Second Common QZ | Phys 105 - Spring 2005 | Version A

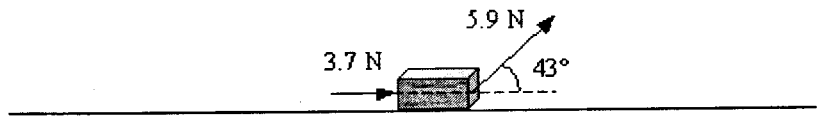
Name_____ ID_____ Section_____

As a student at NJIT I SOLUTIONS, will conduct myself in a professional manner and will comply with the provisions of the NJIT Academic Honor Code. I also understand that I must subscribe to the following pledge on major work submitted for credit as described in the NJIT Academic Honor code: On my honor, I pledge that I have not violated the provisions of the NJIT Academic Honor Code.

The exam is closed book and closed lecture notes. One page of formulas/notes is permitted

There are 10 multiple choice questions (1 pint each) and 2 Workout problems (3 and 2 points)
Make sure you put your name, section, and ID number on the SCANTRON form. The answers for the multiple choice Questions are to be placed on the SCANTRON form provided. Use a Number 2 pencil to fill in answers on the SCANTRON form. Make sure you give only one (1) answer to each question. **If you erase an answer on the SCANTRON form, make sure all traces are removed.**

1. Two forces act on a 4-kg block resting on a frictionless surface as shown. What is the magnitude of the horizontal acceleration of the block?



A) 1.8 m/s^2
B) 2.0 m/s^2
C) 4.0 m/s^2
D) 8.0 m/s^2
E) 9.8 m/s^2

$m \cdot a_x = 3.7[N] + 5.9[N] \cdot \cos 43^\circ$

$a_x = 8[N]/4[kg] = 2\ m/s^2$

2. A 60-kg person stands on a bathroom scale inside an elevator.
What does the scale read if the elevator is accelerating upwards with **a=3.0** m/s^2 ?

A) 168 N
B) 488 N
C) 588 N
D) 768 N
E) 968 N

$\vec{a} \uparrow$ $\uparrow \vec{N}$ $\downarrow m\vec{g}$

$\vec{N} + m\vec{g} = m\vec{a}$; $N - mg = ma$

$|\vec{N}| = m(a+g) = 60kg \cdot 12.8 \frac{m}{s^2} =$
$= 768\ [N]$

3. A 1000-kg car is traveling along a straight, level road at a constant speed of 56.0 mph when the driver removes his foot from the accelerator. After 12.5 s, the car's speed is 28.0 mph. What is the magnitude of the average net force acting on the car during the 12.5 s interval?

A) 532 N
B) 2210 N
C) 9800 N
D) 12335 N
E) 1000 N

$V_o = 56\ mph = 25\ m/s$

$V_f = 28\ mph = 12.5\ m/s$

$|a| = \frac{|V_f - V_o|}{\Delta t} = 1\ m/s^2$; $F = ma = 1000[N]$

4. A 2.0-kg book is given an initial velocity of 4.9 m/s on a horizontal wooden surface and slides 2.4 meters before coming to rest. The coefficient of kinetic friction is most nearly:

A) 0.51
B) 0.18
C) 0.26
D) 0.02
E) 1.02

$|a| = \frac{V_f^2 - V_o^2}{2\Delta X} = \frac{4.9^2}{2 \cdot 2.4} = 5\ m/s^2$

$F = ma = mg\mu_k$; $\mu_k = \frac{a}{g} = \frac{5\ m/s^2}{9.8\ m/s^2} = 0.51$

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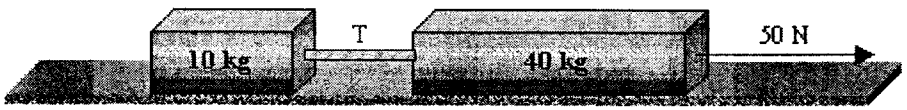
Problems 5 and 6

A 10-kg block is connected to a 40-kg block as shown in the figure. The surface on which the blocks slide is frictionless. A force of 50 N pulls the blocks to the right.



