net work found in part (c) is the sum of the work by the student plus the work done by friction (and/or air resistance-assumed negligible). The work done by friction is negative because the angle between the directions of the force of friction and the displacement is 180° and W = Fdsinθ. Thus, the net work is the sum of the work done by the student and the negative work don by friction. Therefore, the work done by the student will be greater than the net work done found in part (c).

2. (a) $GPE_1 = KE_2$

$MgH = ½Mv^2$

$$\boxed{v = \sqrt{2gH}}$$

(b) $m_1v_1 + m_2v_2 = (m_1 + m_2)v'$

$M\sqrt{2gH} + 0 = (M + M)v'$

$$\boxed{v' = \frac{\sqrt{2gH}}{2} = \sqrt{\tfrac{1}{2}gH} = v'}$$

(c) $T = 2\pi\sqrt{\frac{k}{m}}$

$T = 2\pi\sqrt{\frac{Mg/D}{2M}}$

$$\boxed{T = 2\pi\sqrt{\frac{g}{2D}}}$$

$\Sigma F = F_s - F_g = ma$

$kx - mg = 0$

$k = \frac{Mg}{D}$

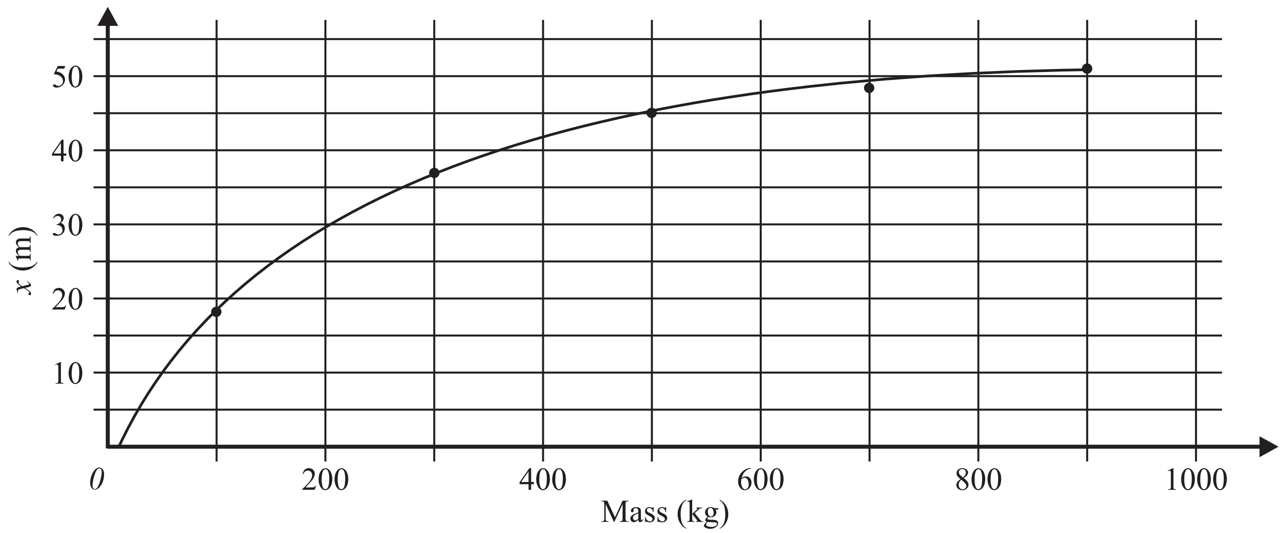
(d) The pan will be at its maximum speed at the equilibrium point which is the position where the system was at rest before the clay fell and hit the pan. Therefore, the is stretched a distance, D, form its initial unstretched length when the speed of the pan is a maximum.

(e)

_**X**_Greater than ___Less Than ___ Equal to

The system will have half the mass as it had before. Since the period is inversely proportional to the mass, the period of the resulting simple harmonic motion of the pan will be greater than it was before (by a factor of $\sqrt{2}$).

