Memorial University of Newfoundland

Physics 1020

Final Examination ***Name_____***

December 7, 2007 *MUN NO._____*

Time 2 Hours **Instructor(Circle) Dr Goulding/ Dr Beaulieu**

INSTRUCTIONS:

1. Non-programmable calculators are permitted. Programmable ones are subject to scrutiny.

2. There are three parts to the exam. **ANSWER ALL QUESTIONS FROM PART A , 7 out of 8 questions from Part B. Answer one out of two from Part C.**

3. Questions from part A are 2 marks each(Total 20%). Questions from part B and C are 10 marks each(Total 80%)

4. The last page of the exam is a formula sheet. Feel free to tear it off.

5. Please use **THREE** significant figures in all calculations.

6. **Relax!** Good luck!

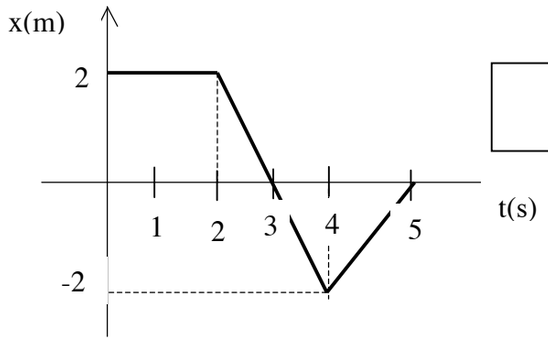
A	1	2	3	4	5	6	7	8	9	10	Total

Part A- **2 marks each(Total-20%)**

1. The speed of a car on the Outer Ring Road is 120 km/h. In SI units the speed is:
   a. 432 m/s
   b. 33.3 m/s
   c. 2000 m/s
   d. 3.33 m/s

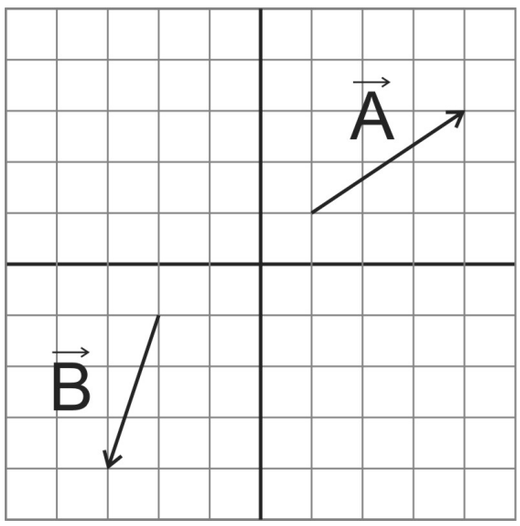
2. Two identical objects of the same mass are thrown from a balcony with the same speeds but in two different directions, one straight down and one horizontally. Neglecting air resistance, it is true that they will all hit the ground:
   a. with the same velocity
   b. with the same kinetic energy
   c. at the same time
   d. with different kinetic energies

3. Consider the Position-Time curve shown below. The velocity of the object at t=3.00 s seconds is:
   a. zero
   b. -2.00 m/s
   c. 2.00 m/s
   d. -.500 m/s
   e. .500 m/s



4. You are riding your bike at highspeed when a parked car suddenly appears magically in front of you. As you pass over the car, in the air, you realize that your inability to stop with the bike is a consequence of Newton's:
   a. First law
   b. Second Law
   c. Third Law
   d. three laws

