Name= **Studio Day/Time=**

Eng. Phys. I **Exam 1 - Chs. 1 & 3 - Measurements, Units, 1D Kinematics** **Jan. 28, 2022**

Write **neat** & **clear** work. Show **formulas** used, essential steps, results with correct **units** and **significant figures**. Points shown in parenthesis. For TF and MC, choose the *best* answer. Use $g = 9.80$ m/s^2.

1. (4) Show how to convert 2.4×10^{-5} kg into mg.

2. (4) Show how to convert 9.57×10^{5} s into days.

3. (4) Which of the following is the largest mass?

a. 25 kg. b. 2.5×10^3 mg. c. 25,000 μg. d. 0.0025 Gg.

4. (4) Which of the following is the longest length?

a. 16.0 inches. b. 1.25 feet. c. 45.0 cm. d. 0.3048 m.

5. (4) Respecting significant figures and units, what is the product $x = (42 \text{ m/s}) \times (21.256 \text{ s})$?

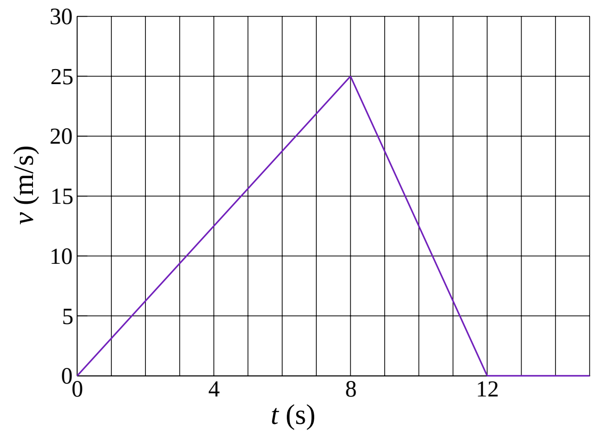
6. (4) Respecting significant figures and units, what is the sum $m = 2.50 \text{ kg} + 0.25 \text{ kg} + 27.8 \text{ g}$?

7. (12) Ralph has measured a window to be of width = 0.450 m $\pm$ 2 mm, height = 0.880 m $\pm$ 3 mm.

a) (4) Calculate the percent uncertainty in the width of the window.

b) (8) Calculate the area A of the window, and its uncertainty δA.

8. (16) A particle starts at $x = 50.0$ m at time $t = 0$, moving along a straight line (the x-axis) for 12.0 s with the velocity $v(t)$ shown here.



a) (8) Calculate the particle's position x at $t = 12.0$ s.

b) (4) Calculate the particle's average velocity between $t = 0$ and $t = 12.0$ s.

c) (4) Calculate the particle's average acceleration between $t = 0$ and $t = 12.0$ s.

9. (16) Ralph claims that he can be running in one direction at 24 m/s and then reverse direction in 120 ms, ending at 18 m/s in the other direction. If that is true,

a) (8) Find the magnitude of Ralph's average acceleration in m/s^2 when reversing direction.

b) (8) Assuming constant acceleration, over what distance does Ralph's velocity change from 24 m/s to 0 m/s (instantaneously), before reversing direction?

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10. (16) Waiting at a stoplight, the police are passed by robbers in a car traveling a constant 48.0 m/s (or about 173 km/h) down a straight road. What acceleration in units of $g = 9.80$ m/s^2 does the police car need to catch up to the robbers in 5.00 seconds?

11. (16) A ball is thrown vertically straight up in the air with an initial speed of 12.0 m/s from a cliff above a river. It lands in the river below 6.80 seconds later.

a) (8) How high is the cliff?

b) (8) With what speed does the ball hit the river?

Total Score = ____________/100

Prefixes

z=10^{-21},	a=10^{-18},	f=10^{-15},	p=10^{-12},	n=10^{-9},	$\mu = 10^{-6}$,	m=10^{-3},	c=10^{-2},	k=10^{3},	M=10^{6},	G=10^{9},	T=10^{12},	P=10^{15},	E=10^{18},	Z=10^{21}
zepto,	atto,	femto,	pico,	nano,	micro,	milli,	centi,	kilo,	mega,	giga,	tera,	peta,	exa,	zeta.

