Animation Foundations

Introduction

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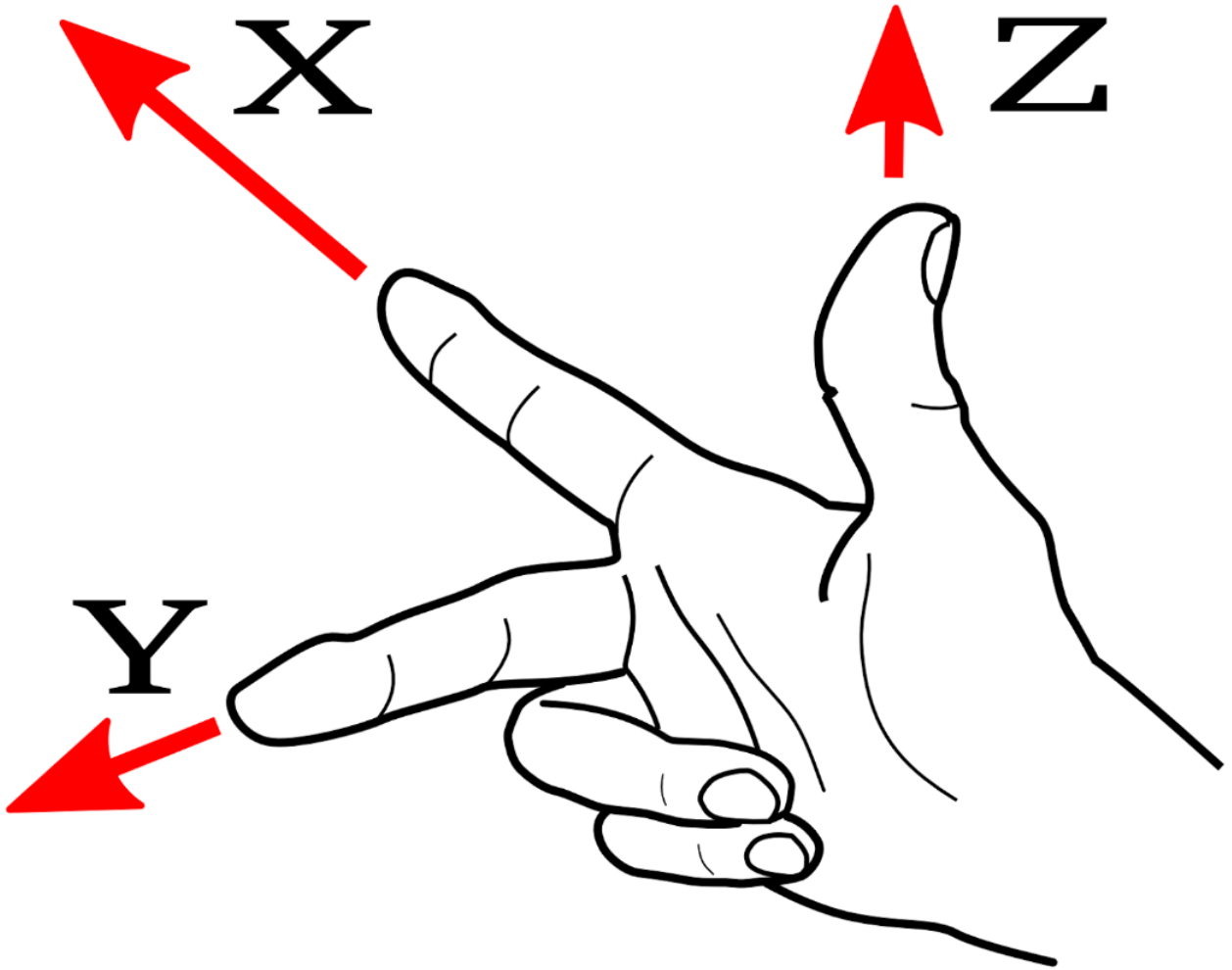
Outline

1. Basic Vocabulary
2. Physics Examples
3. Character Animation examples
4. Both combined

1. Basic Vocabulary

1. Direct Kinematics
2. Inverse Kinematics
3. Differential equation
4. Analytic Formula
5. Direct Dynamics
6. Inverse Dynamics
7. Constraints
8. Centre of mass
9. Inertia
10. Angular Momentum
11. Rigid Body
12. Particle



2. Physics Example: drop an object

Drop an object

1. analyse the system
2. write the equation of the system
3. find (or simulate) a solution

Should we consider?

