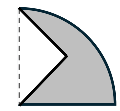
161 Fall 2026 Test 1A Once the exam has officially started, remove the top sheet. The remaining sheets comprise your exam. It is each student's individual responsibility to ensure the instructor has received her or his completed exam. Any exams not received by the instructor earn zero points. Smart watches, phones, or other devices (except scientific calculators) are not permitted during the exam.

$V_{sphere} = \frac{4}{3}\pi R^3$	$V_{box} = LWH$	$V_{cyl} = \pi R^2 H$	$\rho = \frac{M}{V}$
$A_{sphere} = 4\pi R^2$	$V = (A_{base}) \times (height)$	$A_{circle} = \pi R^2$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
$C = 2\pi R$	$A_{rect} = LW$	$A_{CylSide} = 2\pi RH$	
$160\underline{9}\text{ m} = 1\text{ mi}$	$12\text{ in} = 1\text{ ft}$	$60\text{ s} = 1\text{ min}$	$1000\text{ g} = 1\text{ kg}$
$2.54\text{ cm} = 1\text{ in}$	$1\text{ cc} = 1\text{ cm}^3 = 1\text{ mL}$	$60\text{ min} = 1\text{ hr}$	$100\text{ cm} = 1\text{ m}$
$1\text{ cm} = 10\text{ mm}$	$1\text{ yard} = 3\text{ ft}$	$3600\text{ s} = 1\text{ hr}$	$1\text{ km} = 1000\text{ m}$
$1\text{ furlong} = 220\text{ yards}$	$528\underline{0}\text{ ft} = 1\text{ mi}$	$24\text{ hrs} = 1\text{ day}$	$1\text{ rev} = 2\pi\text{ rad} = 360°$
$g = 9.8\ \frac{\text{m}}{\text{s}^2}$	$G = 6.67 \times 10^{-11}\frac{\text{N}\cdot\text{m}^2}{\text{kg}^2}$	$P_0 = 1.0 \times 10^5\text{ Pa}$	$1\text{ eV} = 1.60\underline{2} \times 10^{-19}\text{ J}$
$1\text{ N} = 1\frac{\text{kg}\cdot\text{m}}{\text{s}^2}$	$1\text{ J} = 1\text{ N}\cdot\text{m}$	$1\text{ Pa} = 1\ \frac{\text{N}}{\text{m}^2}$	$m_e = 9.11 \times 10^{-31}\text{ kg}$
$x_f = x_i + v_{ix}t + \frac{1}{2}a_x t^2$	$v_{fx}^2 = v_{ix}^2 + 2a_x(\Delta x)$	$v_{fx} = v_{ix} + a_x t$	$r = \sqrt{x^2 + y^2}$
$\vec{A}\cdot\vec{B} = AB\cos\theta_{AB}$	$\lVert\vec{A}\times\vec{B}\rVert = AB\sin\theta_{AB}$	$\sin(A \pm B)$ $= \sin A\cos B \pm \cos A\sin B$	$\cos(A \pm B)$ $= \cos A\cos B \mp \sin A\sin B$
$\vec{v}_{ae} + \vec{v}_{eb} = \vec{v}_{ab}$	$\hat{r} = \cos\theta\,\hat{\imath} + \sin\theta\,\hat{\jmath}$	$\hat{\theta} = -\sin\theta\,\hat{\imath} + \cos\theta\,\hat{\jmath}$	$\omega = 2\pi f = 2\pi/\mathbb{T}$
$a_{tan} = r\alpha$	$a_c = \frac{v^2}{r} = r\omega^2$	$\vec{a} = a_r\hat{r} + a_{tan}\hat{\theta}$	$\vec{a} = a_c(-\hat{r}) + a_{tan}\hat{\theta}$
$\Sigma\vec{F} = m\vec{a}$	$f \le \mu n$	$\vec{F}_G = \frac{GmM}{r^2}(-\hat{r})$	$U_G = -\frac{GmM}{r}$
$TKE = \frac{1}{2}mv^2$	$RKE = \frac{1}{2}I\omega^2$	$U_S = SPE = \frac{1}{2}kx^2$	$U_G = GPE = mgh$
$E_i + W_{\substack{non-con \\ or\ ext}} = E_f$	$\Delta KE = W_{ext.\&\,non-con}$	$W = Fd\cos\theta = F_{\parallel}d$	$W = \int F_x dx$
$\Delta U = -W = -\int_i^f \vec{F}\cdot d\vec{s}$	$F_x = -\frac{d}{dx}U(x)$	$\mathcal{P}_{inst} = \frac{dE}{dt} = \vec{F}\cdot\vec{v}$	$\mathcal{P}_{avg} = \frac{\Delta E}{\Delta t} = \frac{Work}{time}$
$\vec{J} = \Delta\vec{p} = \vec{F}\Delta t$	$\vec{p} = m\vec{v}$	$x_{\text{CM}} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$	$x_{\text{CM}} = \frac{\int x\,dm}{\int dm}$
$\vec{\tau} = \vec{r}\times\vec{F}$	$\Sigma\vec{\tau} = I\vec{\alpha}$	$L = I\omega = mvr_{\perp}$	$\mathcal{P}_{inst} = \vec{\tau}\cdot\vec{\omega}$
$s = r\Delta\theta$	$v = r\omega$	$a_{tan} = r\alpha$	$a_c = \frac{v^2}{r} = r\omega^2$
$I_{\parallel axis} = I_{\text{CM}} + md^2$	$I_{zz} = I_{xx} + I_{yy}$	$I = \int r^2 dm$	$\frac{F}{A} = E\frac{\Delta L}{L_0}$
$P = \frac{F}{A}$	$P_{gauge} = P_{abs} - P_{ambient}$	$B = \rho_f V_{disp} g$	$A_1v_1 = A_2v_2$
$P(h) = P_0 + \rho gh$	$P + \frac{1}{2}\rho v^2 + \rho gh = \text{constant}$	$R = \frac{\pi r^4 \Delta P}{8\eta L}$	$F = \eta A\frac{\Delta v_x}{\Delta y}$

