proprep™

# Workbook

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# D Alemberts Principle – Fictitious Forces

## Basic Explanation

### Questions

**1) Simple Fictitious Force in Elevator**

A man of mass 70 kg is standing on a scale in an elevator.
What value will the scale show, in the following situations:

a. The elevator is at rest.

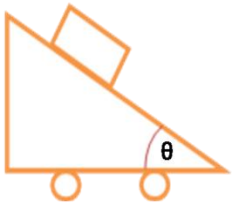
b. The elevator is moving at a constant velocity of $5\frac{\text{m}}{\text{s}}$.

c. The elevator is accelerating upwards with an acceleration of $5\frac{\text{m}}{\text{s}^2}$.

d. The elevator is accelerating downwards with an acceleration of $5\frac{\text{m}}{\text{s}^2}$.

**2) Triangular Car**

A Triangular Car has angle $\theta$ at its front. On the car a mass $M$ is placed.
Between the car and the mass there is frictional force.
We are told that $\sin\theta = 0.6$ and that $\mu_k = \mu_s = 0.2$.




a. What is the condition on the acceleration, $a$, such that the mass, $M$, won't slip downwards?

b. We are now told that $a = 0.2\text{g}$.
Calculate the acceleration of the mass in the car's frame of reference.

c. Calculate the acceleration of the mass in the lab's frame of reference.

d. We are now told that the car is travelling to the left.
What must be the car's acceleration leftwards, such that the mass will detach from the car?

### Answer Key

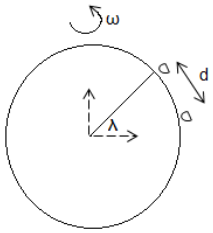
**1)** a. $700N$ b. $700N$ c. $1050N$ d. $N = 350N$

**2)** a. $a \geq 0.48\text{g}$ b. $a_x' = 0.2569\text{g}$ c. $a_x = 0.4g,\ a_y = 0.15\text{g}$ d. $a = 1.33\text{g}$

# Coriolis and Centrifugal Forces

## Questions

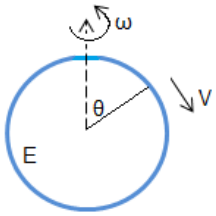
**1) A Ship Firing a Shell.**




Ship A, sailing at latitude $\lambda$, fires a shell at a velocity of $v$ towards ship B, which is sailing at a distance of $d$ South of Ship A.
Find the deviation of the position of the shell caused by the Coriolis Force.
Disregard the effect of the force on the East-West velocity of the shell and on the orthogonal velocity, relative to Earth.

Assume that the shell is moving in a straight line and disregard the ballistic trajectory of the shell. The velocity of the earth's rotation is $\omega$.

**2) River.**




A river is flowing with velocity $v$ from north to south.
The position of the river is $\theta$, relative to Earth's axis of rotation.
Earth's radius is $R$ and the width of the river is $D$.
Earth's angular velocity is $\omega = 2\pi / 24$.
Find the height difference between the banks of the river.

## Answer Key

**1)** $z = \dfrac{\omega d^2}{v} \sin\lambda$

**2)** $\tan\varphi = \dfrac{2mv\omega\cos\theta}{-mg + m\omega^2 R_E \sin^2\theta}$