Physics 12
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Graphical Analysis - Solutions

Note: $k_{experimental}$ will vary for hand-drawn graphs and best fit lines.

1. $d \propto t;\ d = kt$

   Velocity is directly proportional to time.

   $$k_{\text{experimental}} = \frac{\Delta d}{\Delta t} = 14.1\frac{\text{m}}{\text{s}}$$

   Using kinematics:

   $$k_{\text{theoretical}} = v = 50\frac{\text{km}}{\text{h}} = 14\frac{\text{m}}{\text{s}}$$

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

   Acceleration is inversely proportional to mass.

   $$k_{\text{experimental}} = \frac{\Delta a}{\Delta \frac{1}{m}} = 4.10\ \text{N}$$

   Using Newton's second law:

   $$k_{\text{theoretical}} = F = 4.0\ \text{N}$$

3. $v \propto t^2;\ v = kt^2$

   Velocity is directly proportional to the square of time.

   $$k_{\text{experimental}} = \frac{\Delta d}{\Delta t^2} = 0.395\frac{\text{m}}{\text{s}^2}$$

   Using kinematics and Newton's second law:

   $$k_{\text{theoretical}} = \frac{1}{2}a = \frac{1}{2}\frac{F}{m} = 0.40\frac{\text{m}}{\text{s}^2}$$

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

Time is inversely proportional to power.

$$k_{\text{experimental}} = \frac{\Delta t}{\Delta \frac{1}{P}} = 496\ \text{J}$$

Using power and gravitational potential energy:

$$k_{\text{theoretical}} = mgh = 490\ \text{J}$$

5. $v \propto \frac{1}{m};\ v = \frac{k}{m}$

Velocity is inversely proportional to mass.

$$k_{\text{experimental}} = \frac{\Delta v}{\Delta \frac{1}{m}} = 4.99\ \text{kg}\frac{\text{m}}{\text{s}}$$

Using impulse:

$$k_{\text{theoretical}} = F_{\text{net}}\Delta t = 5.0\ \text{Ns}$$

6. $V \propto r^3;\ V = kr^3$

Volume is directly proportional to the cube of radius.

$$k_{\text{experimental}} = \frac{\Delta V}{\Delta r^3} = 4.17$$

Using the volume of a sphere:

$$k_{\text{theoretical}} = \frac{4}{3}\pi = 4.2$$

7. $t \propto F_{\text{net}};\ t = \dfrac{k}{F_{\text{net}}}$

Time is inversely proportional to net force.

$$k_{\text{experimental}} = \frac{\Delta t}{\Delta \frac{1}{F_{\text{net}}}} = 40.7\ \text{Ns}$$

Using impulse:

$$k_{\text{theoretical}} = \Delta p = m\Delta v = 40\ \text{kg}\frac{\text{m}}{\text{s}}$$

8. $T \propto \sqrt{L};\ T = k\sqrt{L}$

Period is directly proportional to the square root of length.

$$k_{\text{experimental}} = \frac{\Delta T}{\Delta \sqrt{L}} = 2.05\frac{\text{s}}{\text{m}^{\frac{1}{2}}}$$

Using the equation for the period of a pendulum:

$$k_{\text{theoretical}} = \frac{2\pi}{\sqrt{g}} = 2.0\frac{\text{s}}{\text{m}^{\frac{1}{2}}}$$

9. $I \propto \dfrac{1}{R};\ I = \dfrac{k}{R}$

Current is inversely proportional to resistance.

$$k_{\text{experimental}} = \frac{\Delta I}{\Delta \frac{1}{R}} = 117\ \text{V}$$

Using Ohm’s law:

$$k_{\text{theoretical}} = V = 120\ \text{V}$$

10. $R \propto L;\ R = kL$

Resistance is directly proportional to length.

$$k_{\text{experimental}} = \frac{\Delta R}{\Delta L} = 97100\frac{\Omega}{\text{m}}$$

Using resistivity:

$$k_{\text{theoretical}} = \frac{\rho}{A};\ \rho = kA = k\pi r^2 = 31\ \Omega\text{m}$$

11. $v \propto \sqrt{r};\ v = k\sqrt{r}$

Tangential velocity is directly proportional to the square root of radius.

$$k_{\text{experimental}} = \frac{\Delta v}{\Delta\sqrt{r}} = 6.33\frac{\text{m}^{\frac{1}{2}}}{\text{s}}$$

Using Newton's second law and centripetal acceleration:

$$k = \sqrt{a_\text{c}} = \sqrt{\frac{F_\text{T}}{m}};\ F_\text{T} = k^2 m = 4.0\ \text{N}$$

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

Gravitational force is inversely proportional to the square of distance.

$$k_{\text{experimental}} = \frac{\Delta F_\text{g}}{\Delta \frac{1}{r^2}} = 2.80 \times 10^{16}\ \text{N m2}$$

Using Newton's law of universal gravitation:

$$k_{\text{theoretical}} = GMm = 2.8 \times 10^{16}\ \text{N m}^2$$