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}

Name:____

***1) A 45-45-90 triangular section is removed from quarter-circular plate of radius R. Write an expression for the remaining (shaded) area. **Answer as a number with three sig figs times R^2.**



1	

2a) How many sig figs are in the number $t = 0.000000020200$ s?
2b) Write t in **engineering notation** with best choice of prefix.

2a	
2b	

***3) Use the following data table to compute $u = \frac{ab}{c-d}$.
Answer with correct sig figs & units in **scientific notation**.
Show your work and put your final answer in the box.

a $\left(\frac{\mathrm{m}}{\mathrm{s}}\right)$	b (mm)	c (m)	d (m)
8.75×10^{-7}	25.6	4.90×10^{1}	52.0

3	

A physics equation is

$$U_0 = \frac{3\alpha}{r^2} + \frac{1}{2}\beta x^3$$

4) Solve this equation algebraically for r. Simplify your result into a single fraction under a radical. To be clear, **no fractions should appear in the numerator or denominator of the fraction used in your final result.

4	

Two vectors are $\vec{A} = 7.00\,\frac{\text{m}}{\text{s}}\hat{\jmath}$ and $\vec{B} = \left(-4.00\hat{\imath} + 5.00\hat{\jmath} - 3.00\hat{k}\right)$ m.

5a) Determine B.

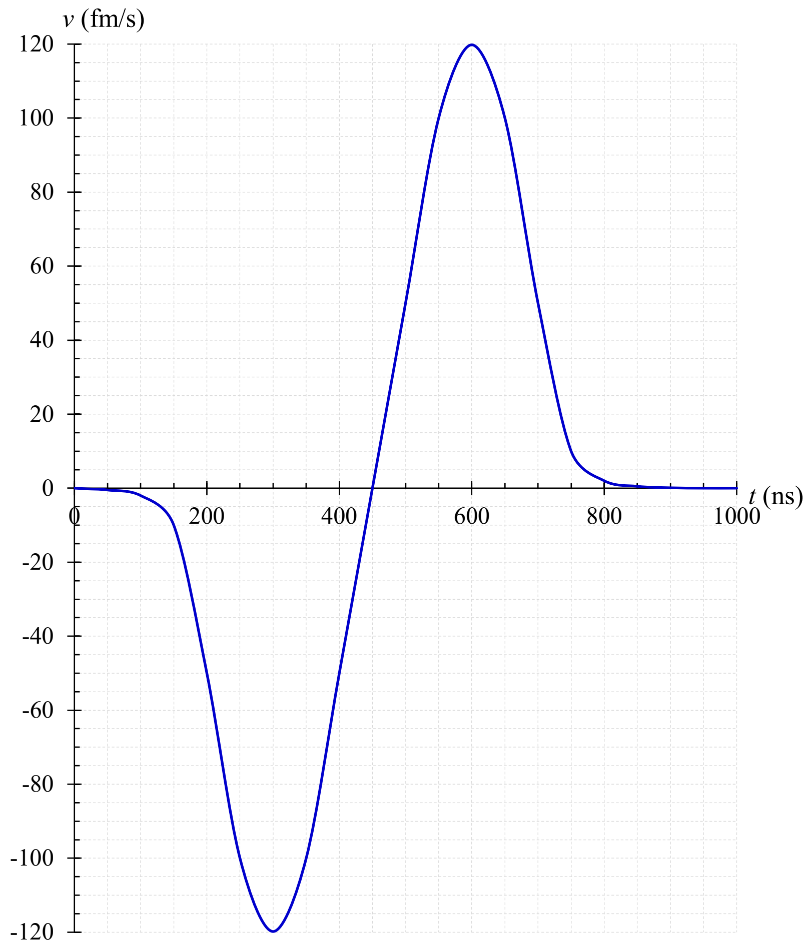
5b) Determine $\hat{B}$ in Cartesian form.

**5c) Determine $\vec{A} \times \vec{B}$ in Cartesian form.

5d) Determine $\vec{A} \cdot \vec{B}$.