5. In the vector diagram below, which answer best represents the vector sum $\vec{A} + \vec{B}$ is:

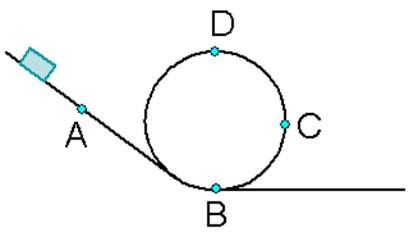


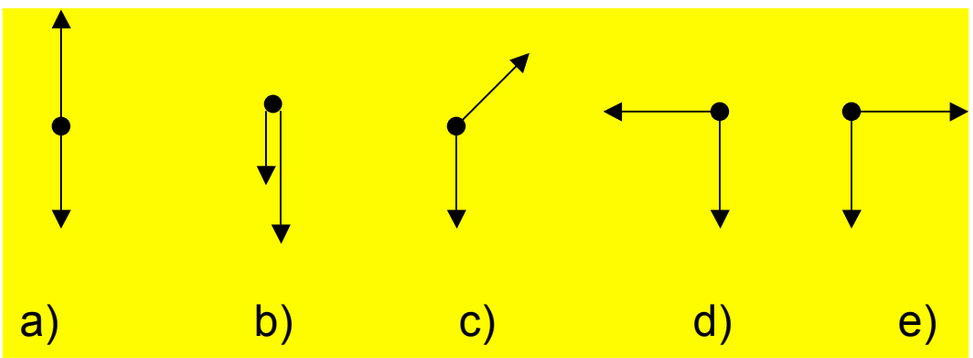
a) →
b) ↗
c) ↘
d) ←
e) ↙

6. Linear momentum is conserved in a two body collision only if:
   a. both bodies come to rest
   b. the net external force acting on the two body system is zero
   c. the collision is perfectly elastic
   d. the kinetic energy of the system is conserved

7. Starting from rest, two people of different masses ride identical sleighs down a smooth hill and slow to a stop on the rough horizontal section at the bottom. The coefficient of friction on the rough section is exactly the same for both sleds. Which statement is true?
   a. the heavier person will go farther
   b. they would go the same distance
   c. the lighter person will go farther
   d. the actual masses need to be known in order to answer this question

8. A cart slides along a frictionless surface of a loop-the-loop as shown in the figure. Which free body diagram best represents the forces which act on the cart at point C.





9. A train moving at high speed collides with a solid wall and stops. If the time during which the collision occurs is increased the force exerted on the train is:
   a. increased
   b. decreased
   c. unchanged
   d. there is insufficient information given

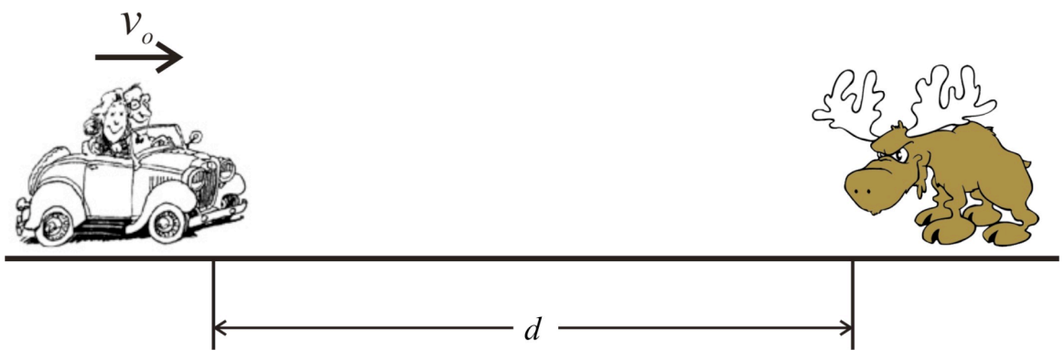
10. An object travels around a circle at constant speed. Which of the following is true?
   a. The net force on the object and its acceleration are both zero
   b. Its velocity is constant
   c. There is a net force on the object, directed towards the center
   d. There is a net force on the object, directed along the direction of motion

Part B – ATTEMPT 7 out of 8 QUESTIONS
All questions are of equal value-Total Value 70%

Note: The last page of the exam is a formula sheet. Feel free to tear it off.

1. Driving home in a hurry on the highway back from Holyrood, Harry and Harriet in their new Honda hatchback convertible, see a moose in their path a distance d = 71.0 m down the road . Travelling at 110 km/h, Harry applies the brakes causing the car to slow down with an acceleration a = 25.0 km/h per second. The mass of the car and occupants is 1480 kg.

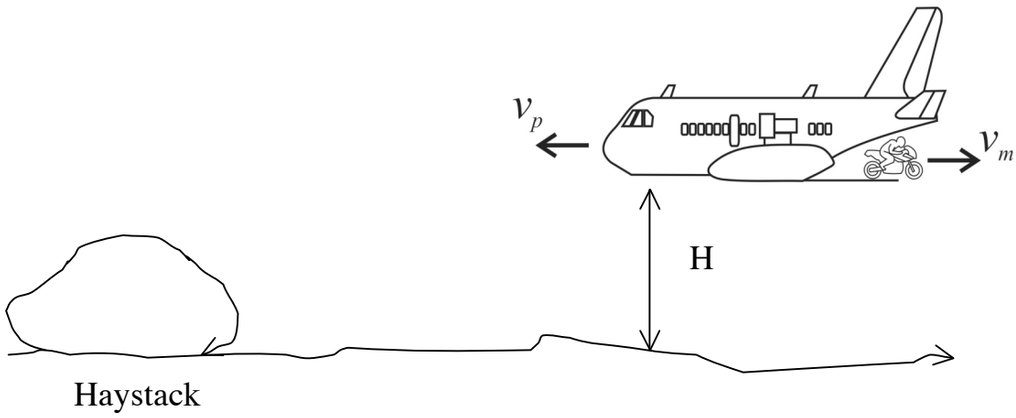
   a) Show that 25.0 km/h per second is 6.94 m/s^2
   b) By calculating how far the car travels, determine the answer to the question "Do Harry and Harriet hit the moose?"?
   c) What is the work down by the road in bringing the car to a halt?



