Mechanics 1

Warm-Up questions

Kinematics (Chapter 2.2)

i. Alice throws a ball vertically upwards. She wants the ball to reach the height of the school wall, which a classmate tells her is 7 m tall. Alice throws the ball from 1 m above the ground. We neglect all friction.

a) Alice throws the ball upwards with an initial velocity of 18 km/h. Does the ball reach the top of the school wall?

b) Which minimal initial velocity does the ball need to have so that it reaches the top of the school wall?

c) In this case, what would the final velocity of the ball upon impact with the ground?

ii. While Denis is using his salad spinner, he wonders at what speed the leaves are rotating at the perimeter of the salad spinner. The salad spinner has a diameter of 30 cm and completes 9 rotations in 2 s.

a) At what speed do the leaves rotate at the perimeter of the salad spinner?

b) What is their acceleration?

Upon opening the salad spinner, Denis discovers that there are more leaves at the perimeter of the spinner than before. However, Denis has learned in school that the acceleration vector is opposed to the position vector, and should therefore be pointing to the center.

c) Explain why the leaves have moved to the perimeter of the salad spinner.

Dynamics (Chapter 2.3)

iii. A wooden block is placed on a ramp. The coefficient of static friction is μ_s is 0.6 and the coefficient of kinetic friction is μ_k is 0.4. The block weighs 2 kg.

a) What is the maximal angle of inclination of the ramp so that the block doesn't slide down the ramp?

b) Assume the ramp is at the maximal angle of inclination calculated above. We lightly push the block. Describe the velocity of the block over time.

iv. Fred is driving 60 km/h along a country road. Suddenly, a deer crosses the road and Fred slows down. After 1.5 s, he is now driving at 10 km/h and the deer disappears. We know that the combined mass of Fred and the car are 800 kg. What is the average applied force during the deceleration?

v. We assume that the moon moves around the Earth in a circular orbit.

a) What is the velocity of the moon?

b) What is the period of revolution of the moon around the Earth?

Some useful information: the distance between the Earth and moon is 3.84×10^5 km and the mass of the Earth is 5.97×10^{24} kg.

Work and Energy (Chapter 2.4)

vi. Two balls are affixed to the ends of a long rod. The balls weigh 2 kg and 3 kg and the length of the rod is 1 m. We assume the mass of the rod is negligible. The rod rotates around its center of mass at a speed of 10 rotations per minute.

a) What is the rotational energy of the system?

b) What is the moment of inertia of the system?

c) What is the angular momentum of the system?

d) How do these quantities change if the rod rotates around its geometric center?