1.

a. $2.45 = 2\pi\sqrt{\frac{m}{30}}$

m = 4.56kg

b. $E = ½(4.56)(2.5^2) + ½(30)(0.55^2) = 18.79J$

c. $18.79 = ½(30)(A^2)$

A = 1.12m

d. $18.79 = ½(4.56)(v^2)$

v = 2.87 m/s

e. 0m

2.

a. $T = 2\pi\sqrt{\frac{0.2}{50}} = 0.397s$

b. Amplitude is the difference between the lowest position (here, the initial position) and the equilibrium position (where the net force is zero).

Lowest position: $-mg + k\Delta L_{lp} = 0$ so $-(0.4)(10) + (50)(\Delta L_{lp}) = 0$ and $\Delta L_{lp} = 0.08m$

Equilibrium position: $-mg + k\Delta L_{ep} = 0$ so $-(0.2)(10) + (50)(\Delta L_{lp}) = 0$ and $\Delta L_{lp} = 0.04m$

Amplitude = 0.08 – 0.04 = 0.04m

c. Suppose the initial height of the top block is zero. Then,

$U_{sp} = U_{sp} + U_g + K$

$½(50)(0.08)^2 = ½(50)(0.04)^2 + (0.2)(10)(0.04) + ½(0.2)(v_{max}^2)$

$v_{max} = 0.63m/s$

d. The period will not change because it only depends upon the spring and the upper mass. However, the amplitude will change because the lower mass will give the block a lower initial position. This will also give the system more initial potential energy, raising the maximum velocity.

e. $U_{sp} = U_{sp} + U_g + K$

$½(50)(0.08)^2 = ½(50)(\Delta L_{new})^2 + (0.2)(10)(0.08 - \Delta L_{new}) + ½(0.2)(\frac{0.63}{2})^2$

$0.16 = 25 \cdot \Delta L_{new}^2 + 0.16 - 2 \cdot \Delta L_{new} + 0.0099$

$0 = 25 \cdot \Delta L_{new}^2 - 2 \cdot \Delta L_{new} + 0.0099$

$\Delta L_{new} = 0.0747m$ or $0.0053m$

3.

a. $E = U + K$

$\frac{1}{2}kA^2 = \frac{1}{2}k(\frac{1}{2}A)^2 + \frac{1}{2}Mv^2$

$v = \sqrt{\frac{3kA^2}{4M}}$

b. $p_i = p_f$

$M \cdot \sqrt{\frac{3kA^2}{4M}} = (M + m) \cdot v$

$$v = \frac{M \cdot \sqrt{\frac{3kA^2}{4M}}}{M+m}$$

c. $T = 2\pi\sqrt{\frac{M+m}{k}}$

d. $K + U = U$

$\frac{1}{2}(M + m)v^2 + \frac{1}{2}k(\frac{1}{2}A)^2 = \frac{1}{2}kA_{new}^2$ where $v = \frac{M \cdot \sqrt{\frac{3kA^2}{4M}}}{M+m}$

$A_{new} = \sqrt{\frac{3MA^2}{4(M+m)} + \frac{A^2}{4}}$ this agrees with the result if $m = 0$

e. No, the period is dependent only on the masses and spring constant, which are not affected by the parameters of the collision.

f. Yes, the faster the lower block is moving during the collision, the more thermal energy is generated in the collision. This would decrease the amplitude of the oscillation.

4.

a. Stopwatch

b. Use the stopwatch to time ten full oscillations. One oscillation is the motion involved when the pendulum swings from its left-most position, to the right, and back to its left-most position. Divided this time by ten to find the period, or the time of one oscillation. Divide one by the period to determine the frequency.

