ÇANKAYA UNIVERSITY
PHYS 131 – PHYSICS I

CHAPTER VI
FORCE AND MOTION II
PROBLEM SET

1) A car can decelerate at $-3.80\ m/s^2$ without skidding when coming to rest on a level road. What would its deceleration be if the road is inclined at 9.3° and the car moves uphill? Assume the same static friction coefficient.

[Answer: $\boldsymbol{a = -5.3\ m/s^2}$, $\boldsymbol{\mu_s = 0.3878}$]

2) (*a*) Show that the minimum stopping distance for an automobile traveling at speed $\boldsymbol{v}$ is equal to $\boldsymbol{v^2/(2\mu_s g)}$ where μ_s is the coefficient of static friction between the tires and the road, and g is the acceleration of gravity. (*b*) What is this distance for a 1200-kg car traveling 95 km / h if $\mu_s = 0.65$? (*c*) What would it be if the car were on the Moon (the acceleration of gravity on the Moon is about $g/6$) but all else stayed the same? **[Answer: b) 55 m, c) 330 m]**

3) The crate shown in Fig. 5–33 lies on a plane tilted at an angle $\theta = 25.0^0$ to the horizontal, with $\mu_k = 0.19$ (*a*) Determine the acceleration of the crate as it slides down the plane. (*b*) If the crate starts from rest 8.15 m up the plane from its base, what will be the crate's speed when it reaches the bottom of the incline?

[Answer: a) $\mathbf{2.5\ m/s^2}$, b) 6.3 m/s]

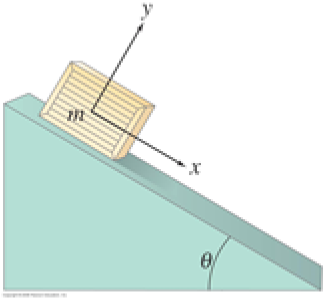


Fig. 5–33

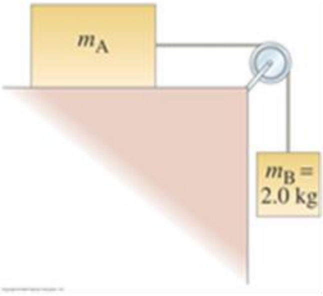
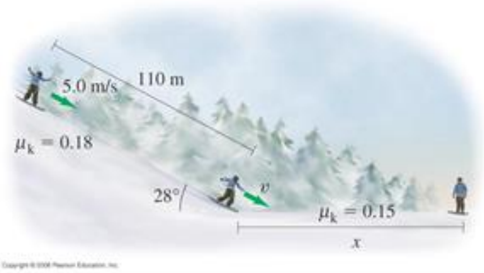
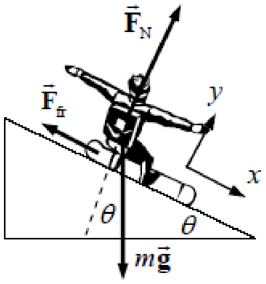


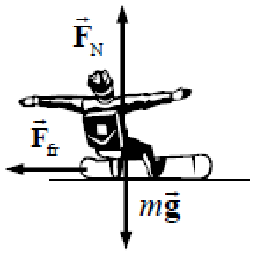
Fig. 5–35

4) In Fig. 5–35 the coefficient of static friction between mass m_A and the table is 0.40, whereas the coefficient of kinetic friction is 0.30 (*a*) What minimum value of m_A will keep the system from starting to move? (*b*) What value(s) of m_A will keep the system moving at constant speed? **[Answer: a) $\mathbf{m_A \geq 5.0\ kg}$, b) $\mathbf{m_A = 6.7\ kg}$]**

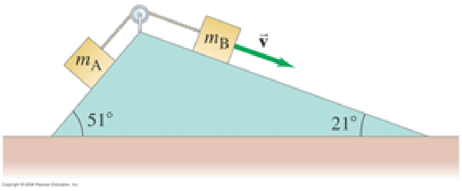
5) *** A 75-kg snowboarder has an initial velocity of 5.0 m / s at the top of a 28° incline (Fig. 5–36). After sliding down the 110-m long incline (on which the coefficient of kinetic friction is $\mu_k = 0.18$), the snowboarder has attained a velocity $\boldsymbol{v}$. The snowboarder then slides along a flat surface (on which $\mu_k = 0.15$) and comes to rest after a distance *x*. Use Newton's second law to find the snowboarder's acceleration while on the incline and while on the flat surface. Then use these accelerations to determine *x*. **[Answer: $\mathbf{a_{slope} = 3.0\ m/s^2, a_{flat} = -1.5\ m/s^2, x = 240\ m}$]**