2. Skyhigh Bob, the stuntman rides his motorcycle out the back of a transport plane. The plane is 550 m above the ground ,flying in level flight at a constant speed of 38.5 m/s. The speedomenter on Bobs bike reads 14.0 m/s, as he leaves the plane.

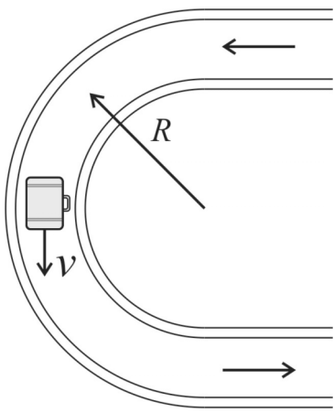
   a. How long is Bob in the air?
   b. Bob hopes to land in a haystack, which is 260 m horizontally from the back part of the plane where Bob jumps out. By calculating how far he travels horizontally, determine whether Bob lands in the haystack.
   c. What is the horizontal distance between Bob and the plane when Bob hits the haystack?
   d. Sketch Bob's trajectory in the air. Clearly show the direction of the bike relative to the path of the plane.

(Choose the *x*-axis and the *y*-axis as the horizontal and vertical axis respectively)



3.

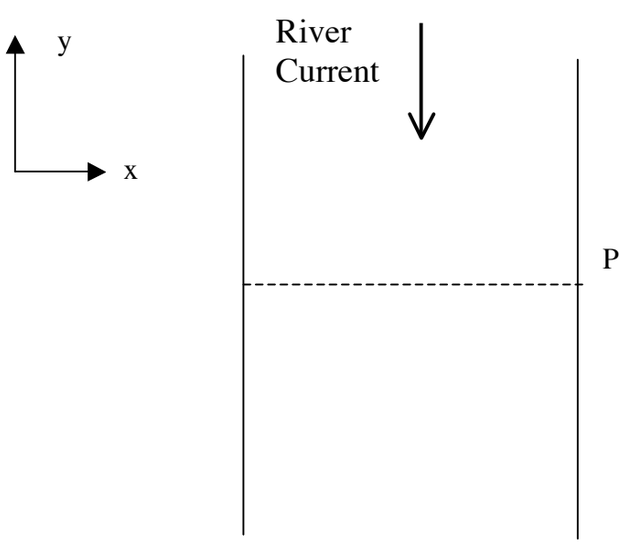
a. In an attempt to speed up baggage distribution, Air Canada developed a new high speed carousel capable of moving luggage at a speed of v = 12 m/s. If the carousel has a radius R = 12.4 m, what is the coefficient of friction between the luggage and the conveyor belt is needed to keep the luggage from flying off the carousel? Draw a Free body diagram indicating all the forces involved.



b. A boater attempts to cross a river to a point P directly on the other side. The river flows south at a speed of 1.50 m/s. The boat can travel at 2.70 m/s in still water.

a. At what angle should the boater travel (relative to x axis) so she ends up directly across on the other side. Sketch the boat and appropriate vector triangle on the diagram.

b. What is the boaters speed relative to the shore?



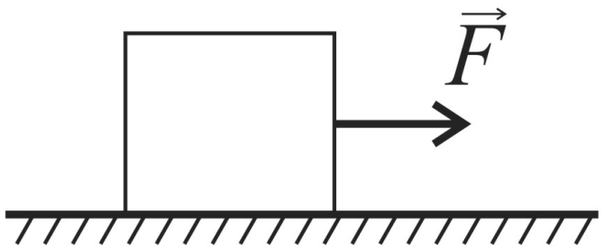
4.

a. A man looking out his window at the MUN library notices that a physics textbook dropped from rest from a window above him takes 1.50 s to reach the top of his window. From what height above him was the book dropped?

b. A 2.00 kg block rests on a rough horizontal surface where $\mu_S = 0.21,\ \mu_K = 0.12$. A force $\vec{F}_0$ is applied as shown.

i. What minimum force F_{min} is required to just start the mass moving?

ii. What is the acceleration of the mass due to F_{min}?



