Study Guide 2 for Algebra-Based Physics-1: Mechanics (PHYS135A-01)

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1 Equations

- Newton's First Law: $\vec{F}_{Net} = 0$ if $\vec{v}$ is constant. Newton's Second Law: $\vec{F}_{Net} = m\vec{a}$. Newton's Third Law: $\vec{F}_{AB} = -\vec{F}_{BA}$.
- Normal force: $\vec{N} = +mg\hat{y}$, if weight is $w = -mg\hat{y}$ (flat surface).
- Force of Friction: $\vec{F} = -\mu\vec{N}$ (minus sign: opposes motion).
- Static versus kinetic friction: $\mu_s \geq \mu_k$.

2 Newton's Laws

1. An swimmer sinks at constant velocity to the bottom of the ocean near the shore. The swimmer has a weight force downwards. In which direction is there another force on the swimmer?
    - A: Upwards.
    - B: Downwards.
    - C: Towards the shore.
    - D: Away from shore.
2. A soccer player in training begins to sprint down the field. She has a mass m, is wearing a harness than has mass M, and has acceleration a. If she exerts constant force through her cleats on the turf, and drops the harness, which of the following is true?
    - A: Her new acceleration will be less than a.
    - B: Her new acceleration will be greater than a.
    - C: Her new acceleration will be equal to a.
    - D: Her new acceleration will be 0.
3. Consider Fig. 1. Which of the following is true regarding the system in the diagram?
    - A: It has no net force.
    - B: It is accelerating to the left.
    - C: It is accelerating to the right.
    - D: It is accelerating downwards.

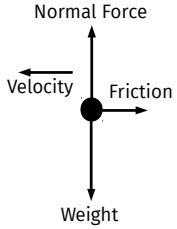

Figure 1: A free body diagram for a system.

4. Consider Fig. 1. Suppose the system reaches a point where there is no longer friction. Which of the following is true?
    - A: The system will move at a constant velocity.
    - B: The system will accelerate to the right.
    - C: The system will stop moving.
    - D: The system will accelerate to the left.
5. A 70 kg sprinter begins a run at rest and reaches 10 m/s in 3.0 seconds. What force does he exert on the track?

6. Consider Fig. 2, in which two children pull their friend on a sled resting on snow with forces $\vec{F_1}$ and $\vec{F_2}$. (a) What is the magnitude of the net force (no friction)? (b) If sled and the child on it have total mass 40 kg, what is the acceleration?

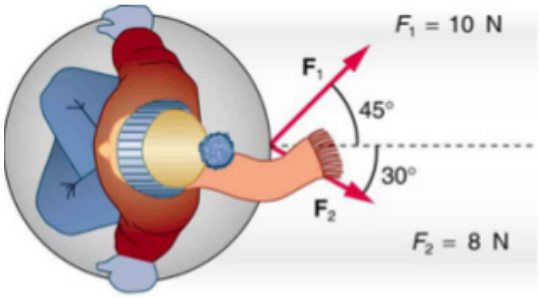

Figure 2: Two children pull a third on a sled.

7. A 20,000 kg jet pushes through the air with a forward force of 10^6 N, and faces air resistance equivalent to 5×10^4 N. What is the acceleration of the jet?

3 Friction and Drag

1. A woman drags a piece of luggage across a floor. If the mass of the luggage is 30 kg, and she exerts a force of 300 N, what is the coefficient of kinetic friction between the luggage and floor?

2. Consult Fig. 3. (a) What is the magnitude of the force of friction exerted on an oiled steel piston experiencing a normal force of 10 N from another steel surface? (b) What would the result have been if the steel had no oil?

Table 5.1 Coefficients of Static and Kinetic Friction

System	Static friction μ_s	Kinetic friction μ_k
Rubber on dry concrete	1.0	0.7
Rubber on wet concrete	0.7	0.5
Wood on wood	0.5	0.3
Waxed wood on wet snow	0.14	0.1
Metal on wood	0.5	0.3
Steel on steel (dry)	0.6	0.3
Steel on steel (oiled)	0.05	0.03
Teflon on steel	0.04	0.04
Bone lubricated by synovial fluid	0.016	0.015
Shoes on wood	0.9	0.7
Shoes on ice	0.1	0.05
Ice on ice	0.1	0.03
Steel on ice	0.4	0.02

Figure 3: (Left) Frictional coefficients for exercise 2, **Friction and Drag**.

3. Consult Fig. 4. Recall the lab in which we measured the coefficient of static friction, μ_s. If $\mu_s = 0.5$, and $m_2 = 200$ grams, what is the largest mass m_1 can be before the system begins to accelerate?

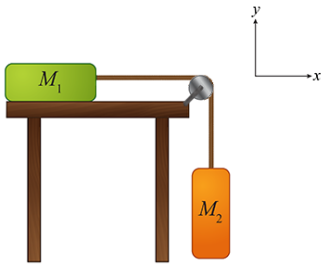

Figure 4: Diagram for exercise 3, **Friction and Drag**.

4. A system travels at a *terminal velocity* $v_T = \sqrt{2mg/C\rho A}$. (a) What is v_T for a falling system who with $m = 200$ kg, $A = 2$ m^2, $C \approx 0.4$, in air with $\rho_{air} = 1.225$ kg/m^3? (See section 5.3 of the textbook).