EF 151 Exam #2, Fall, 2005

Name: ___________________  Section: ____________

This exam consists of 10 short-answer questions, each worth 10 points

Be sure to:
- Show all of your work
- Include units for all answers
- Include the correct number of significant digits
- Include directions for all vectors
- Write your final answer in the box provided

Hints:
- Stay calm
- Glance over all problems, tackle the "easy" ones first
- Use reasonableness to guide you
- Allow yourself an average of 5 minutes per problem

Some Key Equations:
- Area of a circle = πr²
- Volume of a cylinder = πr²h
- Law of Sines
  \[
  \frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}
  \]
- Law of Cosines
  \[c^2 = a^2 + b^2 - 2ab\cos C\]

Useful Conversions:
- 1 gallon = 231 cubic inches
- 1 gallon = 4 quarts
- 1 gallon = 128 fluid ounces
- 1 m³ = 1000 L
- 1 acre = 43,560 ft²
- 1 mile = 8 furlongs
- 1 fathom = 6 ft
- 1 rod = 16.5 ft
- 1 chain = 22 yards
- 1 inch = 25.4 mm
- 1 watt = 1 N m/sec
- 1 hp = 745.7 watts (approximate)
- 1 hp = 550 ft lb / sec
- 1 lb = 4.45 N (approximate)
- 1 m = 1000 mm
- 1 g = 32.2 ft/sec² = 9.81 m/sec²

Constant Acceleration Equations:
\[
s_2 = s_1 + \left(\frac{v_1 + v_2}{2}\right)\Delta t
\]
\[
s_2 = s_1 + v_1 \Delta t + \frac{1}{2} a \Delta t^2
\]
\[
s_2 = s_1 + \frac{v_2^2 - v_1^2}{2a}
\]
\[v_2 = v_1 + a\Delta t\]
1. The T-Bus travels for 0.75 miles at 11 mph in a straight line and then stops for 0.80 minutes. What is the average speed of the T-Bus from the start of the 0.75 miles until the end of the stop?

\[ v_{avg} = \frac{\Delta s}{\Delta t} = \frac{\Delta s_1 + \Delta s_2}{\Delta t_1 + \Delta t_2} \]

\[ v_{avg} = \frac{0.75 \text{ mi} + 0 \text{ mi}}{0.8 \text{ min} + 0.0133 \text{ hr}} = \frac{13.5 \text{ ft/s}}{11 \text{ mi/hr}} \]

\[ v_{avg} = 0.682 \text{ hr} \]

\[ v_{avg} = 4.92 \text{ min} \]

2. The star of the Karns junior varsity soccer team moves in a straight line. At t=2.0 seconds she is moving at 6.2 ft/sec. At t=8.0 seconds she is moving at 9.1 ft/sec. At t=12.0 seconds, she is moving at -2.4 ft/sec. What is the average acceleration of the soccer star from t=2.0 seconds to t=12.0 seconds?

\[ a_{avg} = \frac{\Delta v}{\Delta t} \]

\[ a_{avg} = \frac{9.1 \text{ ft/sec} - 6.2 \text{ ft/sec}}{10 \text{ sec} - 2 \text{ sec}} \]

\[ a_{avg} = 0.68 \text{ ft/} \text{sec}^2 \]

3. Sketch the acceleration curve and label each phase of the Drop Zone ride.

Use a coordinate system with the origin on the ground and positive upwards.
A. starts at rest at the bottom of the tower
B. slowly takes you up to the top of the tower at constant velocity.
C. stops and hoids you there for a few seconds
D. drops you in free fall
E. quickly brings you to a stop at the bottom of the ride.

-10 no parts correct
-4 D & E flipped
-4 ab ≠ 0
-2 each missing part
4. A car travels in a straight line for 66 miles at 33 mph and then for 1.0 hours at 42 mph. What is the average speed of the car?

\[
\text{Part 1}
\]
\[
\begin{align*}
\Delta s &= 66 \text{ mi}, \\
\Delta t &= 1 \text{ hr}, \\
\therefore \quad v &= \frac{\Delta s}{\Delta t} = \frac{66 \text{ mi}}{1 \text{ hr}} = 66 \text{ mi/hr}.
\end{align*}
\]

\[
\text{Part 2}
\]
\[
\begin{align*}
\Delta s' &= 42 \text{ mi}, \\
\Delta t' &= 1 \text{ hr}, \\
\therefore \quad v' &= \frac{\Delta s'}{\Delta t'} = \frac{42 \text{ mi}}{1 \text{ hr}} = 42 \text{ mi/hr}.
\end{align*}
\]

\[
\text{Part 3}
\]
\[
\begin{align*}
\Delta s &= v \Delta t, \\
\therefore \quad \Delta s &= 42 \text{ mi/hr} \times 1 \text{ hr} = 42 \text{ mi}.
\end{align*}
\]