5.

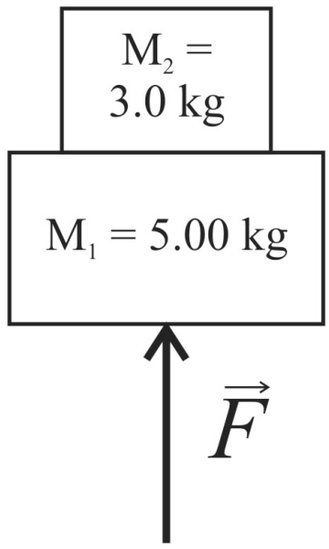
a. Two blocks are raised vertically by a force $\vec{F}$. If M_1=5.00 kg, M_2=3.00 kg and the acceleration of the system is 4.00 m/s^2:

i. Draw a Free body diagram for each block

ii. Write down the equations of motion(Newton's Second Law) for each block

iii. Determine the magnitude of the force F

iv. the contact force between M_1 and M_2

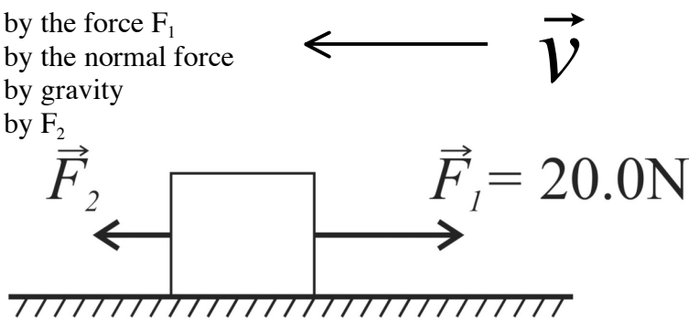


6.

a. State the Work-Energy theorem. Define any terms that you use.

b. A 5.00 kg block initially moving to the left at 5.00 m/s across a smooth surface is suddenly acted on by two forces, as shown. After moving 2.00 m the speed of the block is 3.50 m/s. Determine:

i. the work done by the force F_1
ii. the work done by the normal force
iii. the work done by gravity
iv. the work done by F_2



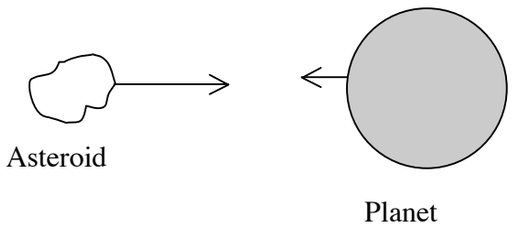
7.

a. In a car crash, the modern car is designed to crumple. Briefly explain in terms of Impulse-Momentum theory why this is so.

b. In a chance encounter, a stray asteroid of mass of 9800 kg moving at 12,000 m/s collides with a gaseous planet of mass 1.80E6 kg moving towards it at 180 m/s. After passing through the planet the asteroid emerges with a speed of 8100 m/s.

i. Find the speed of the planet after the collision

ii. How much energy in the form of heat is lost in this collision?



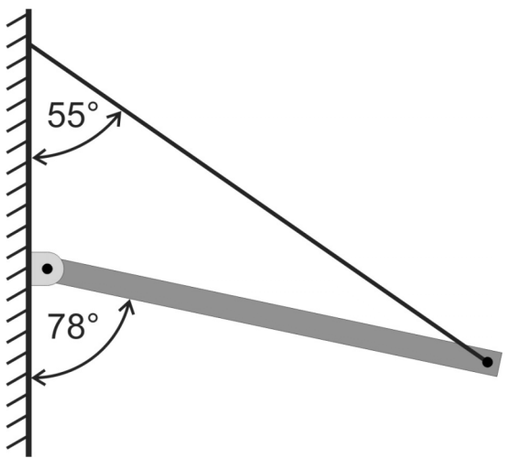
8.

a. State the two conditions for static equilibrium

b. A beam of mass $m = 5.62$ kg is secured to a wall by a pivot and held at a downwards angle of 78º by a string at the other end. The string makes an angle of 55^0 with the wall.