$a = \frac{F}{m_1+m_2} = \frac{50N}{50kg} = 1 m/s^2$

$T = 10kg \cdot 1 m/s^2 = 10N$

5. What is the magnitude of the tension **T** in the rope that connects the two blocks?

A) 0 N; B) 10 N; C) 20 N; D) 40 N; E) 50 N

6. What is the magnitude of the acceleration of the 40 kg block ?

A) 0 m/s^2 B) 1 m/s^2 C) 1.25 m/s^2 D) 5 m/s^2 E) 9.8 m/s^2

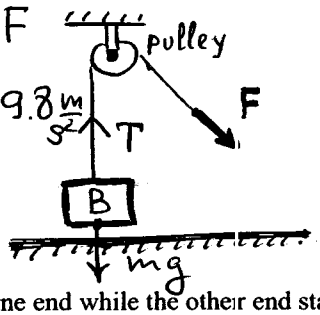
7. Block B, which has a mass of 100 kg, is raised from the Earth's surface by means of pulley system shown. If force F has a magnitude of 1100 N and friction is negligible, block B will move upward with a constant

A) velocity of about 1 m/s
B) velocity of about 11 m/s
C) acceleration of about 1 m/s^2
D) acceleration of about 11 m/s^2
B) impossible to solve; need to know the angle between the force and the vertical direction

$a = \frac{T-mg}{m}$; $T = F$

$a = \frac{F}{m} - g = 11 m/s^2 - 9.8 \frac{m}{s^2}$

$a \simeq 1 m/s^2$

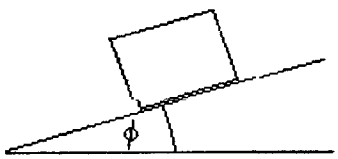


8. A block is at rest on a horizontal plank of wood. The plank is slowly lifted at one end while the other end stays on the floor. The steepest angle the plank can have before the block begins to slide without being pushed is 45°. What is the magnitude of the coefficient of static friction between the block and the plank ?

A) 1
B) 0.5
C) 0.25
D) 0.71
E) impossible to solve, need the mass of the block

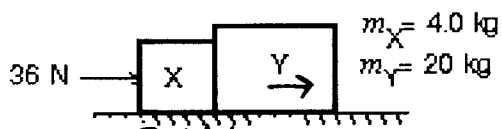
$\tan\phi = \mu_{stat.}$

$\tan 45^\circ = 1$



9. Two blocks (X and Y) are in contact on a horizontal frictionless surface. A 36-N constant force is applied to X as shown. The magnitude of the net force for the block Y is:

A) 6.0 N to the left
B) 6.0 N to the right
C) 30 N to the left
D) 30 N to the right
E) 18 N to the right



$a = \frac{F}{m_x+m_y} = \frac{36N}{24kg} = 1.5 m/s^2$ $F_y = m_y \cdot a = 30[N]$

10. What is the magnitude of the acceleration vector of a particle with m =5 kg due to a combination of two forces:

$\mathbf{F}_1 = (2N)\mathbf{i} + (2N)\mathbf{j} - (3N)\mathbf{k}$ and $\mathbf{F}_2 = (-2N)\mathbf{i} + (2N)\mathbf{j} + (6N)\mathbf{k}$?

$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 = 0\hat{i} + 4N\hat{j} + 3N \cdot \hat{k}$ $|F| = \sqrt{4^2+3^2}[N] = 5[N]$

A) 9.8 m/s^2 B) 1.4 m/s^2 C) 1.2 m/s^2 D) 5 m/s^2 E) 1 m/s^2

$a = \frac{|F|}{m} = \frac{5N}{5kg} = 1 m/s^2$

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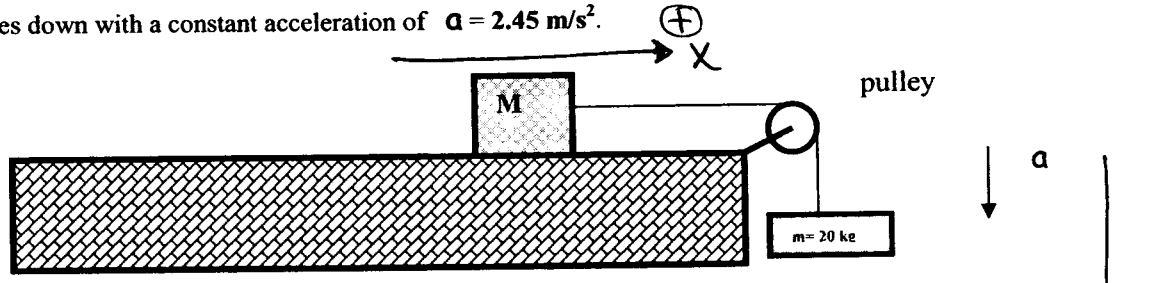
Workout Problems

