110 Fall 2022 Test 3A 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}

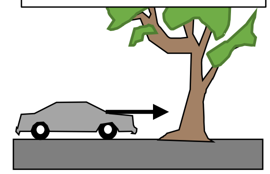
$[\mathrm{M}] = \frac{\text{units of}}{\text{mass}} = \mathrm{kg}$ $\quad [\mathrm{L}^2] = \frac{\text{units of}}{\text{area}} = \mathrm{m}^2$ $\quad [\mathrm{T}] = \frac{\text{units of}}{\text{time}} = \mathrm{s}$ $\quad \left[\frac{\mathrm{L}}{\mathrm{T}^2}\right] = \frac{\text{units of}}{\text{acceleration}}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

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

Name:

A car runs into a tree. Just before the collision, the tree is at rest. During the first part of the collision, the tree accelerates to the right. The tree then slows down and comes to rest. During the entire collision, the car is slowing down. A set of figures at right tries to show the various stages of the collision. Note: during stage 2, the car and tree slow *at the same rate*.

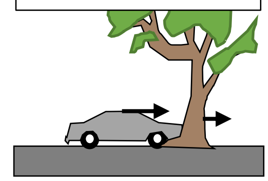
Stage 0
Just *before* collision



1a) During stage 1, which object is exerting a larger magnitude force: the car on the tree or the tree on the car? Circle the best answer below.

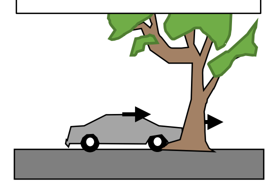
a) Tree exerts more force on the car
b) Car exerts more force on the tree
c) Car & tree exert equal magnitude forces on each other
d) Impossible to determine without knowing the car's speed
e) Impossible to determine without knowing masses of tree & car
f) Impossible to determine without knowing masses of tree & car and the car's speed
g) None of the other answers is correct.

Stage 1
Car slowing
Tree speeding up

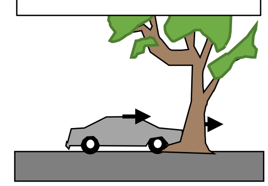


1b) Explain the reasoning behind your previous answer.

Stage 2
Car & tree slowing
at same rate



Stage 3
Car at rest
Tree at rest

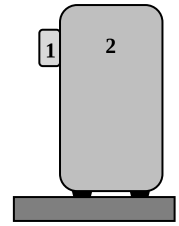


1c) During stage 2, which object is exerting a larger magnitude force: the car on the tree or the tree on the car? Circle the best answer below.

a) Tree exerts more force on the car
b) Car exerts more force on the tree
c) Car & tree exert equal magnitude forces on each other
d) Impossible to determine without knowing the car's speed
e) Impossible to determine without knowing masses of tree & car
f) Impossible to determine without knowing masses of tree & car and the car's speed
g) None of the other answers is correct.

1d) Explain the reasoning behind your previous answer.

A magnet (obj. **1**) sticks to a refrigerator (obj. **2**) as shown at right (not to scale). The magnet is at rest.

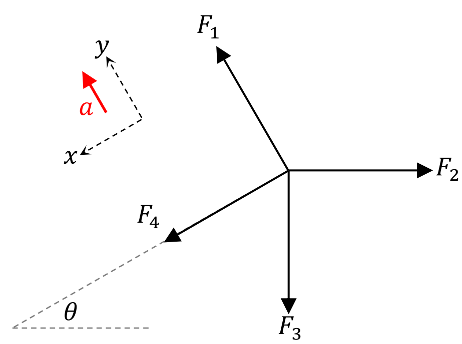


**2a) Draw an FBD of the magnet.
Label the magnetic force (magnitude) attracting the magnet to the fridge as F_B.

**2b) Write down the action reaction pair (both the action and the reaction) associated with the gravitational force acting on the magnet. For both the action and the reaction state 1) the object exerting the force, 2) the type of force, 3) the direction of the force, and 4) the object experiencing the force. Both must be correct to get any points.

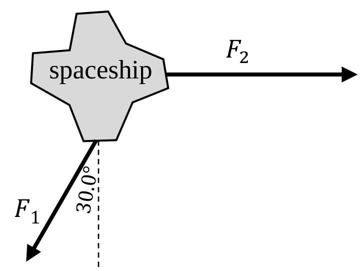
Action	
Reaction	

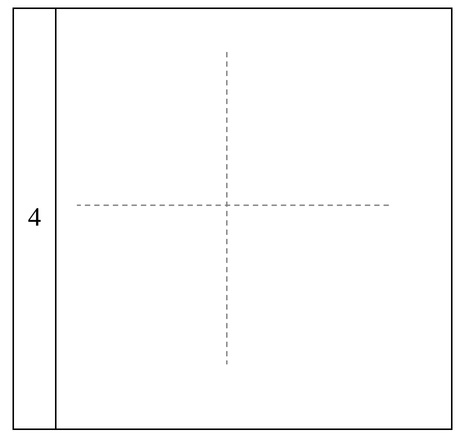
****3) Mass m is subjected to the forces shown. Write a correct set of force equations for the FBD and coordinate system shown at right. Arrows not to scale. Notice an angle is indicated in the figure. Your equations must be correct for the given coordinate system and acceleration vector indicated next to the FBD. You must also sub in appropriately for the terms a_x& a_y based on the image shown.



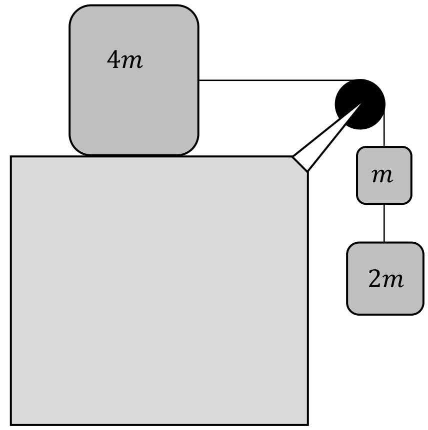
$\boldsymbol{\Sigma F_x}$:	
$\boldsymbol{\Sigma F_y}$:	

******4) A 675 kg spaceship is located in deep space (far from any sources of gravitational forces). Two forces act on the ship as shown. The magnitudes of these forces are $F_1 = 20.0$ kN and $F_2 = 27.5$ kN. The astronauts in the space ship wish to apply a third force such that the ship accelerates with magnitude $\frac{g}{2}$ in straight up. Determine the magnitude and direction of the required third force. To summarize your results, draw an arrow in the box labeling both the magnitude of the 3rd force and an angle to one of the principle axes.





Three blocks are connected using a light, inextensible strings of and a massless pulley with negligible axle friction as shown. Assume the masses are known.



****5a) What *minimum* coefficient of friction (between $4m$ & the horizontal surface) is required to prevent $4m$ from sliding?
Write your answer as a decimal number with three sig figs.

***5b) Determine acceleration *magnitude* when the frictional coefficients are $\mu_s = 0.555$ & $\mu_k = 0.444$?
Write your answer as a decimal number with three sig figs times g.

**5c) Determine tension in the upper string when $\mu_s = 0.555$ & $\mu_k = 0.444$?
Write your answer as a decimal number with three sig figs times mg.

5a	
5b	
5c	

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