110 Fall 2022 Test 1A Once the exam has officially started, remove the top sheet. The remaining sheets comprise your exam. It is each student's individual responsibility to ensure the instructor has received her or his completed exam. Any exams not received by the instructor earn zero points. Smart watches, phones, or other devices (except scientific calculators) are not permitted during the exam.

$V_{sphere} = \frac{4}{3}\pi R^3$	$V_{box} = LWH$	$V_{cyl} = \pi R^2 H$	$\rho = \frac{M}{V}$
$A_{sphere} = 4\pi R^2$	$V = (A_{base}) \times (height)$	$A_{circle} = \pi R^2$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
$C = 2\pi R$	$A_{rect} = LW$	$A_{CylSide} = 2\pi RH$	
$160\underline{9}\ \mathrm{m} = 1\ \mathrm{mi}$	$12\ \mathrm{in} = 1\ \mathrm{ft}$	$60\ \mathrm{s} = 1\ \mathrm{min}$	$1000\ \mathrm{g} = 1\ \mathrm{kg}$
$2.54\ \mathrm{cm} = 1\ \mathrm{in}$	$1\ \mathrm{cc} = 1\ \mathrm{cm}^3 = 1\ \mathrm{mL}$	$60\ \mathrm{min} = 1\ \mathrm{hr}$	$100\ \mathrm{cm} = 1\ \mathrm{m}$
$1\ \mathrm{cm} = 10\ \mathrm{mm}$	$1\ \mathrm{yard} = 3\ \mathrm{ft}$	$3600\ \mathrm{s} = 1\ \mathrm{hr}$	$1\ \mathrm{km} = 1000\ \mathrm{m}$
$1\ \mathrm{furlong} = 220\ \mathrm{yards}$	$528\underline{0}\ \mathrm{ft} = 1\ \mathrm{mi}$	$24\ \mathrm{hrs} = 1\ \mathrm{day}$	$1\ \mathrm{rev} = 2\pi\ \mathrm{rad} = 360°$
$g = 9.8\ \frac{\mathrm{m}}{\mathrm{s}^2}$	$G = 6.67 \times 10^{-11} \frac{\mathrm{N \cdot m^2}}{\mathrm{kg}^2}$	$P_0 = 1.0 \times 10^5\ \mathrm{Pa}$	$1\ \mathrm{eV} = 1.60\underline{2} \times 10^{-19}\ \mathrm{J}$
$1\ \mathrm{N} = 1 \frac{\mathrm{kg \cdot m}}{\mathrm{s}^2}$	$1\ \mathrm{J} = 1\ \mathrm{N \cdot m}$	$1\ \mathrm{Pa} = 1 \frac{\mathrm{N}}{\mathrm{m}^2}$	
$x_f = x_i + v_{ix}t + \frac{1}{2}a_x t^2$	$v_{fx}^2 = v_{ix}^2 + 2a_x(\Delta x)$	$v_{fx} = v_{ix} + a_x t$	$r = \sqrt{x^2 + y^2}$
$\vec{A} \cdot \vec{B} = AB \cos\theta_{AB}$	$\lVert \vec{A} \times \vec{B} \rVert = AB \sin\theta_{AB}$	$\sin(A \pm B)$ $= \sin A \cos B \pm \cos A \sin B$	$\cos(A \pm B)$ $= \cos A \cos B \mp \sin A \sin B$
$\vec{v}_{ae} + \vec{v}_{eb} = \vec{v}_{ab}$	$\hat{r} = \cos\theta\, \hat{\imath} + \sin\theta\, \hat{\jmath}$	$\hat{\theta} = -\sin\theta\, \hat{\imath} + \cos\theta\, \hat{\jmath}$	
$a_{tan} = r\alpha$	$a_c = \frac{v^2}{r} = r\omega^2$	$\vec{a} = a_r\hat{r} + a_{tan}\hat{\theta}$	$\vec{a} = a_c(-\hat{r}) + a_{tan}\hat{\theta}$
$\Sigma\vec{F} = m\vec{a}$	$f \leq \mu n$		

Prefix	**Abbreviation**	**$10^?$**		**Prefix**	**Abbreviation**	**$10^?$**
Giga	G	10^9		milli	m	10^{-3}
Mega	M	10^6		micro	µ	10^{-6}
kilo	k	10^3		nano	n	10^{-9}
centi	c	10^{-2}		pico	p	10^{-12}
				femto	f	10^{-15}

$$[\mathrm{M}] = \text{units of mass} = \mathrm{kg} \qquad [\mathrm{L}^2] = \text{units of area} = \mathrm{m}^2 \qquad [\mathrm{T}] = \text{units of time} = \mathrm{s} \qquad \left[\frac{\mathrm{L}}{\mathrm{T}^2}\right] = \text{units of acceleration} = \frac{\mathrm{m}}{\mathrm{s}^2}$$

$$[\mathrm{L}] = \text{units of length} = \mathrm{m} \qquad [\mathrm{L}^3] = \text{units of volume} = \mathrm{m}^3 \qquad \left[\frac{\mathrm{L}}{\mathrm{T}}\right] = \text{units of velocity} = \frac{\mathrm{m}}{\mathrm{s}} \qquad \left[\frac{\mathrm{L \cdot M}}{\mathrm{T}^2}\right] = \text{units of force} = \frac{\mathrm{kg \cdot m}}{\mathrm{s}^2} = \mathrm{N}$$