5. Professor F. B. Overholt is returning from a doctor’s appointment to teach his class. His position is described by the function \( s = 0.2t^3 + 0.9t + 6 \) where the position is measured in ft and the time in minutes. What is Professor Overholt’s acceleration at \( t=4.00 \) minutes?

\[
\begin{align*}
\text{Part 1}
\end{align*}
\]
\[
\begin{align*}
s &= 0.2t^3 + 0.9t + 6, \\
v &= 0.6t^2 + 0.9, \\
a &= 1.2t \\
a &= 1.2(4) = 4.8 \text{ ft/min}^2.
\end{align*}
\]
6. The infamous Mini Cooper is driving down Cumberland Avenue and passes 16th street at a velocity of 22.0 ft/sec. 720 ft and 23.0 seconds later the Mini passes 17th street. Assuming constant acceleration, what is the acceleration of the Mini Cooper between 16th and 17th street?

\[
\begin{align*}
0.809 \text{ ft/s}^2
\end{align*}
\]

\[
\begin{align*}
S_2 &= S_1 + V_1 \Delta t + \frac{1}{2} a \Delta t^2 \\
S_2 - S_1 &= 720 \text{ ft} \\
V_1 &= 22 \text{ ft/s} \\
\Delta t &= 23 \text{ s} \\
720 \text{ ft} &= 22 \text{ ft/s} \cdot (23 \text{ s}) + \frac{1}{2} a (23 \text{ s})^2 \\
a &= 0.809 \text{ ft/s}^2
\end{align*}
\]

7. In a panic stop, a 100 ton train can slow down with an acceleration of 0.12g. What is distance is required to stop a train from a speed of 75 mph?

\[
\begin{align*}
1570 \text{ ft}
\end{align*}
\]

\[
\begin{align*}
a &= -0.12g \left(\frac{322 \text{ ft/s}^2}{9}\right) = -3.864 \text{ ft/s}^2 \\
v_1 &= 75 \text{ mi/hr} \left(\frac{5280 \text{ ft}}{\text{ mi}}\right) \left(\frac{1 \text{ hr}}{3600 \text{ sec}}\right) = 110 \text{ ft/s} \\
v_2 &= 0 \text{ (stop)} \\
S_2 &= S_1 + \frac{v_2^2 - v_1^2}{2a} \\
S_2 - S_1 &= \frac{0^2 - (110 \text{ ft/s})^2}{2(3.864 \text{ ft/s}^2)} = 1565.7 \text{ ft}
\end{align*}
\]
8. A bowling ball is dropped from the top of Neyland Stadium. What is the velocity of the bowling ball just before it hits the ground 112 ft below? Neglect air resistance and use a coordinate system with positive being up.

\[
S_2 = S_1 + \frac{v_f^2 - v_i^2}{2a}
\]

\[
v_f^2 = v_i^2 + 2a(S_2 - S_1)
\]

\[
v = \frac{v_i}{\sqrt{2(S_2 - S_1)}}
\]

\[
v = -84.9 \frac{ft}{s}
\]

9. The bowling ball of the previous problem hits and bounces off the ground. The time from when the bowling ball bounces off the ground until it hits the ground again is 2.36 seconds. What is the velocity of the bowling ball just after it bounced off the ground? Neglect air resistance and use a coordinate system with positive being up.

\[
S_3 = S_2 + v_2 \Delta t + \frac{1}{2}a \Delta t^2
\]

\[
v_2 = \frac{1}{2}a \Delta t
\]

\[
v_2 = \frac{1}{2}(-32.2 \frac{ft}{s^2})(112 \text{ ft}) = 38 \frac{ft}{s}
\]

10. If instead of being dropped, the bowling ball is thrown downward from a height of 112 ft with a speed of 21.8 ft/sec. How much time passes from when the bowling ball is thrown down until it hits the ground? Neglect air resistance and use a coordinate system with positive being up.

\[
S_2 = S_1 + v_1 \Delta t + \frac{1}{2}a \Delta t^2
\]

\[
o = 112 \text{ ft} + (-21.8 \frac{ft}{s}) \Delta t + \frac{1}{2}(-32.2 \frac{ft}{s^2}) \Delta t^2
\]

\[
16.1 t^2 - 21.8 t - 112 = 0
\]

\[
t = \frac{-21.8 \pm \sqrt{21.8^2 - 4(16.1)(112)}}{2(16.1)}
\]

\[
t = 2.05 \text{ sec} \quad \text{or} \quad t = -3.40 \text{ sec}
\]