Final Exam—PHYS 103-4T  
16 November 2010

1) (10 pts) (Practical) Measure the diameter of the provided cylinder with the vernier caliper.

   Diameter=___________ cm

2) (20 pts) (Practical) Determine the spring constant of the provided spring. Use the graph paper to plot data in order to find the spring constant. The force exerted by the spring is given by Hooke’s Law: \( F=kx \).

   Use this table to record your data:

   \[ k=______________ \text{ N/m} \]

<table>
<thead>
<tr>
<th>mass (kg)</th>
<th>elongation (m)</th>
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3) (15 pts) The following data were taken for the velocity and displacement of a car starting at rest and accelerating at a constant rate, \( a \). The equation describing the relationship between these quantities is:

   \[ v^2 = 2ax \]

   Plot the data for \( v \) and \( x \) (so that it is linear) and interpret it appropriately to determine the value for the acceleration.

   Use the provided graph paper.

<table>
<thead>
<tr>
<th>Velocity (m/s)</th>
<th>Displacement (m)</th>
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<tr>
<td>9</td>
<td>2</td>
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<tr>
<td>14</td>
<td>4</td>
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<tr>
<td>23</td>
<td>12</td>
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<td>26</td>
<td>15</td>
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<td>28</td>
<td>18</td>
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4) (5pts) Draw the vector diagram (with resolved vectors) for a plane travelling in a circular path. The figure is as follows. Write the equations that follow from Newton’s 2nd Law, including the centripetal acceleration in the appropriate place.

5) (20 pts) Determine the period of motion for the plane in the previous problem. The length of the string is 1 m. The mass of the plane is 0.5 kg. The radius of the motion is 0.4 m.
6) (10 pts) This figure shows a system balanced at the center of mass for the ruler. On the left, an object of unknown mass \( m_{\text{unk}} \) is attached with a lever clamp, whose mass is 20 g. The mass is a distance of 40 cm from the balance point.

On the right, some known masses \( m \) are hanging on a mass hanger (50 g). These masses have a mass of \( m=25 \) g and are attached to the ruler by a lever clamp, whose mass is 20 g. The known mass is 30 cm from the balance point of the system.

What is the mass of the unknown, \( m_{\text{unk}} \)?

\[
m_{\text{unk}} = \text{___________ g}
\]

7)(10 pts) A cylinder has a diameter of 3.2 cm. The mass of the cylinder is 43 g. What is the density of the cylinder (in kg/m\(^3\))? \( V_{\text{cylinder}} = \frac{4}{3} \pi r^3 \)

\[
\rho_{\text{cyl}} = \text{___________ kg/m}^3
\]
8) (10 pts) An object has a mass of 0.02 kg and a density of 1200 kg/m$^3$. What is the apparent weight of the object when it is submerged in water, whose density is $\rho_w=1000$ kg/m$^3$.

9) (10 pts) 100 grams of water, whose specific heat is 1 cal/g/°C, is at an initial temperature of 20°C is mixed with 500 g of a metal at a temperature of 100°C. The final temperature of the water/metal mixture is 40°C. What is the specific heat of the metal?

$$C_{metal} = \underline{\hspace{2cm}} \text{cal/g/°C}$$
10) (10 pts) Describe the motion of the particle at points A, B, and C in this figure.

Particle A:
  a) Is the position positive, negative, or zero?
  b) Is the velocity positive, negative, or zero?
  c) Is the speed increasing, decreasing, or remaining constant?
  d) Is the acceleration positive, negative or zero?

Particle B:
  a) Is the position positive, negative, or zero?
  b) Is the velocity positive, negative, or zero?
  c) Is the speed increasing, decreasing, or remaining constant?
  d) Is the acceleration positive, negative or zero?

Particle C:
  a) Is the position positive, negative, or zero?
  b) Is the velocity positive, negative, or zero?
  c) Is the speed increasing, decreasing, or remaining constant?
  d) Is the acceleration positive, negative or zero?
11) (5 pts) Determine the period and radius of motion for this plane travelling in a circular path, whose displacement versus time is graphed in this figure:

**Simple Harmonic Motion (x vs. t)**

![Graph of Simple Harmonic Motion](image)

**Equations**

Standard Error = \( \sqrt{\frac{\Sigma (x - \bar{x})^2}{n(n-1)}} \)

Standard Percent Error = \( \frac{SE_x}{\bar{x}} \times 100\% \)

Percent Difference = \( \frac{|\text{Calculated} - \text{Actual}|}{\text{Actual}} \times 100\% \)

\( \rho = \frac{M}{V} \)

\( B = \rho_{\text{fluid}} V_{\text{obj}} g \)

\( \rho_{\text{water}} = 1000 \frac{\text{kg}}{\text{m}^3} \)

\( Q = mc\Delta T \)