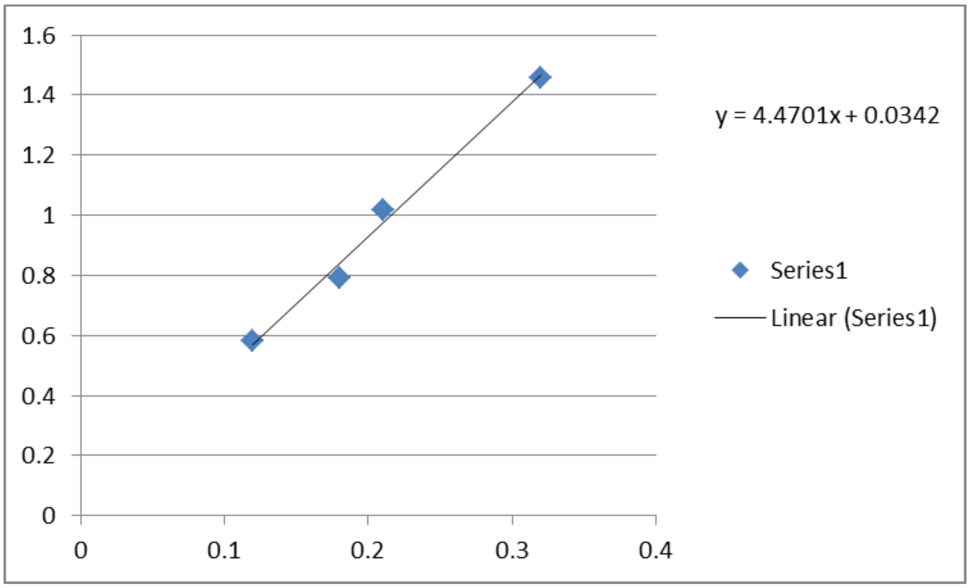
c. One independent variable is the amplitude of oscillation, or the maximum angular displacement. This could be tested using the protractor. Invert the protractor so that the 90º mark is aligned with the pendulum when it hangs vertically. Pull the pendulum bob back 2º from vertical (or 88º along the protractor). Release the pendulum and record the time of ten oscillations. Calculate the related frequency using the same procedure in (b). Repeat for initial angles of 4, 6, 8, and 10º. Graph frequency on the y-axis and initial angle on the x-axis. If the resulting regression line is horizontal, this is good evidence that frequency is independent of initial angular displacement. If there is some non-zero slope, then there is a dependence.

5.

a.

L (m)	T_{10}	T	T^2
0.12	7.62	0.762	0.580
0.18	8.89	0.889	0.790
0.21	10.09	1.009	1.018
0.32	12.08	1.208	1.459

b.



c.

$T = 2\pi\sqrt{\frac{L}{g}}$ so $\frac{T^2}{4\pi^2 L} = \frac{1}{g}$ or $\frac{1}{4\pi^2}$ x slope $= \frac{1}{g}$

$g = 8.83\ m/s^2$

d. $9.80 m/s^2 \pm 4\%$ means $9.41 m/s^2 < g < 10.19 m/s^2$

$8.83 m/s^2$ is outside this range

e. $g_{effective} = g + a$

$8.83 = 9.8 + a$

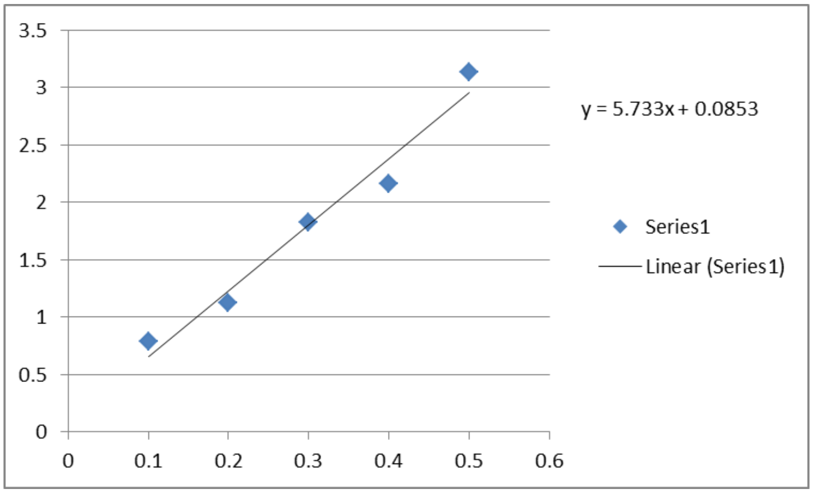
$a = 0.97 m/s^2$

6.

a.

Mass	T_{10}	T	T^2
0.10	8.86	0.886	0.785
0.20	10.6	1.06	1.124
0.30	13.5	1.35	1.823
0.40	14.7	1.47	2.161
0.50	17.7	1.77	3.133

b.



c. $T^2 = 2.59$ so m = 0.45kg

d. If $T = 2\pi\sqrt{\frac{m}{k}}$ then $\frac{T^2}{4\pi^2 m} = \frac{1}{k}$ or $\frac{1}{4\pi^2}$ x slope = $\frac{1}{k}$ solve for k

e. Yes, even though the shuttle is in constant freefall, a mass/spring oscillator will oscillate independent of g.

f. $g = \frac{G \cdot m}{R^2} = \frac{6.67\ x\ 10^{-11} \cdot 6.0\ x\ 10^{24}}{(6.7\ x\ 10^6)^2} = 8.9\ m/s^2$

g. If the astronauts are in freefall, their acceleration of –g implies that their net force is the same as the force of gravity on them (ma = mg). Because there is no support force counteracting the force of gravity, which they are accustomed to in life on the surface of the Earth, they feel weightless.