PHYS -201, Test 1 Solutions

NAME (please print your name clearly):

201 SECTION: 1 (Conetti) 2 (Liyanage)

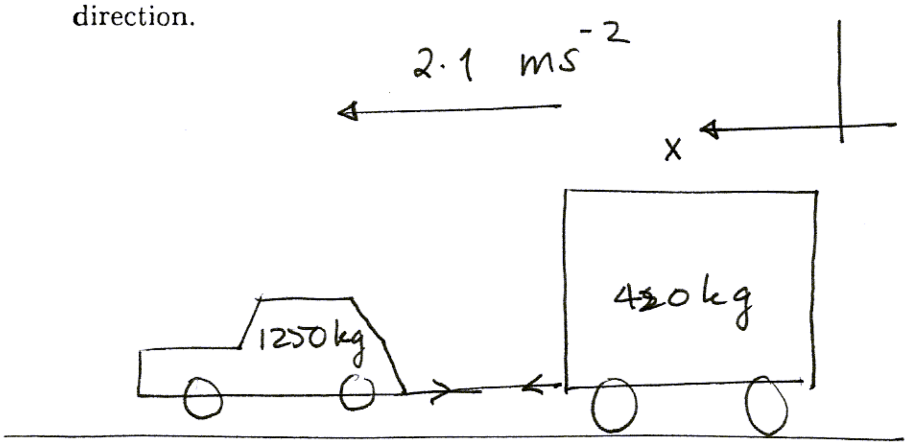
Physics 201, Test 1 **Sep 26, 2006**

In this test you are allowed only your calculator and the formula sheet you have prepared. You have 1 hour and 15 minutes to solve the three problems and answer the five questions. Each problem has a maximum score of 10, and each question is worth 2 points, therefore 1 problem has the same weight as 5 questions. In the problems you should **clearly** show all the steps you did to reach the solution. Giving an answer without showing how it was arrived at is worthless.

Don't forget to write your name. By writing your name you are automatically taking the honor pledge.

(10)

Problem 1: Leaving a speed zone, a 1250. kg car pulling a 420. kg trailer accelerates at the rate of 2.1 m/s^2. What is the force exerted by the car on the trailer? What force does the trailer exert on the car? What is the net force acting on the car? For each answer, specify magnitude and direction.



Assumming No Friction, the net force on the trailer is exerted by the car.

For the trailer ←

$$\bar{F} = m\bar{a}$$

$$\bar{F}_T = 420 \times 2.1 \text{ N}$$

$$= 882 \text{ N } (\hat{x})$$

Newton's 3rd law Force on the trailer = equal, and opposite to the force by the trailer on the car

$$F_c = -882\hat{x} N$$

Problem #7 Continued.

Net Force acting on the car is responsible for it's acceleration

$$\Rightarrow \quad \leftarrow \quad \bar{F}_{Net,\,car} = m\bar{a}$$

$$= 1250 \times 2.1 \ \hat{x} \ N$$

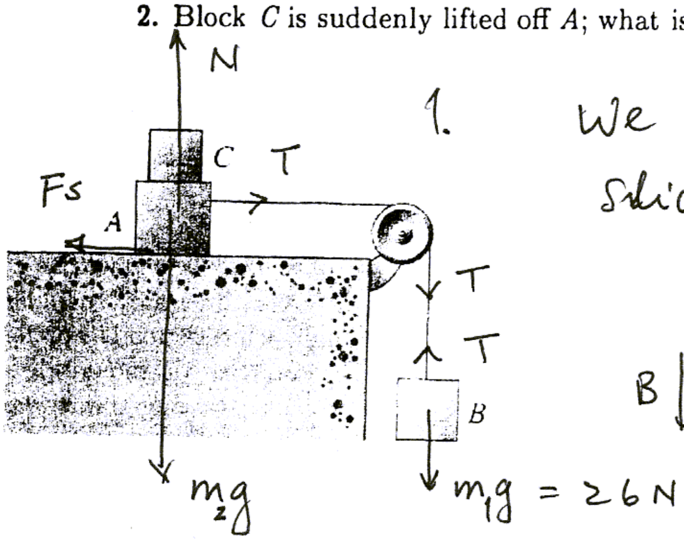
$$= 2625 \ \hat{x} \ N$$

Problem 2 :

A is a 4.4 kg block and B is a 2.6 kg block. The coefficients of static and kinetic friction between A and the table are 0.18 and 0.15 respectively.

