Note: kexperimental will vary for hand-drawn graphs and best fit lines.

1.
$$v \propto \sqrt{h}$$
; $v = k\sqrt{h}$

Velocity is directly proportional to the square root of height.

$$k_{\text{experimental}} = \frac{\Delta v}{\Delta \sqrt{h}} = 4.31 \frac{\text{m}^{\frac{1}{2}}}{\text{s}}$$

Using kinematics or the conservation of energy:

$$k_{\text{theoretical}} = \sqrt{2g} = 4.4 \frac{\text{m}^{\frac{1}{2}}}{\text{s}}$$

2.
$$d \propto t^2$$
; $d = kt^2$

Displacement is directly proportional to the square of time.

$$k_{\text{experimental}} = \frac{\Delta d}{\Delta t^2} = 4.77 \frac{\text{m}}{\text{s}^2}$$

Using kinematics:

$$k_{\text{theoretical}} = \frac{1}{2}g = 4.9 \frac{\text{m}}{\text{s}^2}$$

3.
$$a \propto \frac{1}{m}$$
; $a = \frac{k}{m}$

Acceleration is inversely proportional to mass.

$$k_{\text{experimental}} = \frac{\Delta a}{\Delta \frac{1}{m}} = 1.94 \text{ N}$$

Using Newton's second law:

$$k_{\text{theoretical}} = F = 2.0 \text{ N}$$

4.
$$v \propto t$$
; $v = kt$

Velocity is directly proportional to time.

$$k_{\text{experimental}} = \frac{\Delta v}{\Delta t} = 0.397 \frac{\text{m}}{\text{s}^2}$$

Using impulse:

$$k_{\text{theoretical}} = \frac{F}{m} = a = 0.40 \frac{\text{m}}{\text{s}^2}$$

5.
$$t \propto \frac{1}{P}$$
; $t = \frac{k}{P}$

Time is inversely proportional to power.

$$k_{\text{experimental}} = \frac{\Delta t}{\Delta \frac{1}{P}} = 203 \text{ kJ} = 2.03 \times 10^5 \text{ J}$$

Using power and kinetic energy:

$$k_{\text{theoretical}} = \frac{1}{2}mv^2 = 200 \text{ kJ} = 2.0 \times 10^5 \text{ J}$$

6.
$$h \propto v_i^2$$
; $h = k v_i^2$

Height is directly proportional to the square of initial speed.

$$k_{\text{experimental}} = \frac{\Delta h}{\Delta v_i^2} = 0.0501 \frac{\text{s}^2}{\text{m}}$$

Using the conservation of energy:

$$k_{\text{theoretical}} = \frac{1}{2g} = 0.051 \frac{\text{s}^2}{\text{m}}$$

7.
$$v_{\text{max}} \propto \sqrt{r}$$
; $v_{\text{max}} = k\sqrt{r}$

Maximum speed is directly proportional to the square root of the track radius.

$$k_{\text{experimental}} = \frac{\Delta v_{\text{max}}}{\Delta \sqrt{r}} = 2.70 \frac{\text{m}^{\frac{1}{2}}}{\text{s}}$$

Using Newton's second law and centripetal acceleration:

$$k = \sqrt{\mu g}$$
; $\mu = k^2/g = 0.74$

8.
$$F_{\rm g} \propto \frac{1}{r^2}$$
; $F_{\rm g} = \frac{k}{r^2}$

Gravitational force is inversely proportional to the square of distance.

$$k_{\text{experimental}} = \frac{\Delta F_{\text{g}}}{\Delta \frac{1}{r^2}} = 3.19 \times 10^{16} \text{ N kg}^2$$

Using Newton's law of universal gravitation:

$$k_{\text{theoretical}} = GMm = 3.19 \times 10^{16} \text{ N kg}^2$$

9.
$$B \propto \frac{1}{d^2}$$
; $B = \frac{k}{d^2}$

Brightness is inversely proportional to the square of distance.

$$k_{\text{experimental}} = \frac{\Delta B}{\Delta \frac{1}{d^2}} = 4.58 \text{ W}$$

Using the brightness equation:

$$k_{\text{theoretical}} = \frac{L}{4\pi} = 4.77 \text{ W}$$

10.
$$T \propto r^{\frac{3}{2}}$$
; $T = kr^{\frac{3}{2}}$

Orbital period is directly proportional to orbital radius to the power of 3/2.

$$k_{\text{experimental}} = \frac{\Delta T}{\Delta r^{\frac{3}{2}}} = 2.55 \times 10^{-7} \frac{\text{s}}{\text{m}^{\frac{3}{2}}}$$

Using Newton's law of universal gravitation and centripetal acceleration:

$$k = \frac{2\pi}{\sqrt{GM}}$$
; $M = \frac{4\pi^2}{Gk^2} = 9.10 \times 10^{24} \text{ kg}$