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PHY101 Assignment 1 Solution

Fall 2026

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PHY101 Assignment 1 Solution

Physics (PHY101) — Fall 2026 | Total Marks: 30 | Due Date: 9 November 2026

Question 1 - Forces on the sailboard (5 marks)

What forces govern the motion of the sailboard? Explain to the point as shown.



Forces on the sailboard:

• Wind force on the sail. The wind pushes the sail. The forward part of this force drives the board forward.

• Weight. Gravity pulls the board and the rider down.

• Buoyant force from the water. The water pushes up and balances the weight, so the board floats.

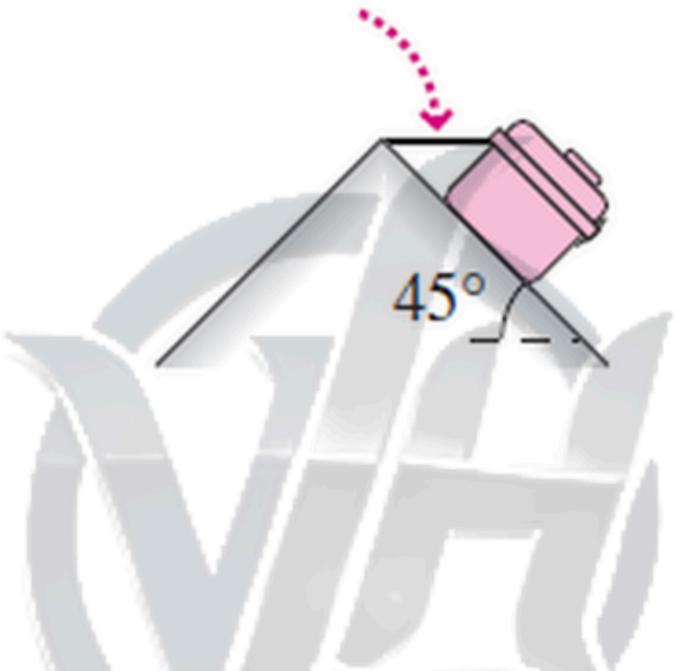
• Water drag. The water pushes back against the board and opposes the motion.

• Force from the rider. The rider holds the mast and stands on the board, so the wind force on the sail is passed to the board.

At the start the forward wind force is bigger than the drag, so the board speeds up. This is Newton's second law. As the speed grows the drag grows too. When the drag equals the forward wind force the net force is zero and the board moves at a steady speed. This is Newton's first law. The sideways part of the wind force is balanced by the board pushing against the water.

Question 2 - Roofer's toolbox on the roof (10 marks)

A roofer's toolbox rests on an essentially frictionless metal roof with a 45° slope, secured by a horizontal rope as shown. Is the rope tension (a) greater than, (b) less than, or (c) equal to the box's weight? Select the suitable choice and explain its Physics as well.



Answer: (c) equal to the box's weight.

The weight mg acts straight down. Along the slope, the part of the weight that pulls the box down the slope is mg sin 45°. The rope is horizontal. The part of the rope tension that pulls the box up the slope is T cos 45°. The roof is frictionless, so there is no friction force. The box is at rest, so the forces along the slope must balance. T cos 45° = mg sin 45°. Since sin 45° = cos 45° = 0.707, T = mg. The tension equals the box's weight. The normal force from the roof balances the parts of the weight and the tension that press into the roof. If the slope were less than 45°, the tension would be less than the weight. If it were more, the tension would be greater.

Question 3 - Car: acceleration and the bend (15 marks)

A 1150 kg car accelerates from rest to 15 m/s in 7 s, moving in a straight line with constant acceleration. (a) Find the net force acting on the car. (b) If the car then rounds a bend 80 m in radius at a steady 20 m/s, what net force acts on it? (c) Can you explain, how Newton's laws apply to the various forces in the accompanying figure.

(a) Net force while speeding up

Acceleration a = (v - u) / t = (15 - 0) / 7 = 2.14 m/s². Net force F = ma = 1150 × 2.14 = 2464 N.

The net force is about 2.46 × 10³ N in the direction of motion.