1. Determine the minimum mass of block C that must be placed on A to keep it from sliding.

2. Block C is suddenly lifted off A; what is the acceleration of block A ?



$m_2 = (4.4 + m_c)$

1. We want block A not to slide $\Rightarrow$ static friction

system is not moving.

B $\downarrow$ $\quad m_1g - T = 0$

$T = m_1g = 26\ N$

$\uparrow$ A $\quad N - m_2g = 0$

$N = m_2g$

Consider the case when block A is about to move;

$F_{s,max} = \mu_s \cdot N$

$= \mu_s \cdot m_2g$

$\xrightarrow{\quad}$ A $\quad T - F_{s,max} = 0 \Rightarrow F_{s,max} = T$

if not to slide $F_{s,max} > T$

$\mu_s \cdot m_2g > m_1g$

Problem #2 cont:

Substitute numbers

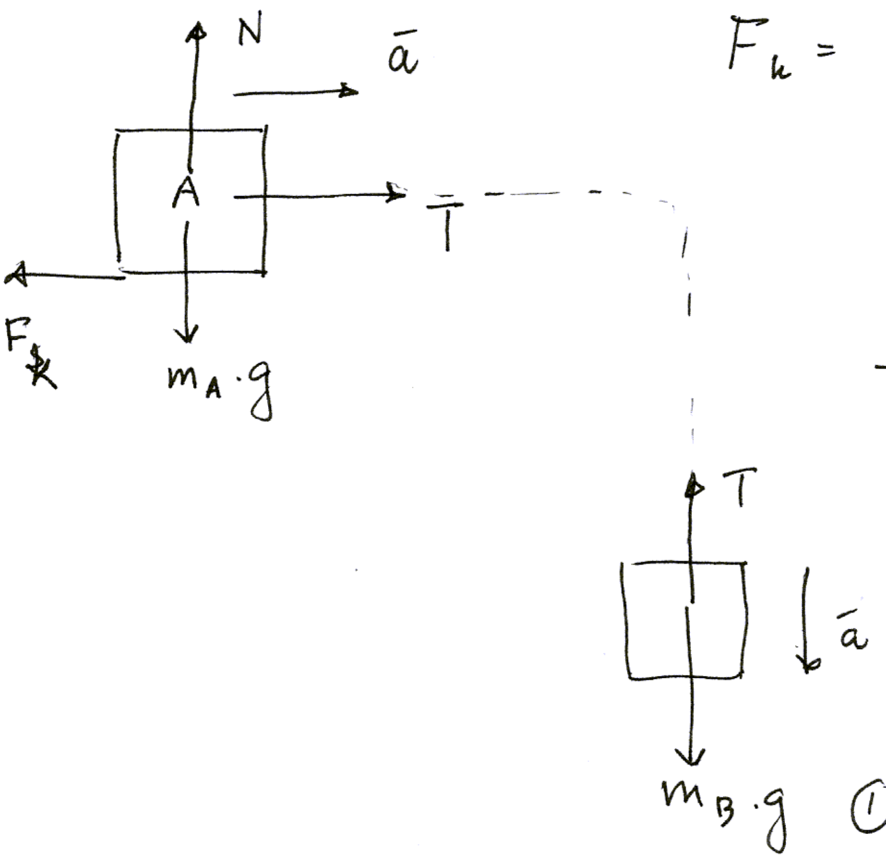
$\Rightarrow$

$$0.18\,(4.4 + m_c)\,g > 2.6\,g$$

$$0.18 \times m_c > 2.6 - 0.18 \times 4.4$$

$$\underline{\underline{m_c > 10.04 \text{ kg}}}$$

(2.) when C is lifted up the blocks are moving $\Rightarrow$ kinetic friction



$$F_k = \mu_k \cdot N = \mu_k m_A g$$

$\downarrow B$

$$m_B g - T = m_B a$$

$$T = m_B \cdot (g - a) \quad -①$$

$\overrightarrow{A}$

$$T - F_k = m_A \cdot a$$

$$T - \mu_k \cdot m_A g = m_A \cdot a$$

$$T = m_A a + \mu_k m_A \cdot g \quad -②$$

① ② $\Rightarrow$

$$m_B g - m_B a = m_A a + \mu_k m_A g$$

Problem #2 Continued

$$a(m_A + m_B) = m_B \cdot g - \mu_k \cdot m_A \cdot g$$

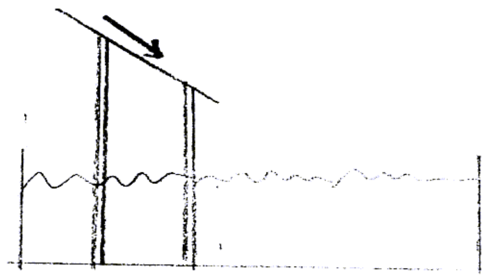
$$a = \frac{m_B g - \mu_k \cdot m_A g}{(m_A + m_B)}$$

Substitute numbers

$$a = \frac{26 - 0.15 \times 44}{(2.6 + 4.4)}$$

$$= 2.77 \ ms^{-2}$$

Problem 3: In an amusement park, fair-goers slide down a water slide and then plunge into the water, 2.5 m below the edge of the slide. If the slide is inclined at 30^0 from the horizontal, and it has a total length of 6.5 m, how far (measured horizontally) from the edge of the slide will people hit the water? (neglect friction and air resistance)



first consider motion on the slide, neglecting friction.

