110 Spring 2019 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.

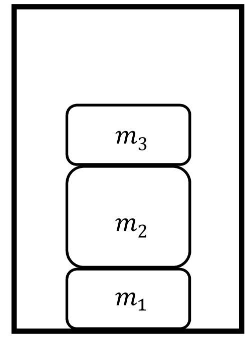
$V_{sphere} = \frac{4}{3}\pi R^3$	$V_{box} = LWH$	$V_{cyl} = \pi R^2 H$	$\rho = \frac{M}{V}$
$A_{sphere} = 4\pi R^2$	$V = (A_{base}) \times (height)$	$A_{circle} = \pi R^2$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
$C = 2\pi R$	$A_{rect} = LW$	$A_{CylSide} = 2\pi RH$	
$160\underline{9}\ \text{m} = 1\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

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}

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

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

NAME: ___________________________________



Three boxes are stacked in an elevator as shown.
For this problem, assume $m_1 = m_3 = 1.00$ kg while $m_2 = 2.00$ kg.
At some instant the elevator is moving down but also slowing down.

1a) Which best describes the acceleration block 2? Circle the best answer.

Impossible to determine without more info	No acceleration	Upwards acceleration	Downwards acceleration

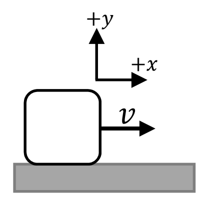
1b) Which best describes the relationship between the normal forces (*magnitudes*) acting on block 2? Circle the best answer.

Impossible to determine without more info	$n_{1on2} < n_{3on2}$	$n_{1on2} = n_{3on2}$	$n_{1on2} > n_{3on2}$

1c) Which best describes the relationship between the normal forces (*magnitudes*) acting between blocks 1 & 2? Circle the best answer.

Impossible to determine without more info	$n_{1on2} < n_{2on1}$	$n_{1on2} = n_{2on1}$	$n_{1on2} > n_{2on1}$

A block was kicked. After the kick, the block slides across a level surface (see figure). Eventually, the block comes to rest. Frictional coefficients between the block and surface are $\mu_s = 0.7$ & $\mu_k = 0.5$.



2a) While the block is sliding (after the kick), which describes the direction of the block's *acceleration*? Circle the best answer.

$+\hat{\imath}$	$-\hat{\imath}$	No friction	Impossible to determine without more info

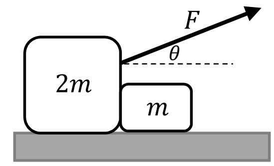
2b) While the block is sliding (after the kick), which describes the direction of friction on the block? Circle the best answer.

$+\hat{\imath}$	$-\hat{\imath}$	No friction	Impossible to determine without more info

2c) In the final state (block at rest), which describes the direction of friction on the block? Circle the best answer.

$+\hat{\imath}$	$-\hat{\imath}$	No friction	Impossible to determine without more info

Two blocks have masses m & $2m$.
An engineer wishes to apply a force to $2m$ at angle $\theta = 15.0°$ as shown.
She wants the blocks to accelerate to the right at rate $\frac{g}{5}$.
Assume friction is negligible for this problem.
Note: the magnitude F of the applied force is unknown…we will solve for it later!



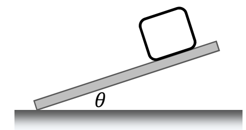
************3a) Draw an FBD for each block & for the system. Write force equations for each FBD.
Include a coordinate system for each FBD so I can follow your work.

FBD for $2m$	FBD for m	FBD for m & $2m$ system
ΣF_x:	ΣF_x:	ΣF_x:
ΣF_y:	ΣF_y:	ΣF_y:

**3b) What applied force (magnitude) is required?
Answer with a decimal number (3 sig figs) times mg.
**3c) What is the normal force (magnitude) exerted by m_1 on m_2?
Answer with a decimal number (3 sig figs) times mg.

3b	
3c	

A 0.300 kg block is placed on an incline of angle θ.
Frictional coefficients between the block and incline are $\mu_s = 0.888$ & $\mu_k = 0.777$.
*****4a) What is the largest possible angle (θ_{max}) for which the block remains at rest?
Provide a numerical result.
If no work is shown you have zero chance for partial credit.
**4b) Determine the frictional force (magnitude) acting on the block if $\theta = 32.1°$ is the actual angle used.
Provide a numerical result.
Notice parts 4c & 4d at the bottom of the page.



4a	
4b	

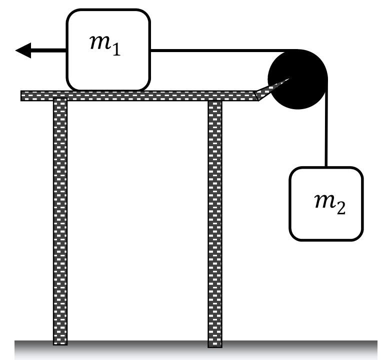
4c) Suppose we use a 0.600 kg block instead of the 0.300 kg block. Assume the frictional coefficients remain the same. How does θ_{max} (described in 4a) change? Circle the best answer.

θ_{max} increases	θ_{max} remains the same	θ_{max} decreases	Impossible to determine without more information

4d) Suppose we use a 0.600 kg block instead of the 0.300 kg block. Assume the frictional coefficients remain the same. Assume we still use $\theta = 32.1°$. How does frictional force magnitude (described in part 4b) change? Circle the best answer.

f increases	f remains the same	f decreases	Impossible to determine without more information

A block of mass $m_1 = m$ is placed on a level surface with $\mu_s = 0.888$ & $\mu_k = 0.777$.
A second block ($m_2 = 2m$) is connected to m_1 using a light, inextensible string.
Assume the pulley is also very light with negligible axle friction.
A scientist can apply a horizontal force to m_1 in the direction shown (black arrow).
****5a) What is the largest possible applied force (magnitude) the scientist can use before m_1 slides? Answer with a decimal number (3 sig figs) times mg.
*****5b) Now assume the scientist applies a force with magnitude $5mg$.
Determine the tension in the string. Answer with a decimal number (3 sig figs) times mg.



5a	
5b	

**Extra Credit)

Two force vectors have magnitudes $F_1 = 3.00$ N & $F_2 = 4.00$ N.
What angle, between $\vec{F}_1$ & $\vec{F}_2$, causes a net force magnitude of 2.00 N?
If this is impossible, explain why.
If it is possible, determine the angle.

EC	

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