(b) Net force on the bend

On the bend the car needs a force toward the centre. F = mv² / r = 1150 × (20)² / 80 = 1150 × 400 / 80 = 5750 N. The net force is about 5.75 × 10³ N toward the centre of the bend. Friction between the tyres and the road provides this force.

(c) Newton's laws and the figure

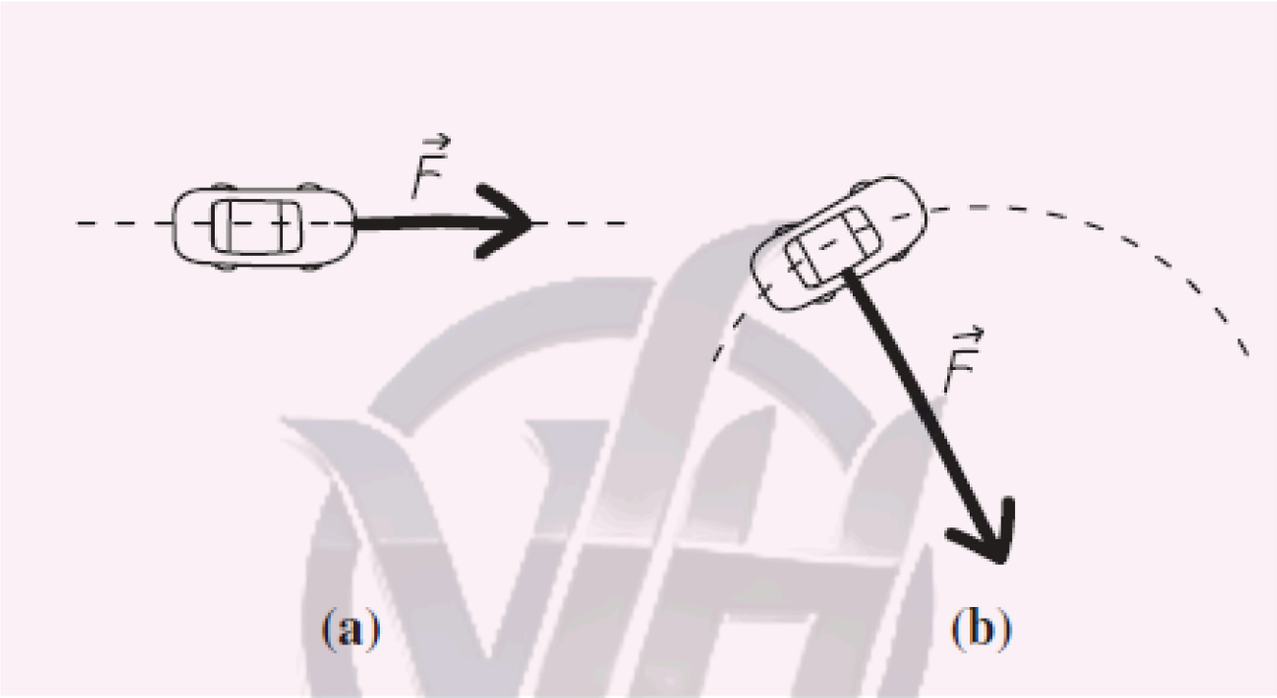


Figure (a): the car speeds up in a straight line. The net force F points forward. Newton's second law says F = ma, so the net force gives the acceleration. The forward force comes from the road pushing the tyres forward. By Newton's third law the tyres push the road backward and the road pushes the tyres forward with an equal force. Air resistance acts backward but it is smaller than the driving force while the car speeds up.

Figure (b): the car rounds the bend at a steady speed of 20 m/s. The speed is steady but the direction changes, so the velocity changes. That means there is an acceleration toward the centre of the bend. Newton's second law says a net force toward the centre is needed. Its size is F = mv² / r = 5750 N. Friction between the tyres and the road provides this force. By Newton's first law, without this force the car would keep going straight and leave the bend. The weight acts down and the normal force from the road acts up. They balance each other since there is no vertical motion. Newton's third law pairs: the road pushes the car toward the centre and the car pushes the road outward. The Earth pulls the car down and the car pulls the Earth up.