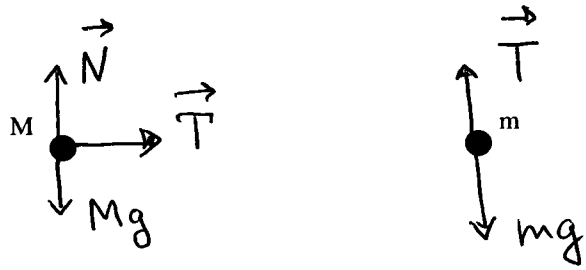
Write full solution to the Workout problems. Answers without complete calculations (step by step) will not be credited. Clearly write the answers with units in the space provided below. Grades will be reduced if the work is hard to read. Use the backside of the page if needed.

Workout problem I. (3 points)

Two blocks, one with the mass **m=20.0 kg** and the second with the unknown mass **M**, are connected by a string as shown. The pulley is massless and the surface is **frictionless**. Starting from rest, the **20 kg** mass moves down with a constant acceleration of **a = 2.45 m/s²**.



Extra credit:
draw the free-body-diagrams for the blocks



a) Write components of the Newton's 2nd Law of Motion for each of the masses using symbols only (M, m, g, T, N)

(x): $Ma_x = T$

(y): $Ma_y = 0 = N - Mg$

(x): $ma_x = 0$

(y): $ma_y = mg - T$

$T = m(g-a)$

$a = g \cdot \frac{m}{m+M}$

$T = g \cdot \frac{m \cdot M}{m+M}$

b) Solve the equations in part (a) using the data supplied and find the tension in the string T

T = 147 [N]

$T = 20kg \cdot (9.8 - 2.45 m/s^2)$

$T = 147 [N]$

$T = g \cdot \frac{m \cdot M}{m+M} = 9.8 m/s^2 \cdot \frac{20 \cdot 60}{80} =$

$= 147 [N]$

c) Solve the equations in part (a) using the data supplied and find the mass M.

M = 60 [kg]

$M = \frac{g}{a} \cdot m - m = m\left(\frac{g}{a} - 1\right) =$

$= 20kg \cdot \left(\frac{9.8 m/s^2}{2.45 m/s^2} - 1\right) = 60kg$

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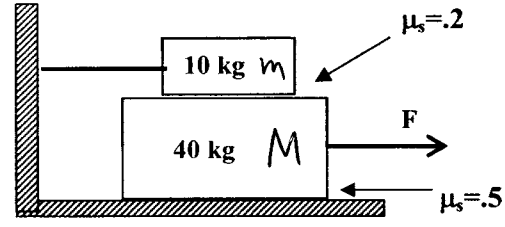
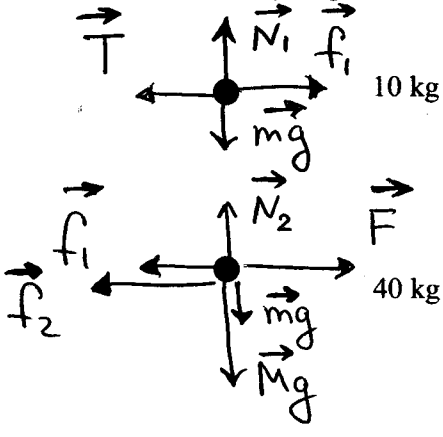
Workout problem II. (2 points)

A horizontal force **F** is gradually increased until the **40 kg** block begins moving to the right. The **10 kg** block cannot move because of the cord attaching it to the wall at left. The static friction coefficient between two blocks is **0.2** and the static friction coefficient between the **40 kg**-block and the supporting horizontal plane is **0.5**.



Extra credit:
draw the free-body-diagrams for the blocks



$a = \emptyset$

a) Find the friction forces between two blocks $\mathbf{f_1}$ and between the supporting plane and the 40 kg block $\mathbf{f_2}$

$f_1 = 19.6$ [N] $f_2 = 245$ [N]

$$f_1 = N_1 \cdot \mu_{s1} = mg \cdot \mu_{s1} = 10\,kg \cdot 9.8\,m/s^2 \cdot 0.2 = 19.6\,N$$

$$f_2 = N_2 \cdot \mu_{s2} = (m+M)g \cdot \mu_{s2} = 50\,kg \cdot 9.8\,m/s^2 \cdot 0.5 = 245\,N$$

b) For what magnitude of the force **F** does the lower block just start to move?

F=265 [N]

$$F \geq f_1 + f_2 = (19.6 + 245)\,N = \simeq 265\,N$$