Name____

Physics 110 Quiz #1, April 4, 2025

Please show all work, thoughts and/or reasoning to receive partial credit. The quiz is worth 10 points total.

I affirm that I have carried out my academic endeavors with full academic honesty.

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1. Roughly how many heartbeats are there in a lifetime? To earn full credit, do not simply state a number. Make reasonable assumptions and show how you arrived at your result.

   Assume that a person lives on average 80 years and that the normal heart rate is $60\frac{beats}{min}$.

   $$80yr \times \frac{365d}{1yr} \times \frac{24h}{1d} \times \frac{60min}{1h} \times \frac{60beats}{min} = 2.52 \times 10^9 beats$$

2. A cyclist rides $27km$ due west and then turns around and rides $12km$ due east. What is their distance traveled and their displacement?

   Distance: $27km + 12km = 39km$

   Assuming east is the positive x-direction the displacement is
   $\Delta x = -27km + 12km = -15km$ or 15 west.

3. Travel by high-speed train is a popular way to travel in Europe, especially in France. The speed of some high-speed trains is $150\frac{mi}{hr}$ on average. If the distance between Paris France and Dijon France is $320km$, how long, in minutes, would it take by high-speed train to make this journey? Hint $1mile = 1.609km$.

   $$v_x = \frac{\Delta x}{\Delta t} \rightarrow \Delta t = \frac{\Delta x}{v_x} = \frac{320 \times 10^3 m}{150\frac{mi}{hr} \times \frac{1hr}{3600s} \times \frac{1609m}{1mi}} \times \frac{1min}{60s} = 79.6min{\sim}80min$$

4. Dr. John Paul Stapp was a U.S. Air Force officer who studied the effects of extreme acceleration on the human body. On December 10, 1954, Dr. Stapp rode a rocket sled, accelerating from rest to a top speed of ($631\frac{mi}{hr}$) in $5s$ and was brought jarringly back to rest in only $1.4s$. What was the magnitude of the acceleration (in $\frac{m}{s^2}$) of Dr. Stapp in the direction of his motion?

$$a_x = \frac{\Delta v_x}{\Delta t} = \frac{631\frac{mi}{hr} \times \frac{1hr}{3600s} \times \frac{1609m}{1mi}}{5s} = 56.4\frac{m}{s^2}$$

5. Consider the following physical quantities mass m, length x, time t, speed v, and acceleration a with units $[m] = M$, $[x] = L$, $[t] = T$, $[v] = LT^{-1}$, and $[a] = LT^{-2}$, respectively. In class/lab we develop equations to model motion. Many problems will involve the motion of an object falling through the air and in these problems, we ignore air resistance. If we did not ignore air resistance, then we would find that objects reach what we call a terminal speed (the fastest speed the falling object will reach) and not fall any faster. If the terminal speed is given by $v = \sqrt{\frac{ma}{\gamma x^2}}$, what are the units of γ?

$$\gamma = \frac{ma}{v^2 x^2} \rightarrow [\gamma] = \frac{[M][LT^{-2}]}{[LT^{-1}]^2[L^2]} = \frac{MLT^{-2}}{L^4T^{-2}} = \frac{M}{L^3}$$