5a	
5b	
5c	
5d	

The plot at right was recorded while analyzing the motion of a particle moving *horizontally*. The particle is initially located at the origin. Use this plot to answer the questions below.
It is ok to ignore units vectors on this problem.
Since you are reading a graph, 2 sig figs ok.



*6a) When is the particle speeding up? State all times or time intervals.

**6b) Estimate acceleration at 200 ns. Simplify your result using engineering notion with appropriate prefix in the *numerator* but no prefix in the denominator.

6c) Estimate displacement **after 450 ns.
Write your result using scientific notation.

*6d) Which of the following phrases best describes the particle's motion? Circle the best answer.

Ball moves to the *right* and then to the *left*.	Ball moves to the *right*, then to the *left*, and then to the *right* again.	Ball moves to the *right*, then to the *left*, then to the *right* again, and then to *left* again.	Impossible to determine without more info.	None of the other answers is correct.
Ball moves to the *left* and then to the *right*.	Ball moves to the *left*, then to the *right*, and then to the *left* again.	Ball moves to the *left*, then to the *right*, then to the *left* again, and then to *right* again.		

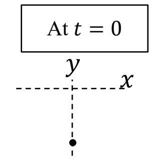
*6e) Which of the following phrases best describes the particle's final location? Circle the best answer.

Significantly *to the right* of the initial position	Approximately *the same as* the initial position	Significantly *to the left* of the initial position	Impossible to determine without more info.	None of the other answers is correct.

A particle moving in two dimensions has velocity described by the equation

$$\vec{v}(t) = (-36.0t^2 + 48.0)\hat{\imath} + 24.0t\hat{\jmath}$$

Notice the particle is initially located 7.00 m *below* the origin.



7a) Which best describes acceleration of the particle?

Both a_x & a_y are constant	a_x is constant a_y is *not* constant	a_x is *not* constant a_y is constant	Neither a_x nor a_y are constant	Impossible to determine without more info	None of the other answers is correct

7b) Which best describes initial motion of the particle?

Moving right	Moving left	Moving right & up	Moving right & down	Impossible to determine without more info	None of the other answers is correct
Moving up	Moving down	Moving left & up	Moving left & down		

7c) What units are assumed on the number -36.0 in the expression above?

**7d) Write an expression for position as a function of time in Cartesian form. Do *not* include units to reduce clutter.

7e) Write an expression for acceleration as a function of time in Cartesian form. Do *not* include units to reduce clutter.

***7f) How far is the particle from the origin when it reverses direction *horizontally*?

I will assume units of meters on your final result; units are not required on this answer.

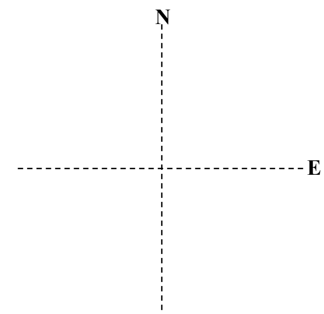
7c	
7d	
7e	
7f	

Relative to earth, a drone flies at $44.4\,\frac{\text{m}}{\text{s}}$ heading $20.0°$ west of south.
This occurs on a day when the wind blows $8.88\,\frac{\text{m}}{\text{s}}$ directed $30.0°$ north of east.

*****8) Determine speed and heading of the drone relative to air.

Answer by drawing an arrow labeled with speed and an angle in the box at right.
A neatly drawn, well-labeled sketch explaining your work is required.
A correct answer with no sketch (or bad sketch) receives zero (or almost zero) credit.

8



A student stands at the edge of a cliff. After ensuring no one is standing below, the student drops a rock. Assume air resistance is negligible as the rock falls. Assume height of the student and size of the rock are also negligible. After the rock impacts the ground, assume the sound from impact travels upwards with rate $343\,\frac{\mathrm{m}}{\mathrm{s}}$. The time required for the rock to fall AND for the sound to return to her ears takes 4.00 s.

9a	

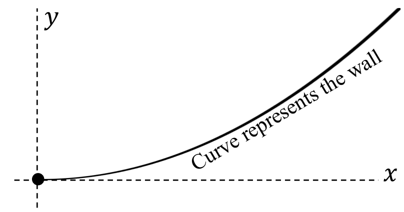
*****9a) Determine the height of the cliff.

A neatly drawn, well-labeled sketch is required.
A correct answer with no sketch (or bad sketch) receives zero (or almost zero) credit.
Notice part 9b at the bottom of the page…

9b) How does ignoring air resistance affect calculated height (h) compared to actual height (h_{real}) of the cliff?

Ignoring drag has no effect: $h = h_{real}$	Ignoring drag causes $h > h_{real}$	Ignoring drag causes $h < h_{real}$	Impossible to determine without more info	None of the other answers is correct

The figure shows a *top view* of a drone (black dot) flying near a wall (black curve).
The wall is modeled by the equation $y = kx^2$ where k is a known positive constant.
Initially the drone is at the origin moving *upwards* with speed v.
The drone accelerates with constant rate a *to the right*.
Sometime later, the drone impacts the wall.



10a) Determine the units assumed on the constant k.

*****10b) Determine the time to impact.
Answer in terms of given quantities & simplify your result. Show your work.

10a	
10b	

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