GADJAH MADA UNIVERSITY
FACULTY OF ENGINEERING
DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

INTERNATIONAL UNDERGRADUATE PROGRAM IN CIVIL ENGINEERING

ACADEMIC YEAR 2024/2025

Basic Physics Mid-term Exam

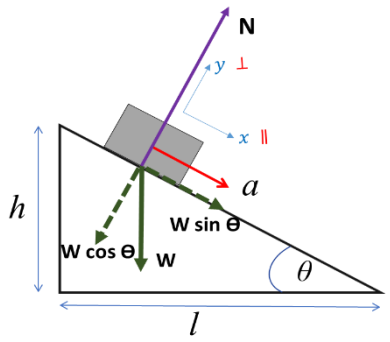
Date	: Monday, 7 October 2024
Time	: 120 minutes (2 hours)
Rule	: Open cheat sheet (1 A4 double-sided, handwritten), Calculator use allowed (not Smartphone calculator)

Questions

1. (Proportion 25%, SO a.1, a.2, a.3)

a) A car moves with an equation $x = 4t^3 + B\ t^2 + 1\ (x\ in\ meter)$. If when t= 5 second the car moves at a speed $(v) = 150\ m/s$, what is the car's speed (v) and acceleration (a) at the time of $t = 12$ second?

b) An object is placed on a rough surface with a slope (see Figure below). The object begins to slide at an angle θ with an acceleration a (parallel to the surface).

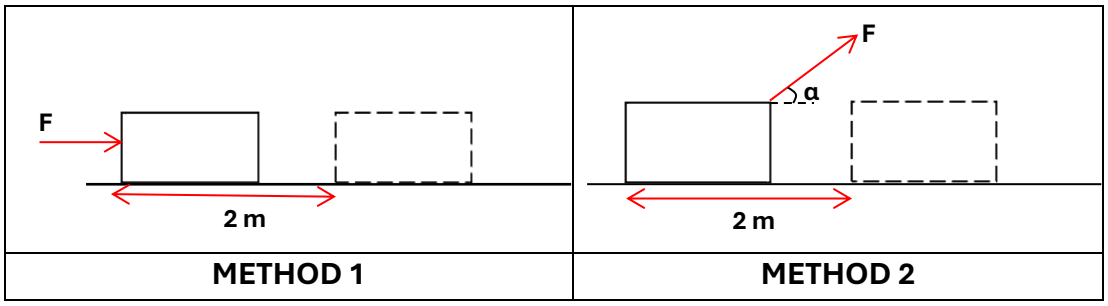


State which Newton's law (I/II/III) applies and why/in what condition that law applies. Then, prove that:

$$\mu_k = \frac{g\ \sin\theta - a}{g\ \cos\theta}$$

2. (Proportion 25%, SO a.1, a.2, a.3)

a) A worker is going to move a 100 kg box over a distance of 2 meters. There are two method options as follows:



With which method will the worker exert less Work? Why?

b) A box with a mass of 5 kg moves down a sloped path to the right, starting from a height of 5 m above the ground. The box reaches the ground with a kinetic energy of 50 J. What is the total work done by friction as the box moves along the sloped path?

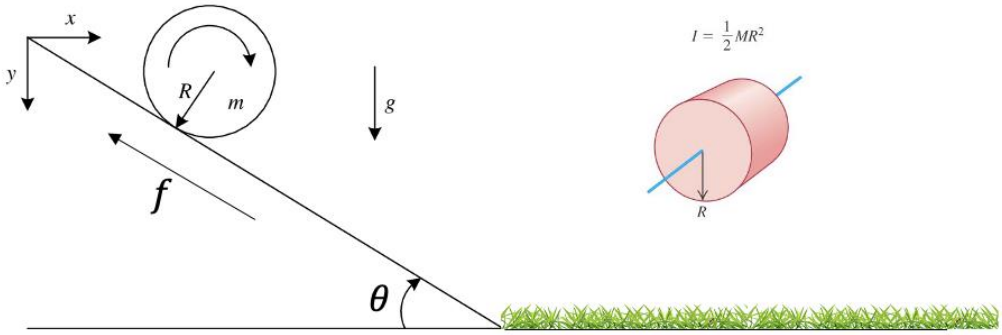
c) The box in question 2b) continues to move to the right without friction on the ground surface until it eventually hits a tree and comes to a stop. What is the magnitude of the change in momentum that occurs? What type of collision is this called?

3. (Proportion 25%, SO a.1, a.3)

A solid cylinder with a mass of $m = 3\,kg$ and a radius of $r = 0.15$ is released from rest at the top of an inclined plane that forms an angle of $\theta = 25°$ with the horizontal (see Figure below). The inclined plane is 5 m long, and its surface is rough enough so that the cylinder rolls without slipping. At the bottom of the inclined plane, the cylinder moves onto a horizontal grassy surface and eventually stops due to friction. Calculate the following:

a) cylinder speed when it reaches the bottom of the inclined plane!
b) the distance d that the cylinder travels on the horizontal surface before stopping!

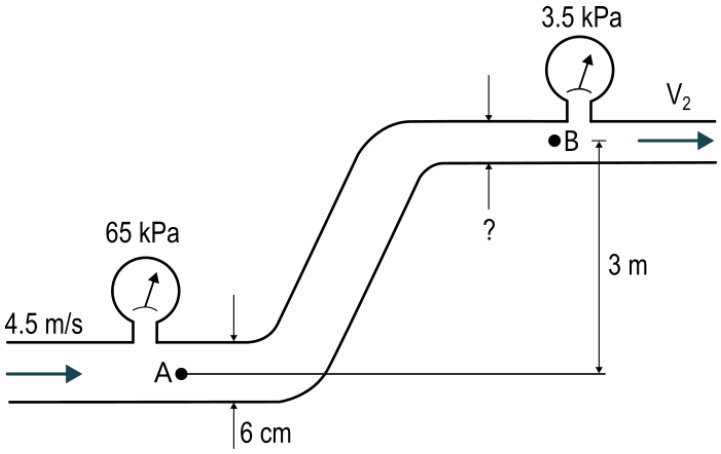
Note: Solid cylinder moment of inertia = 1/2 MR^2. Assume no energy is lost due to friction.



Grass, friction coefficient (μ) = 0.05

4. (Proportion 25%, SO a.1, a.3)

An irrigation pipe flows water as shown in the figure below. The water velocity through the lower pipe (point A) is 4.5 m/s with a pressure of 65 kPa. What is the diameter of the upper pipe (point B) required to maintain the pressure at point B at 3.5 kPa?



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