Name:____

****1) Two measurements are $A = 0.0002030$ s and $B = 240$ ns. Complete the table below.

Number of sig figs implied on A	A in engineering notation with best choice of prefix	Number of sig figs implied on B	B in scientific notation

2) The *slug* is a unit of mass equivalent to 14.5939 kg. The density of one particular brand of aerogel is $8.15 \times 10^{-2} \frac{\text{g}}{\text{cm}^3}$. Convert this density to units of $\frac{\text{slug}}{\text{in}^3}$. **Write your answer in scientific notation. Aerogels are solid materials with ridiculously low densities that can act as excellent thermal insulators. After the test you might do a web search on them because they are crazy.

2	

An equation in a real physics problem is

$$v = \sqrt{\frac{kx^2}{m} + gh}$$

A data table of associated measurements is shown at right.

**3a) Determine an algebraic expression for x.

3b) Compute a numerical value of x in units of meters. **Use correct sig figs in engineering notation with appropriate prefix.

$v\ \left(\frac{\text{m}}{\text{s}}\right)$	$k\ \left(\frac{\text{kg}}{\text{s}^2}\right)$	m (g)	$g\ \left(\frac{\text{m}}{\text{s}^2}\right)$	h (mm)
7.77×10^{-2}	-800.0	9.99	9.80	0.678

3a	
3b	

**4) Suppose you are told an equation is given by

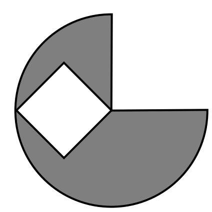
$$v^2 = -\frac{3ka^2}{mx} + \frac{2cma^3}{x^2}$$

In this equation x represents horizontal position, v represents speed, a represents horizontal acceleration, and m represents mass. Furthermore, k & c are positive constants. Determine the units required for the constant k. Write your final answer in terms of kg, m, & s. Note: it is possible for some or all of the units cancel out.

4	

**5) A metal disk of diameter D has the top right quadrant removed. Then a square hole is cut from the disk as shown. Assume the main diagonal of the square is equal to the disk's radius.

Determine an algebraic expression for the surface area of the final shape (gray area, top surface only). **Answer as a decimal number with three sig figs times D^2 for credit.**



5	

Angular momentum ($\vec{L}$) is defined by the equation

$$\vec{L} = m(\vec{r} \times \vec{v})$$

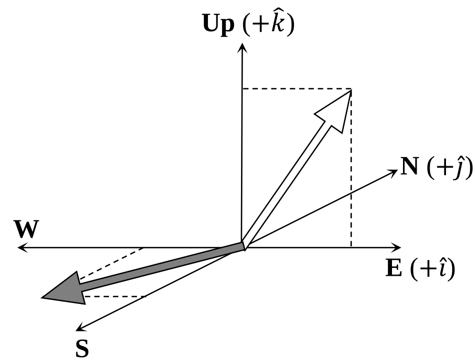
where $\vec{r}$ is a position vector, m is mass, and $\vec{v}$ is velocity.
For this problem:

- $\vec{r} = (4.44\hat{\jmath} - 5.55\hat{k})\text{m}$
- $m = 1.000 \text{ kg}$
- $\vec{v} = (-3.33\hat{\imath} + 2.22\hat{\jmath})\frac{\text{m}}{\text{s}}$

**6a) Rewrite $\vec{v}$ in polar form. Use the coordinates in the answer box to include a sketch. Label an angle in the sketch.
**6b) Determine $\hat{v}$ (in Cartesian form).
**6c) Determine the angle between $\vec{r}$ & $\vec{v}$.
**6d) Determine angular momentum (in Cartesian form).

6a	
6b	
6c	
6d	

A drone travels in two straight line displacements. In the *first* stage, the drone's *displacement* vector is described by $\vec{d}_1 = (8.88\hat{\imath} + 5.55\hat{k})\text{m}$. *After* the second stage, the drone's final *position* is 7.77 m angled 33.3° west of south. Figure not to scale.



*****7) Determine the distance traveled during the second displacement.

7	

This page intentionally left blank as scratch paper.

This page intentionally left blank as scratch paper.