Physical Constants

$g = 9.80$ m/s^2 (gravitational acceleration) $\quad$ $G = 6.67 \times 10^{-11}$ N·m^2/kg^2 (gravitational constant)

$M_E = 5.98 \times 10^{24}$ kg (mass of Earth) $\quad$ $R_E = 6380$ km (mean radius of Earth)

$m_e = 9.11 \times 10^{-31}$ kg (electron mass) $\quad$ $m_p = 1.67 \times 10^{-27}$ kg (proton mass)

$c = 299,792,458$ m/s (speed of light) $\quad$ 1 amu = 1 u = $1.6605402 \times 10^{-27}$ kg (atomic mass unit)

Units & Conversions (all exact)

1 inch = 1 in = 2.54 cm $\quad$ 1 foot = 1 ft = 12 in = 0.3048 m

1 mile = 5280 ft =1760 yards $\quad$ 1 mile = 1609.344 m = 1.609344 km

1 m/s = 3.6 km/hour $\quad$ 88 ft/s = 60 mile/hour

1 acre = (1 mile)^2/640 = 43,560 ft^2 $\quad$ 1 hectare = (100 m)^2 = 10^4 m^2

Geometry

Triangles: $A = \frac{1}{2}bh$, $\quad$ Circles; $C = 2\pi r$, $\quad A = \pi r^2$, $\quad$ arc $= s = r\theta$. $\quad$ Spheres: $A = 4\pi r^2$, $\quad V = \frac{4\pi}{3} r^3$

Trigonometry

$\sin\theta = \frac{(\text{opp})}{(\text{hyp})}$, $\quad \cos\theta = \frac{(\text{adj})}{(\text{hyp})}$, $\quad \tan\theta = \frac{(\text{opp})}{(\text{adj})}$, $\quad (\text{opp})^2 + (\text{adj})^2 = (\text{hyp})^2$.

$\sin^2\theta + \cos^2\theta = 1$, $\quad a^2 + b^2 - 2ab\cos\gamma = c^2$, $\quad \frac{\sin\alpha}{a} = \frac{\sin\beta}{b} = \frac{\sin\gamma}{c}$, $\quad \alpha + \beta + \gamma = 180° = \pi$ rad.

Chapter 1 - Units, measurements, errors or uncertainties

Unit conversions:	value = # (old units),	(old units) $\times \left(\frac{\text{new units}}{\text{old units}}\right)$ = (new units).
Significant figures:	$\div$ or $\times$, use the least no. of sig. figs.,	$+$ or $-$, drop the insignificant *digits*.
Sig. figs. "1" rule:	if 1st digit=1, keep 1 extra digit,	$\longleftarrow$ for division or multiplication only.
Measurements:	measurement $= x \pm \delta x$,	x = observed value, δx = error or uncertainty.
Percent error:	measurement = value $\pm$ error,	percent error = (error / value)$\times$100%.
Combining errors:	$\div$ or $\times$, add the % errors,	$+$ or $-$, $\delta x = \sqrt{(\delta x_1)^2 + (\delta x_2)^2 + \ldots}$.

Chapter 3 - 1D Kinematics - Straight-line motion

Velocity:	$v_{\text{avg}} = \frac{\Delta x}{\Delta t}$,	$\Delta x = x - x_0$,	$v(t) = \frac{dx}{dt}$= slope of $x(t)$.
Acceleration:	$a_{\text{avg}} = \frac{\Delta v}{\Delta t}$,	$\Delta v = v - v_0$,	$a(t) = \frac{dv}{dt}$= slope of $v(t)$.
Integrals = areas:	$x(t) = x_0 + \int_0^t v(t')dt'$,	$v(t) = v_0 + \int_0^t a(t')dt'$.	
Constant acceleration:	$v = v_0 + at$,	$v_{\text{avg}} = \frac{1}{2}(v_0 + v)$,	$\Delta x = v_{\text{avg}}\Delta t$.
	$x = x_0 + v_0 t + \frac{1}{2}at^2$,	$x = x_0 + v_{\text{avg}} t$,	$v^2 = v_0^2 + 2a\Delta x$.
	(position from acceleration)	(using average velocity)	(timeless equation)
Free fall ($+y$-axis is up):	$y = y_0 + v_{0y}t - \frac{1}{2}gt^2$,	$v_y = v_{0y} - gt$,	$v_y^2 = v_{0y}^2 - 2g\Delta y$.