Section instructor_____ ***Section number***_____

Last/First name A. Daylov

Last 3 Digits of Student ID Number: _____

Show all work. Show all formulas used for each problem prior to substitution of numbers. Label diagrams and include appropriate units for your answers. *You may use an alphanumeric calculator during the exam as long as you do not program any formulas into memory. By using an alphanumeric calculator you agree to allow us to check its memory during the exam. Simple scientific calculators are always OK!*

A Formula Sheet Is Attached To The Back Of This Examination

Be Prepared to Show your Student ID Card

Score on each problem:

1. *(30)* ____
2. *(20)* ____
3. *(20)* ____
4. *(20)* ____

Total Score (out of 90 pts) ____

1. Conceptual Questions

(30 point) Put a circle around the letter that you think is the best answer.

1.1. (6pts) A brick is resting on a rough incline as shown in the figure. The friction force acting on the brick, along the incline, is

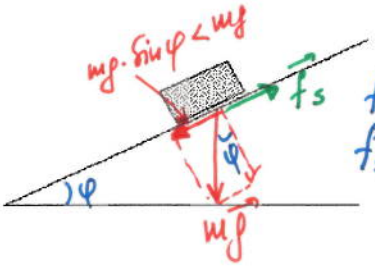
A) zero

B) equal to the weight of the brick

C) greater than the weight of the brick.

D) less than the weight of the brick

E) ω is positive and α is zero



$f_s = mg\sin\varphi < mg$

$f_s < mg$

1.2. (6pts) A box of weight 50 N is at rest on a floor where $\mu_s = 0.4$. A rope is attached to the box and pulled horizontally to the right with tension T = 10 N. Which way does the box move?

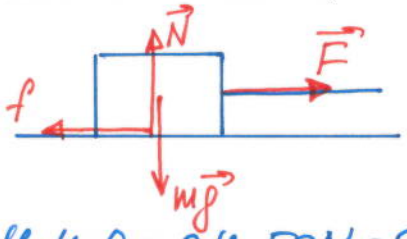
A) moves to the right

B) moves to the left

C) does not move

D) moves down

E) moves up



$(f_s)_{max} = \mu_s \cdot N = \mu_s \cdot mg = 0.4 \cdot 50N = 20N$

since $T < (f_s)_{max}$, the box will be at rest

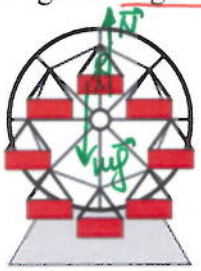
1.3.(6pts) A person of mass m is on a Ferris wheel moving in a vertical circle. A person weighing W=mg is sitting on one of the benches attached at the rim of the wheel. What is the apparent weight of the person as she/he passes through the highest point of the motion?

A) Equal to mg

B) Smaller than mg

C) Larger than mg

D) None of the above



$mg - N = m\frac{v^2}{r}$ (top)

$N = mg - \frac{mv^2}{r} < mg$

1.4. (6pts) A mosquito runs head-on into a truck. Which is true during the collision?

A) The magnitude of the truck's acceleration is larger than that of the mosquito.

B) The magnitude of the mosquito's acceleration is larger than that of the truck.

C) The magnitude of the mosquito's acceleration is the same as that of the truck.

D) The truck accelerates but the mosquito does not.

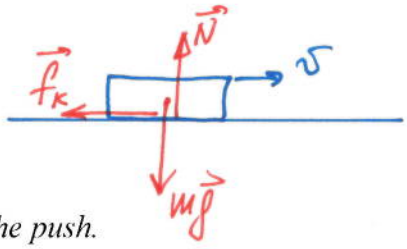
E) The mosquito accelerates but the truck does not.

$M_T > M_M$

$F_{MT} = F_{TM} = F$ (N. 3rd law)

$a_M = \frac{F}{M_M} > a_T = \frac{F}{M_T}$ (N. 2nd law)

1.5. (6pts) A bobsledder pushes her sled across horizontal snow to get it going, then jumps in. After she jumps in, the sled gradually slows to a halt. What forces act on the sled just after she's jumped in?



A) Gravity and kinetic friction

B) Gravity and a normal force.

C) Gravity and the force of the push.

D) Gravity, a normal force, kinetic friction, and the force of the push.

E) Gravity, a normal force, and kinetic friction.

Problem 2. (20 pts)

a) At what minimum speed must a roller coaster be traveling when upside down at the top of a circle so that a passenger does not fall out?
Assume a radius of curvature of 7.6 m.

b) If the speed at the bottom of a circle is 10.0 m/s, find an apparent weight of the passenger. Assume a mass of the passenger is 50 kg.