if the acceleration along slide is $\bar{a}$

$mg \cdot \sin(30^\circ) = ma$

$a = g \sin(30^\circ)$

$= 5 \ ms^{-2}$

$\sin(30) = 0.5$

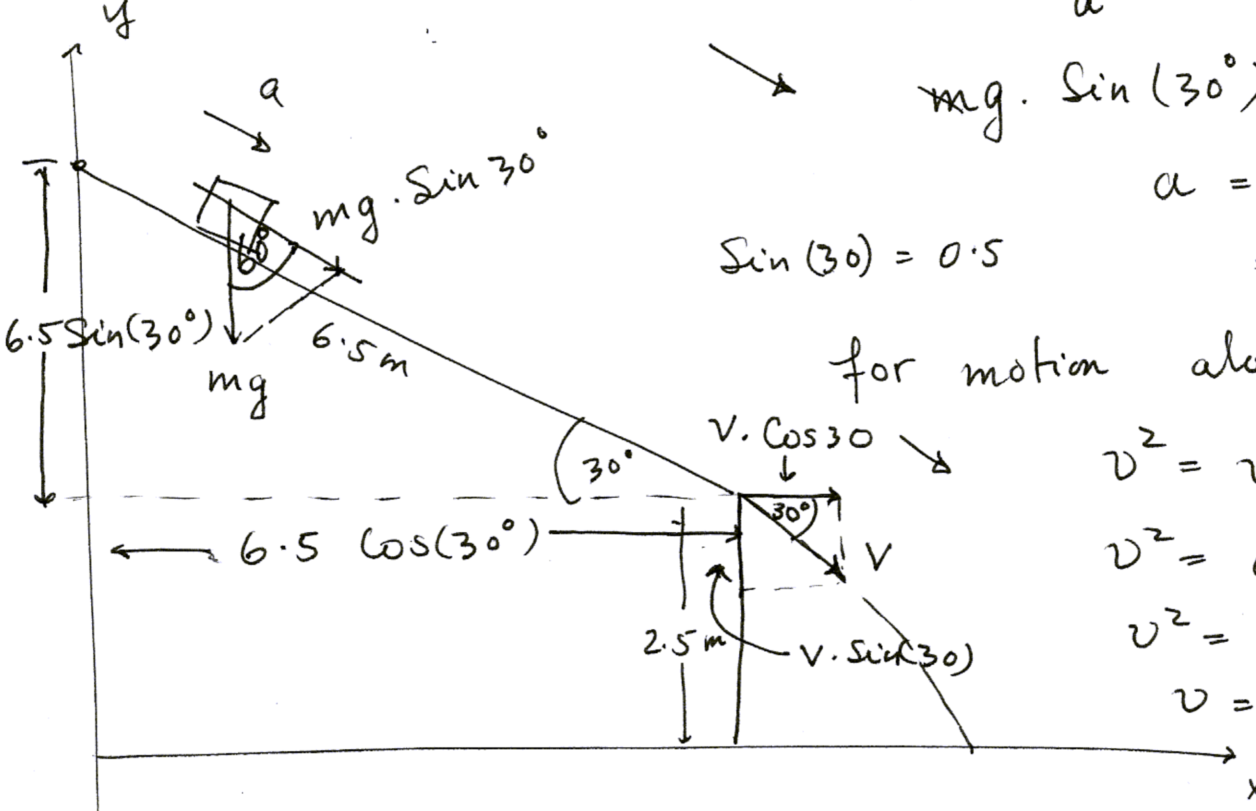
for motion along the slide

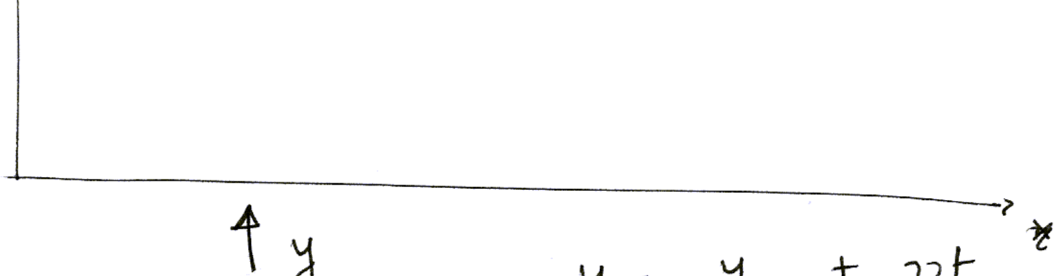
$v^2 = v_0^2 + 2a\Delta x$

$v^2 = 0 + 2.5 \cdot 6.5$

$v^2 = 65$

$v = 8.\text{~~06~~} \ ms^{-1}$





$v_y = -8.\text{~~06~~} \sin(30^\circ)$

$= -4 \ ms^{-1} \Rightarrow$

$y = y_0 + v_y t - \frac{1}{2} g t^2$

$0 = 2.5 - 4t - \frac{1}{2} g t^2$

$t = 0.41 \ s$

Problem # 3 Continued

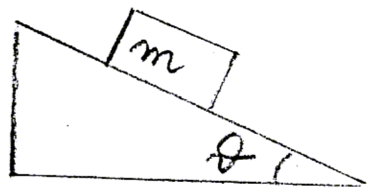
$$x = x_o + v_x t$$

$$x = 0 + v \cdot \cos(30^\circ) \cdot t$$

$$= 8 \cdot \cos 30 \cdot 0.41 \text{ m} = 2.84 \text{ m}$$

1. The block of mass m shown in the figure is at rest on an inclined plane that makes an angle θ with the horizontal. The normal force F acting on the block must be such that

   (a) $F > mg$
   (b) $F > mg \cos\theta$
   (c) $F > mg \sin\theta$
   → (d) $F = mg \cos\theta$
   (e) $F = mg \sin\theta$



2. A projectile is launched at an angle with an initial speed of 3.0 m/s. At the highest point in the trajectory (check all the statements that are true)

   (a) the velocity is zero
   (b) the horizontal component of the velocity is zero
   → (c) the vertical component of the velocity is zero
   → (d) the horizontal component of the acceleration is zero
   (e) the vertical component of the acceleration is zero

3. To move a heavy crate up a rough incline, a person pulls it with a rope and another pushes it from behind. If you were to draw the crate's free-body diagram, how many forces should you include?

   (a) 3
   (b) 4
   → (c) 5
   (d) 6
   (e) more than 6

4. As you drive around an unbanked bend (i.e. on a flat road) you hit a patch of ice. If you assume that the ice is practically frictionless, while on the ice the car's acceleration is

   (a) parallel to the tangent to the bend at the time you hit the ice
   (b) perpendicular to the tangent to the bend at the time you hit the ice
   (c) oriented somewhere between parallel and perpendicular
   (d) not enough information
   → (e) none of the above

5. A 1000-kg barge is being towed by means of two horizontal cables. One cable is pulling with a force of 80.0 N in a direction 30.0° west of north. The second cable pulls in a direction 20.0° east of north. What should the magnitude of its pulling force be so that the barge will accelerate northward?

   (a) 127 N
   (b) 120 N
   → (c) 117 N
   (d) 73.7 N
   (e) 58.5 N