LECTURE 1. NEWTON'S LAWS

Issues under Consideration

Newton's Laws. Reference Frames. Friction. Tension. Hooke's Law.

Recommended Materials

for reading: Serway R.A. and Jewett J.W. Physics for Scientists and Engineers with Modern Physics [6]

5.2. Newton's First Law and Inertial Frames
5.4. Newton's Second Law
5.6. Newton's Third Law
6.3. Motion in Accelerated Frames

for watching: MIT OpenCourseWare, Classical Mechanics [1]

4.1 Newton's First and Second Laws
https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-2-newtons-laws/4-1-newtons-first-and-second-laws/
4.2 Newton's Third Law
https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-2-newtons-laws/4-2-newtons-third-law/
4.3 Reference Frames
https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-2-newtons-laws/4-3-reference-frames/
4.4 Non-inertial Reference Frames
https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-2-newtons-laws/4-4-non-inertial-reference-frames/
6.1 Contact Forces
https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-2-newtons-laws/6-1-contact-forces
6.2 Static Friction
https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-2-newtons-laws/6-2-static-friction-lesson/
7.1 Pushing Pulling and Tension
https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-2-newtons-laws/7-1-pushing-pulling-and-tension/
7.2 Ideal Rope
https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-2-newtons-laws/7-2-ideal-rope/
7.4 Hooke's Law
https://ocw.mit.edu/courses/8-01sc-classical-mechanics-fall-2016/pages/week-2-newtons-laws/7-4-hookes-law/

Problem Set for Lecture 1
Newton's Laws

1. You are pushing a wooden crate across the floor at constant speed. You decide to turn the crate on end, reducing by half the surface area in contact with the floor. In the new orientation, to push the same crate across the same floor with the same speed, the force that you apply must be about …

A	B	C	D	E
four times as great	twice as great	equally great	half as great	one-fourth as great

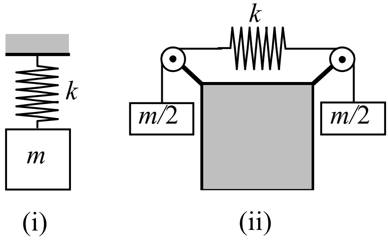
… as the force required before you changed the crate's orientation.

2. Consider a person standing in an elevator that is accelerating upward. The upward normal force N exerted by the elevator floor on the person is …

A	B	C
larger than	identical to	smaller than

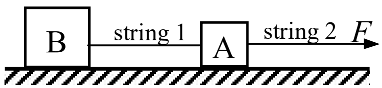
…the downward force of gravity on the person.

3. A body of mass m is suspended from a spring with spring constant k in configuration (i) and the spring is stretched a distance x. If two identical bodies of mass $m/2$ are suspended from a spring with the same spring constant k in configuration (ii), how much will the spring stretch?



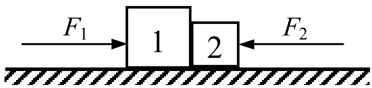
A	B	C	D	E
x	$2x$	$x/2$	$x/4$	not stretch at all

4. In the situation below, a person pulls a string attached to block A, which is in turn attached to another, heavier block B via a second string. Assume the strings are massless and inextensible; and ignore friction. Is the magnitude of the acceleration of block A …



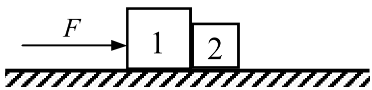
A	B	C	D
greater than the magnitude of the acceleration of block B?	equal to the magnitude of the acceleration of block B?	less than the magnitude of the acceleration of block B?	Do not have enough information to decide.

5. Two blocks 1 and 2, on a frictionless table, are pushed from the left by a horizontal force F_1, and on the right by a horizontal force of magnitude F_2 as shown above. The magnitudes of the pushing forces satisfy the inequality $F_1 > F_2$. Which of the following statements is true about the magnitude N of the contact force between the two blocks?



A	B	C
$N > F_1 > F_2$	$F_1 > N > F_2$	$F_1 > N = F_2$
D	E	F
$F_1 = N > F_2$	$F_1 > F_2 > N$	Cannot be determined from the information given

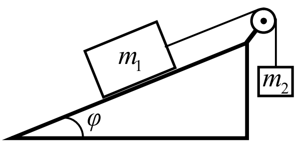
6. Two blocks sitting on a frictionless table are pushed from the left by a horizontal force F, as shown. The magnitude of the contact force between the two blocks is



A	B	C	D
greater than the magnitude of the pushing force F.	lesser than the magnitude of the pushing force F.	equal to the magnitude of the pushing force F.	Cannot determine from the information given.

7. Blocks and Pulley

A block 1 of mass m_1, constrained to move along a plane inclined at angle φ to the horizontal, is connected via a massless inextensible string that passes over a massless pulley, to a second block 2 of mass m_2. Assume the coefficient of static friction between the block and the inclined plane is μ_s and the coefficient of kinetic friction is μ_k. Assume the gravitational constant is g.



a) What is the relation between the masses of block 1 and block 2 such that block 1 just starts to slip up?

For the following questions suppose block 2 has a mass greater than the value you found in part a).

b) Calculate the acceleration of the blocks.

c) Calculate the tension in the string.

d) Block 2 starts out at a height h above the bottom of the inclined plane and is released at rest. How long does it take to fall a distance s? Assume that block 1 starts off a distance greater than s from the pulley.