3. (a) i.



ii. 33 m

(b) i. $y = y_o + v_{yo}t + \frac{1}{2}at^2$

$0 = 15\text{ m} + 0 + \frac{1}{2}(-9.8\text{ m/s}^2)t^2$

$t = 1.75\text{ s}$

ii. $GPE = m_{cw}gh + m_cgh = Mg3 + 10g3$

Note: m_c = mass of weight in cup
m_{cw} = mass weight in counterweight cup

$GPE = 3g(M + 10)$

iii. $GPE_{c1} + GPE_{cw1} + RKE_{c1} + RKE_{cw1} = GPE_{c2} + GPE_{cw2} + RKE_{c2} + RKE_{cw2}$

$m_cgh_{c1} + m_{cw}gh_{cw1} + \frac{1}{2}I_c\omega_1^2 + \frac{1}{2}I_{cw}\omega_1^2 = m_cgh_{c2} + m_{cw}gh_{cw2} + \frac{1}{2}I_c\omega_2^2 + \frac{1}{2}I_{cw}\omega_2^2$

Note: ω_1 for cup and counterweight cup are equal as is ω_2 for the two cups.

$m_cgh_{c1} + m_{cw}gh_{cw1} + \frac{1}{2}m_cR_c^2\omega_1^2 + \frac{1}{2}m_{cw}R_{cw}^2\omega_1^2 = m_cgh_{c2} + m_{cw}gh_{cw2} + \frac{1}{2}m_cR_c^2\omega_2^2 + \frac{1}{2}m_{cw}R_{cw}^2\omega_2^2$

$10g3 + Mg3 + \frac{1}{2}(10)(12)^2(0)^2 + \frac{1}{2}M(3)^2(0)^2 = 10g15 + Mg1 + \frac{1}{2}(10)(12)^2\omega_2^2 + \frac{1}{2}M(2)^2\omega_2^2$

$30g + 3Mg = 150g + Mg + 720\omega_2^2 + 2M\omega_2^2$

$2Mg - 120g = (720 + 2M)\omega_2^2$

$2g(M - 60) = 2(M + 360)\omega_2^2$

$\omega_2 = \sqrt{g\left(\frac{M - 60}{M + 360}\right)}$ But $\omega_2 = \frac{v_{cf}}{R_c}$, so $v_x = v_{cf} = R_c\omega_2$.

$v_x = (12)\sqrt{g\left(\frac{M - 60}{M + 360}\right)}$

(c) i. $x = v_xt = (12)\sqrt{g\left(\frac{M - 60}{M + 360}\right)}(1.7) = (20)\sqrt{g\left(\frac{M - 60}{M + 360}\right)} = x$

ii. $x = (20)\sqrt{g\left(\frac{300 - 60}{300 + 360}\right)} = 37.7\text{ m} = x$

The theoretical value is greater than the experimental value because friction and air resistance; which would reduce v_x and, thus, x; was ignored in the theoretical value.

1. (a) Outside the radius R, the cloud behaves as a point charge.

i. $E = k\dfrac{Q}{r^2}$

$$\boxed{E = k\frac{Q}{(r - R)^2}}$$

ii. $dV = -\mathbf{E}d\ell = -k\dfrac{Q}{(r - R)^2}d\mathbf{r}$

$$V = \int -k\frac{Q}{(r - R)^2}dr = +k\frac{Q}{(r - R)}$$

$$\boxed{V = k\frac{Q}{(r - R)}}$$

(b) It will move to the right in a straight line, continually accelerating, but the rate of acceleration will continually decrease.

(c) $\Delta KE = \Delta PE$

$KE = qV = ek\dfrac{Q}{(r - R)}$

$$\boxed{KE = k\frac{Qe}{(r - R)}}$$

(d) $\rho_o = \dfrac{Q}{V} = \dfrac{Q}{\frac{4}{3}\pi R^3}$

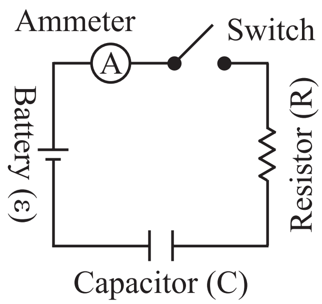
$$\boxed{\rho_o = \frac{3Q}{4\pi R^3}}$$