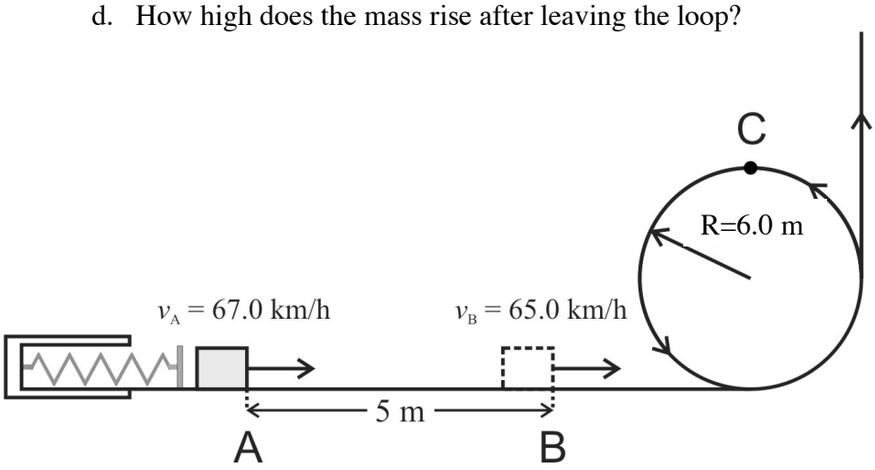
i. Draw a free body diagram showing the forces on the beam. Use symbols to indicate your forces, ie. no numbers.

ii. If the beam is $l = 1.43$ m long, find the tension in the string.



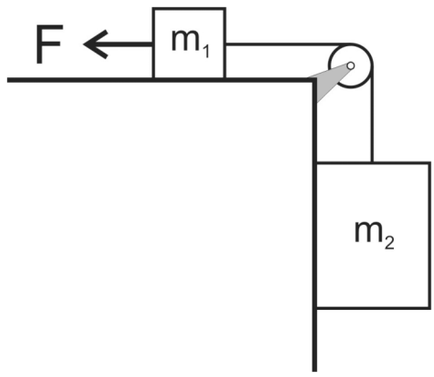
PART C DO one of questions 9 and 10 (Value 10%)

9. A 1.00 kg mass is shot from a spring (k=1200 N/m) loaded cannon with a speed of 67.0 km/h and travels across a rough surface. It then enters a smooth circular loop(R=6.0 m), as shown.
    a. What is the initial distance the spring is compressed?
    b. What is the coefficient of kinetic friction on the surface between points A and B?
    c. By calculation, determine whether the mass falls off the loop at point C.
    d. How high does the mass rise after leaving the loop?



10. Two blocks $m_1 = 2$ kg and $m_2 = 13$ kg are connected together by a string via a pulley (see picture below). Block m_1 is being acted on by a force F = 10 N as shown. The coefficient of static friction and kinetic friction between m_1 and the horizontal surface are $\mu_s = 0.34$ and $\mu_k = 0.14$ respectively. The coefficient of static friction and kinetic friction between m_2 and the vertical surface are $\mu_s = 0.24$ and $\mu_k = 0.11$ respectively.

a) Draw free body diagrams showing all the forces acting on blocks m_1 and m_2. Do not use numbers in your diagrams, use symbols only to represent each force.
b) Calculate the friction acting on each block
c) Calculate the tension in the string.
d) Calculate the acceleration of the system
e) In which direction are the blocks moving.



Clearly indicate your reasoning in this question.

Fall 2007:

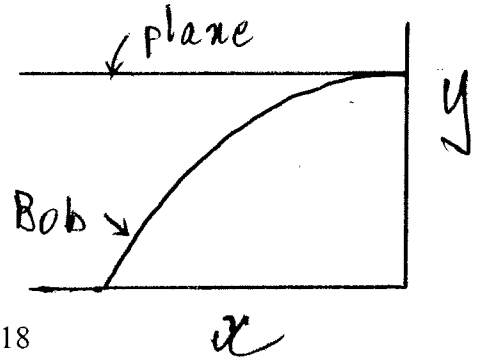
Part A: Multiple choice questions

1. b
2. b
3. b
4. a
5. c
6. b
7. b
8. d
9. b
10. c

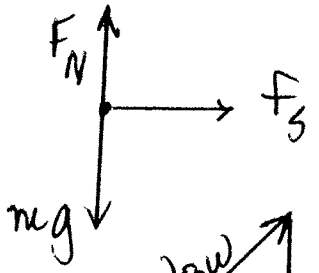
Part B:

1. a. 25.0 km/h/s (1000 m/km)(1/3600 h/s) = 6.94 m/s^2
   b. Δx = 67.3 m, so car does not hit moose
   c. W = $-6.91X10^5$ J

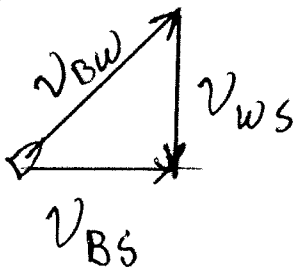
2. a. t = 10.6 s
   b. Δx = 260 m, so Bob does land in the hay stack (exact answer is 259.4 m)
   c. Δx = 148 m
   d.



3. a. μ_s = 1.18



   b. a. θ = 33.7°



   b. v_{BS} = 2.24 m/s

4. a. h = 11.0 m

b. i. $F_{min} = 4.12$ N

ii. $a = 0.883$ m/s^2

5. a. i.

ii. $F_N - m_2 g = m_2 a$

$F - F_N - m_1 g = m_1 a$

iii. F = 110 N

iv. $F_C = F_N = 41.4$ N

6. a. Two possible answers:

The net work done on an object equals the change in its kinetic energy:

$W_{net} = \Delta KE$

Or: The work done by the non-conservative forces equals the change in the total mechanical energy:

$W_{NC} = \Delta E$

b. i. $W_{F1} = -40.0$ J

ii. $W_{FN} = 0$ J

iii. $W_{Fg} = 0$ J

iv. $W_{F2} = 8.12$ J

7. a. The impulse of the force is the force multiplied by the time. If the car crumples, the time of the collision is made longer, which makes the force of the impact less.

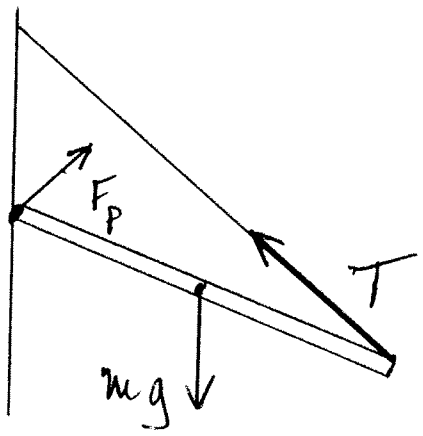
b. i. v = 159 m/s

ii. $E_{lost} = 3.91 \text{X} 10^{11}$ J

8. a. The net force is zero: $\Sigma F = 0$.

The net torque is zero: $\Sigma \tau = 0$.

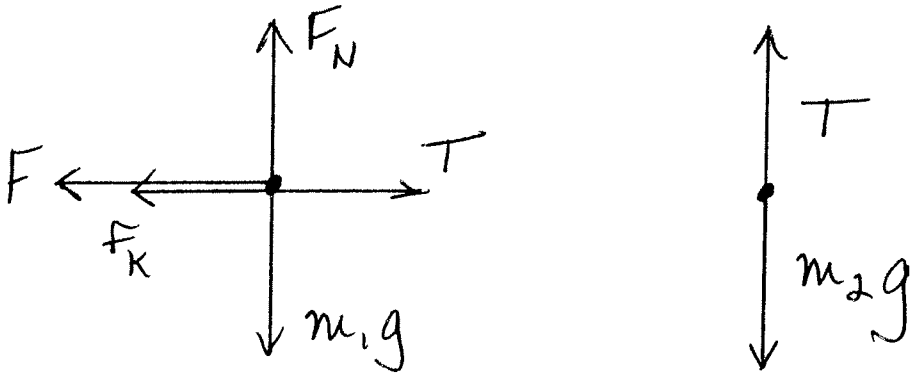
b. i.



ii. T = 69.0 N

9. a. x = 0.537 m
   b. $\mu_k = 0.206$
   c. $v_c = 9.52$ m/s, $v_{min} = 7.67$ m/s, so mass stays on
   d. h = 16.6 m

10. a.



   b. $f_{k1} = 2.75$ N, $f_{k2} = 0$ N (since no normal force)
   c. T = 28.1 N
   d. $a = 7.65$ m/s^2
   e. m_1 moves right and m_2 moves down (F is not sufficient to move masses in opposite direction)