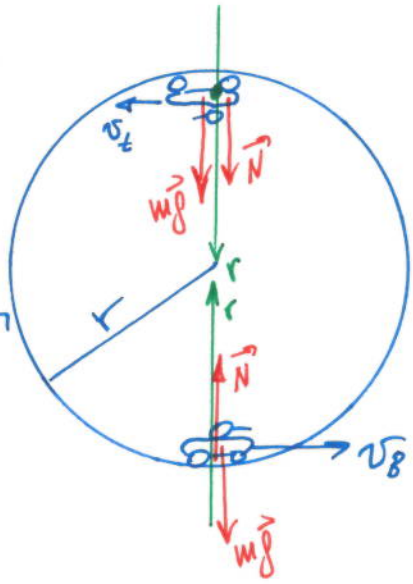
a) $\sum F_r = ma_r$ (top)

$mg + N = m\frac{v_t^2}{r}$

$v_t = \sqrt{\frac{r}{m}(mg+N)}$

when $N=0 \Rightarrow v_{min} = \sqrt{g \cdot r} = \sqrt{9.8\,m/s^2 \cdot 7.6\,m}$

$v_{min} = 8.6\ m/s$



b) bottom $\sum F_r = ma_r$

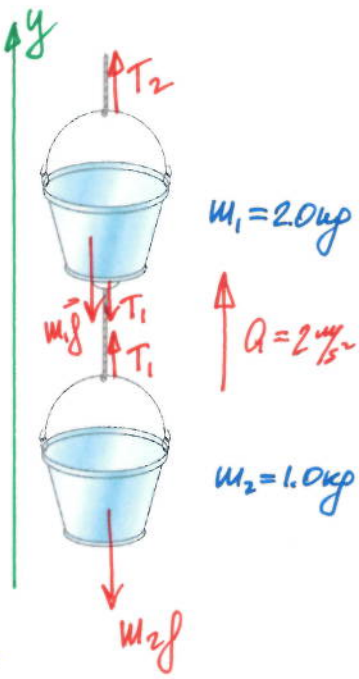
$N - mg = m \cdot \frac{v_6^2}{r}$

$N = mg + \frac{mv_6^2}{r} = m\left(g + \frac{v_6^2}{r}\right) = 50kg \cdot \left(9.8\,m/s^2 + \frac{(10.0\,m/s)^2}{7.6\,m}\right) = 1147.9N$

$N \approx 1148N$

Problem 3. (20 pts)

One 1.0-kg paint bucket is hanging by a massless cord from another 2.0-kg paint bucket, also hanging by a massless cord, as shown in the figure. If the two buckets are pulled upward with an acceleration of 2.0 m/s^2 by the upper cord, calculate the tension in each cord.



N. 2nd law:

$(m_2) \Rightarrow \sum_i F_2 = m_2 a \Rightarrow T_1 - m_2 g = m_2 a \quad (1)$

$(m_1) \Rightarrow \sum_i F_1 = m_1 a \Rightarrow T_2 - T_1 - m_1 g = m_1 a \quad (2)$

$(1) \Rightarrow T_1 = m_2(a+g)$ put it in (2)

$(2) \Rightarrow T_2 = m_1 a + m_1 g + T_1 = m_1(a+g) + m_2(a+g) =$

$T_2 = (m_1 + m_2)(a+g) = (2.0\,kg + 1.0\,kg)(2.0\,m/s^2 + 9.8\,m/s^2) = 35.4\,N$

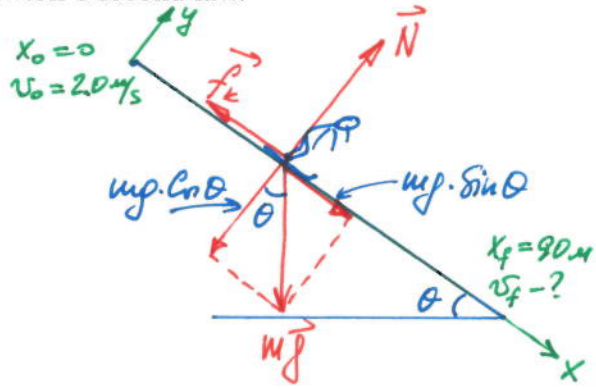
$T_1 = m_2(a+g) = 1.0\,kg \cdot (2.0\,m/s^2 + 9.8\,m/s^2) = 11.8\,N$

Problem 4 (20 pts).

A 100-kg skier has an initial velocity of 2.0 m/s at the top of a 30° incline. After sliding down the 90-m long incline (on which the coefficient of kinetic friction is $\mu_k = 0.15$), the skier has attained a final velocity v.

a) Find the skier's acceleration on the incline using Newton's second law.

b) Find the final velocity v.



a) $\sum \vec{F} = m\vec{a}$

(y) $\Rightarrow \sum F_y = ma_y^{\,0} \Rightarrow N = mg\cos\theta$, so

$f_k = \mu_k N = \mu_k \cdot mg\cos\theta$

(x) $\Rightarrow \sum F_x = ma_x \Rightarrow mg\sin\theta - f_k = ma$

$mg\sin\theta - \mu_k mg\cos\theta = ma$

$a = g(\sin\theta - \mu_k \cos\theta) = 9.8\ m/s^2 \cdot (\sin 30° - 0.15 \cdot \cos 30°) = 3.62\ m/s^2$

b) $v_f - ?$

$v_f^2 = v_0^2 + 2a(x_f - x_i^{\,0})$

$v_f = \sqrt{v_0^2 + 2ax_f} = \sqrt{(2.0\ m/s)^2 + 2 \cdot (3.62\ m/s^2) \cdot 90\ m} = 25.6\ m/s$