

Workbook



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D Alemberts Principle – Fictitious Forces

Basic Explanation

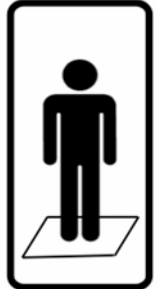
Questions

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:

- The elevator is at rest.
- The elevator is moving at a constant velocity of $5 \frac{\text{m}}{\text{s}}$.
- The elevator is accelerating upwards with an acceleration of $5 \frac{\text{m}}{\text{s}^2}$.
- The elevator is accelerating downwards with an acceleration of $5 \frac{\text{m}}{\text{s}^2}$.



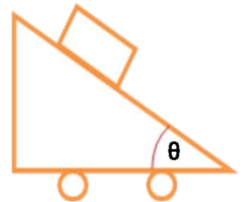
2) Triangular Car

A Triangular Car has angle θ 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 $\mu_k = \mu_s = 0.2$.

- What is the condition on the acceleration, a , such that the mass, M , won't slip downwards?
- We are now told that $a = 0.2g$.
Calculate the acceleration of the mass in the car's frame of reference.
- Calculate the acceleration of the mass in the lab's frame of reference.
- 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

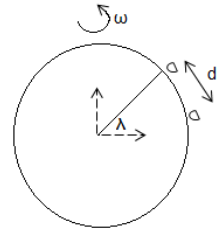
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|----------------------|--------------------|------------------------------|----------------|
| 1) a. $700N$ | b. $700N$ | c. $1050N$ | d. $N = 350N$ |
| 2) a. $a \geq 0.48g$ | b. $a_x = 0.2569g$ | c. $a_x = 0.4g, a_y = 0.15g$ | d. $a = 1.33g$ |

Coriolis and Centrifugal Forces

Questions

1) A Ship Firing a Shell.

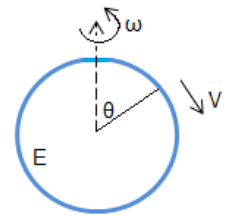
Ship A, sailing at latitude λ , fires a shell at a velocity of v towards ship B, which is sailing at a distance of d South of Ship A. Find the deviation of the position of the shell caused by the Coriolis Force. Disregard the effect of the force on the East-West velocity of the shell and on the orthogonal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

2) River.

A river is flowing with velocity v from north to south. The position of the river is θ , 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)
$$z = \frac{\omega d^2}{v} \sin \lambda$$

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