INFOMGP - GAME PHYSICS

EXERCISES LECTURE 1-2-3

EXERCISE 1.1

Suppose you are programming a 2D game in which the main character jumps into a vehicle with constant velocity of 30 km/h in the x-direction. The vehicle is at position $(10\ m\ , 20\ m)$ at frame t. Where will be the vehicle at the next frame if the frame rate is 60 FPS?

EXERCISE 1.2

Suppose a NPC police officer steps up a speed trap on a straight section of a road. He times the player who covered 400 meters in 14 seconds. If the speed limit on that section is 90 km/h, will the player have a ticket?

EXERCISE 1.3

Suppose the player's car is going at 60 km/h and 5 seconds later it is going at 70 km/h? What is its acceleration?

EXERCISE 1.4

Suppose the player is driving a car and suddenly has to break. He is going at 60 km/h and the car can decelerate at a rate of $-5.55\ m/s^2$. How much time does the player need to stop?

EXERCISE 1.5

Same situation but we want to know if the player will hit a car that is 20 meters in front.

EXERCISE 1.6

Suppose a player wants to launch birds from a catapult. The player catapults them at a speed of 20 m/s at a 30 degree angle. How much time will it take a bird to come back down to the ground?

EXERCISE 1.7

Same situation but we want to know how much time it will take to hit a pig 30 meters away.

EXERCISE 1.8

Same situation but we want to know how far away the bird will hit the ground.

EXERCISE 1.9

In a platform game, the player can run off an edge to land on a lower platform. If the player runs at 10 m/s from an 8 meter high platform, how far away will he land on the ground?

EXERCISE 1.10

Suppose a ball weighting 1.5 kg is rolling down a ramp which is positioned at a 30 degree incline. What it the normal force of the ramp?

EXERCISE 1.11

Suppose you are programming a racing game with a car weighting 1 T. What are the static and kinetic friction forces between the rubber tires and the dry concrete flat road?

EXERCISE 1.12

Suppose a game character is pulling a ball across a field. Initially the ball is sitting still at the origin $(0, 0)$ and its mass is 5 kg. The player pulls with a constant force of 400 N at an angle of 30 degrees with the x-direction of the field. The coefficient of kinetic friction is 0.25. Where the ball will be after respectively 1, 2 and 3 seconds?

EXERCISE 1.13

Imagine the player can shoot cannon balls to his opponent. At some point on its trajectory the ball speed is 100 km/h (that's high) and the ball has a radius of 10 cm. The density of air is 1.2 kg/m^3 and the drag coefficient of the ball is 0.47. What is the drag force opposing the motion of the ball?

EXERCISE 1.14

Suppose a game character of volume 0.1 m^3 and weighting 80 kg. What density of fluid is necessary for the character to float?

EXERCISE 1.15

Suppose a game character throws a ball with a force of 400 N on a distance of 0.75 meter. The ball has a mass of 145 g. What speed will the ball have when the character lets go of it?

EXERCISE 1.16

In a roller coaster game, the cart starts at a height of 100 meters and goes down at the bottom of the first slope. The mass of the cart and the player in it is 200 kg. During the descent, 2000 Joules of energy are lost in heat and sound. How fast the cart goes at the bottom of the slope?

EXERCISE 1.17

In a golf game, the player defines the impulse force applied to the ball. Suppose the mass of the ball is 45 g and the player input an impulse of $\binom{3}{2}$. What is the ball velocity?

EXERCISE 1.18

Suppose you want to program a game based on the Wheel of Fortune game. If the player gives the wheel an initial angular velocity of 8 rad/s, and the pegs decelerate it at a rate of 2 rad/s^2, what is its angular displacement after 3 seconds?

EXERCISE 1.19

Same situation but it takes 10 seconds to the wheel to stop. The wheel has a 3 meter radius. What is the wheel's tangential acceleration?

EXERCISE 1.20

In a racing game the player's car get hit by an opponent. The mass of the player's car is 1.2 T, the impact is at a distance of 3 meters from the COM in a direction perpendicular to the motion. The effect is that the player's car rotates with an angular acceleration of 0.5 rad/s^2. What is the torque of the collision?

EXERCISE 1.21

Imagine a blue hedgehog rolling down a 10 meter high hill with a mass m. Its inertia is given by $\frac{2}{5}mr^2$. What is its translational speed at the bottom of the hill?