(e) $dE = k\dfrac{dq}{r^2} = k\dfrac{\rho A dr}{r^2} = k\dfrac{\rho 4\pi r^2 dr}{r^2} = 4\pi k\rho dr = 4\pi k\rho_o\left(1 - \dfrac{r}{R}\right)dr$

$$E = \int_0^r 4\pi k\rho_o\left(1 - \frac{r}{R}\right)dr = 4\pi k\rho_o\int_0^r\left(1 - \frac{r}{R}\right)dr$$

$$\boxed{E = 4\pi k\rho_o\left(r - \frac{r^2}{2R}\right)}$$

2. (a)



(b) V = IR Use voltage from battery and current flow when the switch is first closed (this is the only time the voltage in the circuit is the ε of the battery)

12 V = (0.010 A)R

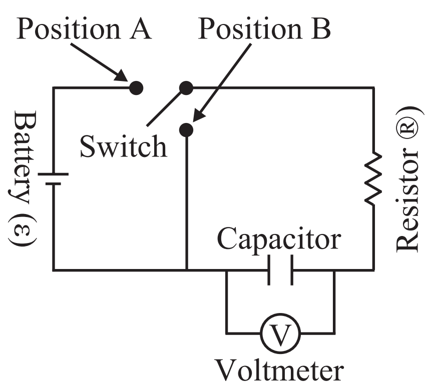
R = 1200 Ω

(c) τ = RC

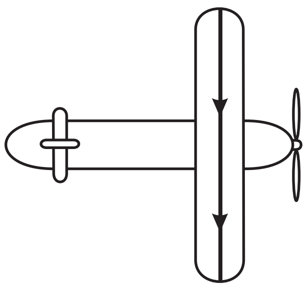
4 s = (1200 Ω)C

C = 3.33 mF = 3333 μF

(d)



3. (a)



The left-hand rule to show the direction of force on negative charges moving through a magnetic field states that the fingers of left hand start of in the direction of the moving charges (in this case, that is the direction of the airplane is moving, north, or to the right in the diagram), the wrist is then rotated (keeping the fingers pointed in the same direction) until the fingers can curl into the direction of the magnetic field (which would start the fingers into the paper on this drawing), the direction in which the thumb is pointing when these tasks are followed shows the direction of the force on the moving charges by the magnetic field (shown in the diagram above with arrows toward the bottom of the page).

(b) $W = \Delta PE$

$F \bullet d = qV$

$(q\mathbf{v} \times \mathbf{B})d = qV$

$(qvB\sin\theta)d = qV$

$vB\sin\theta = \frac{V}{d}$ But $E = -\frac{V}{D}$

$E = vB\sin\theta = (75\text{ m/s})(6.0 \times 10^{-5}\text{ T})\sin 55$ v of moving charges = v of airplane = 75 m/s

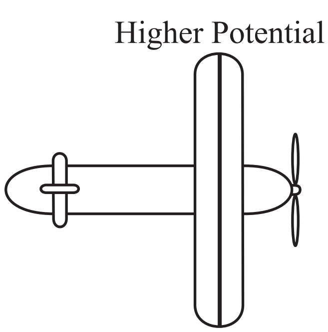
$$E = 3.7 \times 10^{-3}\ \text{V/m}$$

(c) $E = -\frac{V}{D}$

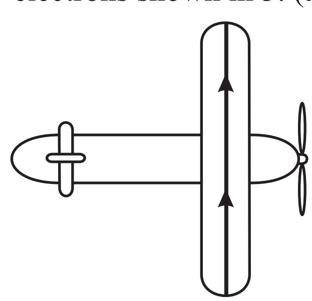
$V = Ed = \left(3.7 \times 10^{-3}\ \text{V/m}\right)(15\text{ m})$

$$V = 5.5 \times 10^{-2}\text{ V}$$

(d)



(e) ii. Conventional current is opposite the flow of electrons shown in 3. (a) above.



(e) i. The wires would could not form any shape resembling a rectangle in any orientation or the wire parallel to the antenna would produce an electric field that exactly countered the one in the antenna. Perhaps, a triangular shape for the circuit with the third point of the triangle toward the tail of the airplane.