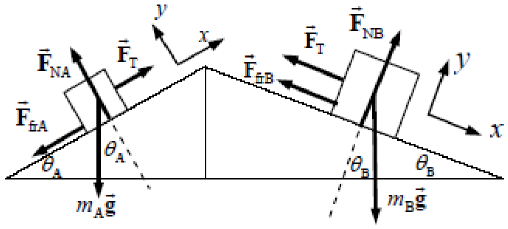






6) Two masses $m_A = 2.0$ kg and $m_B = 5.0$ kg are on inclines and are connected together by a string as shown in Fig. 5–37. The coefficient of kinetic friction between each mass and its incline is $\mu_k = 0.30$. If m_A moves up, and m_B moves down, determine their acceleration. **[Answer: $\mathbf{-2.2\ m/s^2}$]**

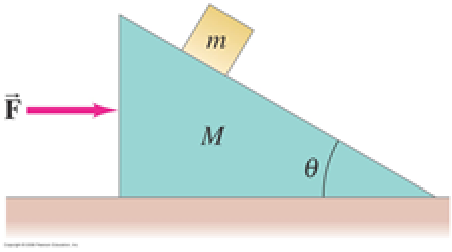


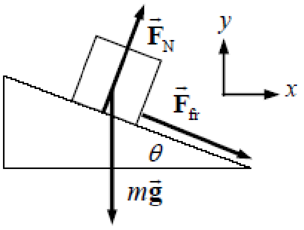


7) *** A small block of mass *m* rests on the rough, sloping side of a triangular block of mass *M* which itself rests on a horizontal frictionless table as shown in Fig. 5–41. If the coefficient of static friction is μ , determine the minimum horizontal force *F* applied to *M* that will cause the small block *m* to start moving up the incline.

[Answer:

$$(M+m)\,g\,\frac{(\sin\theta+\mu\cos\theta)}{(\cos\theta-\mu\sin\theta)}$$ **]**





8) *** Two blocks, with masses m_A and m_B, are connected to each other and to a central post by cords as shown in Fig. 5–46. They rotate about the post at frequency f (revolutions per second) on a frictionless horizontal surface at distances r_A and r_B from the post. Derive an algebraic expression for the tension in each segment of the cord (assumed massless).

[Answer:

$$F_{TB} = m_B v_B^2 / r_B = m_B (2\pi r_B f)^2 / r_B = \boxed{4\pi^2 m_B r_B f^2}$$

$$F_{TA} = F_{TB} + m_A v_A^2 / r_A = 4\pi m_B r_B f^2 + m_A (2\pi r_A f)^2 / r_A = \boxed{4\pi^2 f^2 (m_A r_A + m_B r_B)}$$

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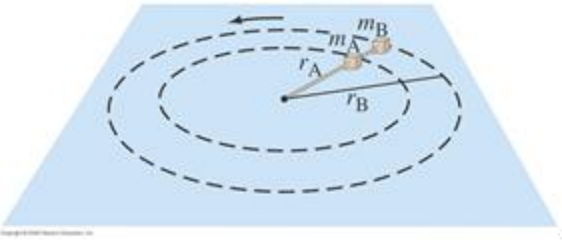

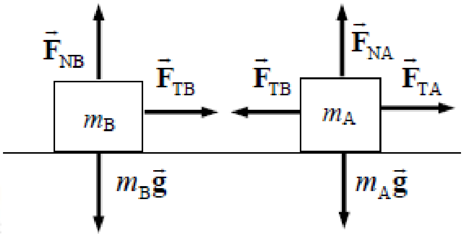

9) The terminal velocity of a $3 \times 10^{-5}\ kg$ raindrop is about 9 m / s. Assuming a drag force $\boldsymbol{F_D = -bv}$, determine (*a*) the value of the constant *b* and (*b*) the time required for such a drop, starting from rest, to reach 63% of terminal velocity.

[Answer: a) $3,27 \times 10^{-5}$ kg/s, b) 0,917 s]

10) A 72-kg water skier is being accelerated by a ski boat on a flat ("glassy") lake. The coefficient of kinetic friction between the skier's skis and the water surface is $\mu_k = 0.25$ (Fig. 5–55). (*a*) What is the skier's acceleration if the rope pulling the skier behind the boat applies a horizontal tension force of magnitude $F_T = 240\ \text{N}$ to the skier ($\theta = 0^0$) (*b*) What is the skier's horizontal acceleration if the rope pulling the skier exerts a force of $F_T = 240\ \text{N}$ on the skier at an upward angle $\theta = 12^0$ (*c*) Explain why the skier's acceleration in part (*b*) is greater than that in part (*a*).

[Answer: a) 0.88 m/s^2, b) 0.98 m/s^2, c) upward tilt of the tow rope reduces the normal force, which then reduces the friction. The reduction in friction is greater than the reduction in horizontal applied force, and so the horizontal acceleration increases.**]**