Linear drag: $\vec{F}_d = C_d\ \vec{v}$, with C_d constant

Quadratic drag: $F_d = \frac{1}{2}\rho\ v^2 A\ C_d$

Terminal Velocity

$$v_t = \sqrt{\frac{2\ m\ g}{c_d \rho A}}$$

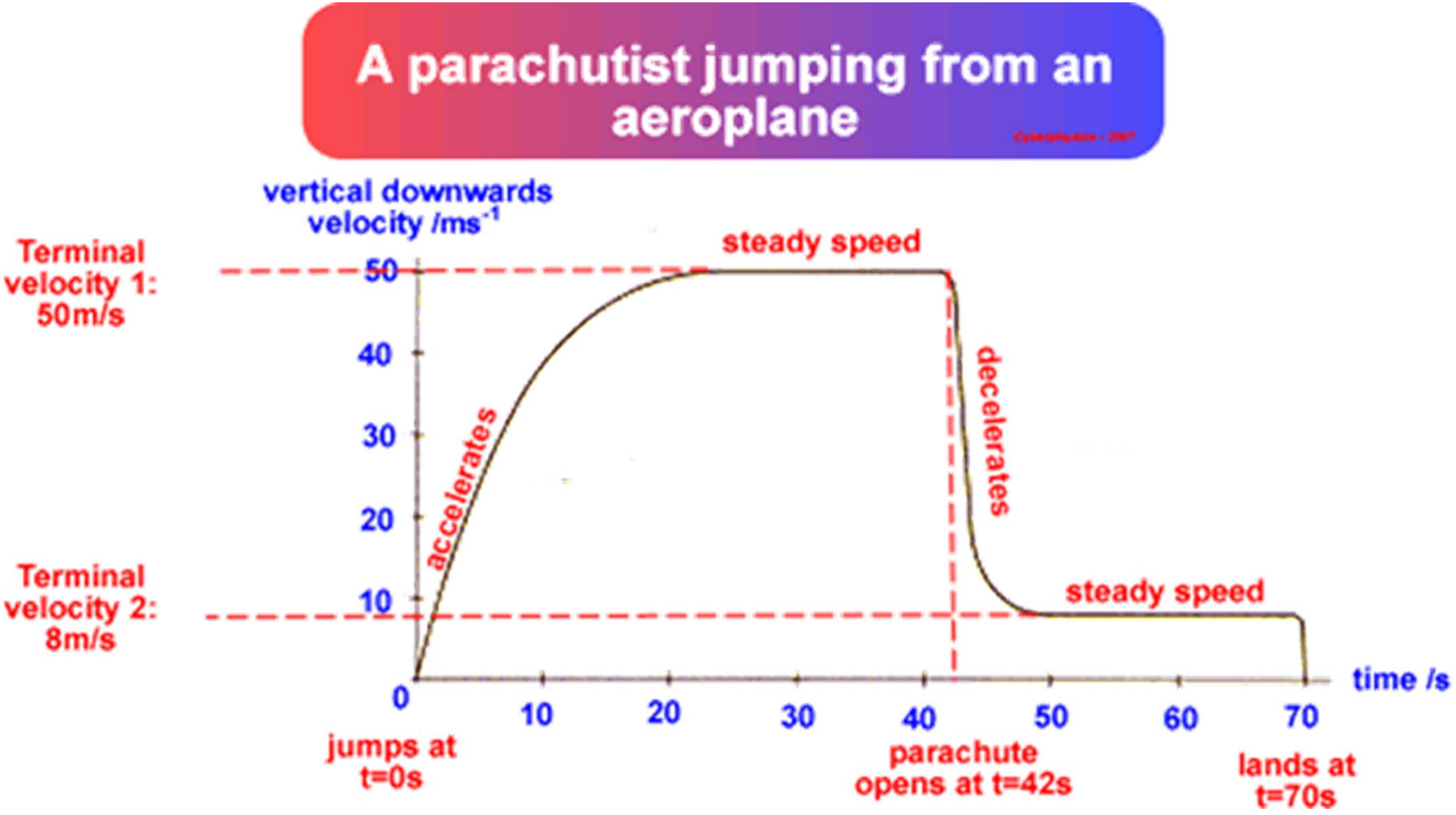
ρ density of the fluid

A projected area

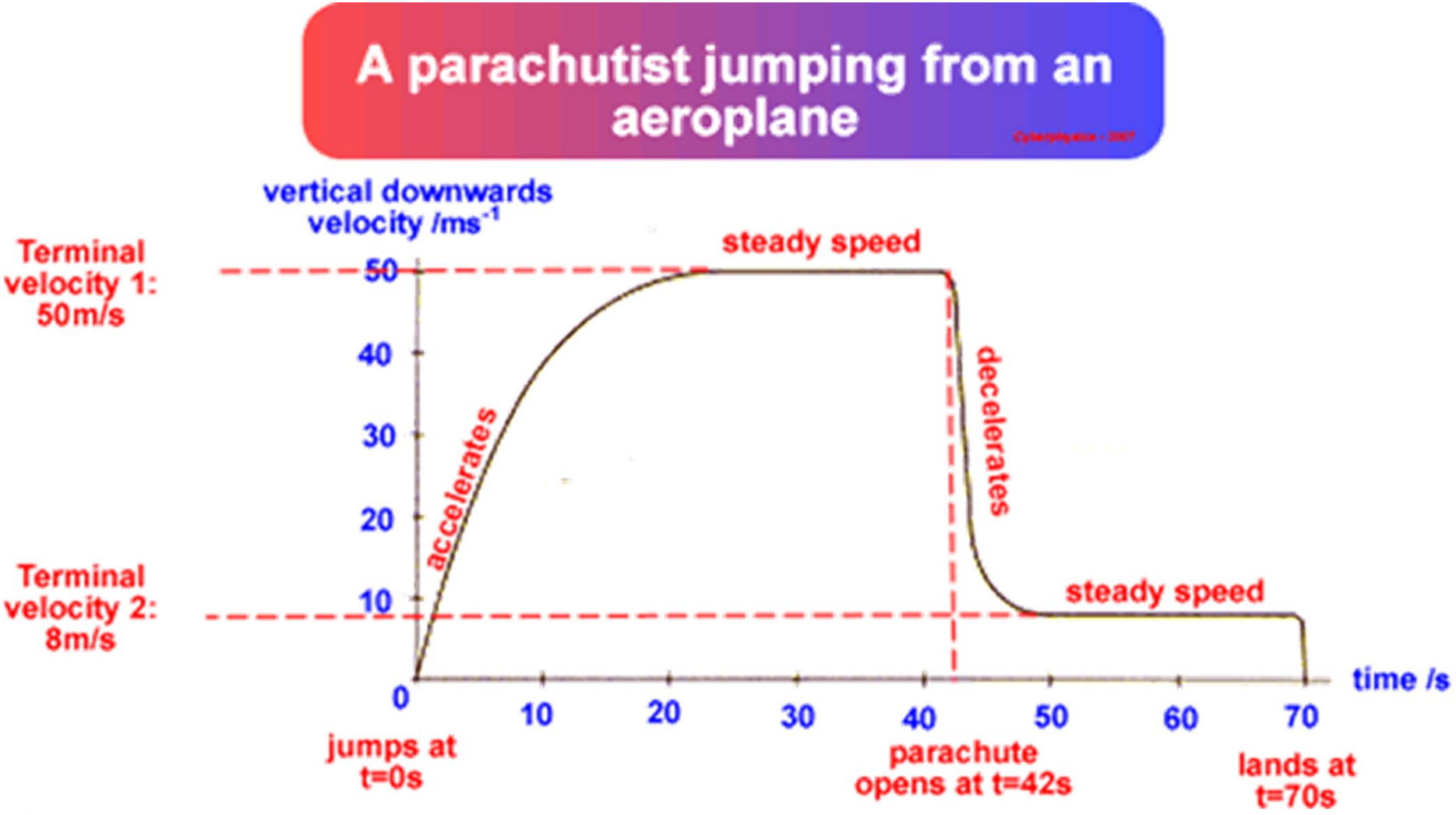
2. Example: drop an object

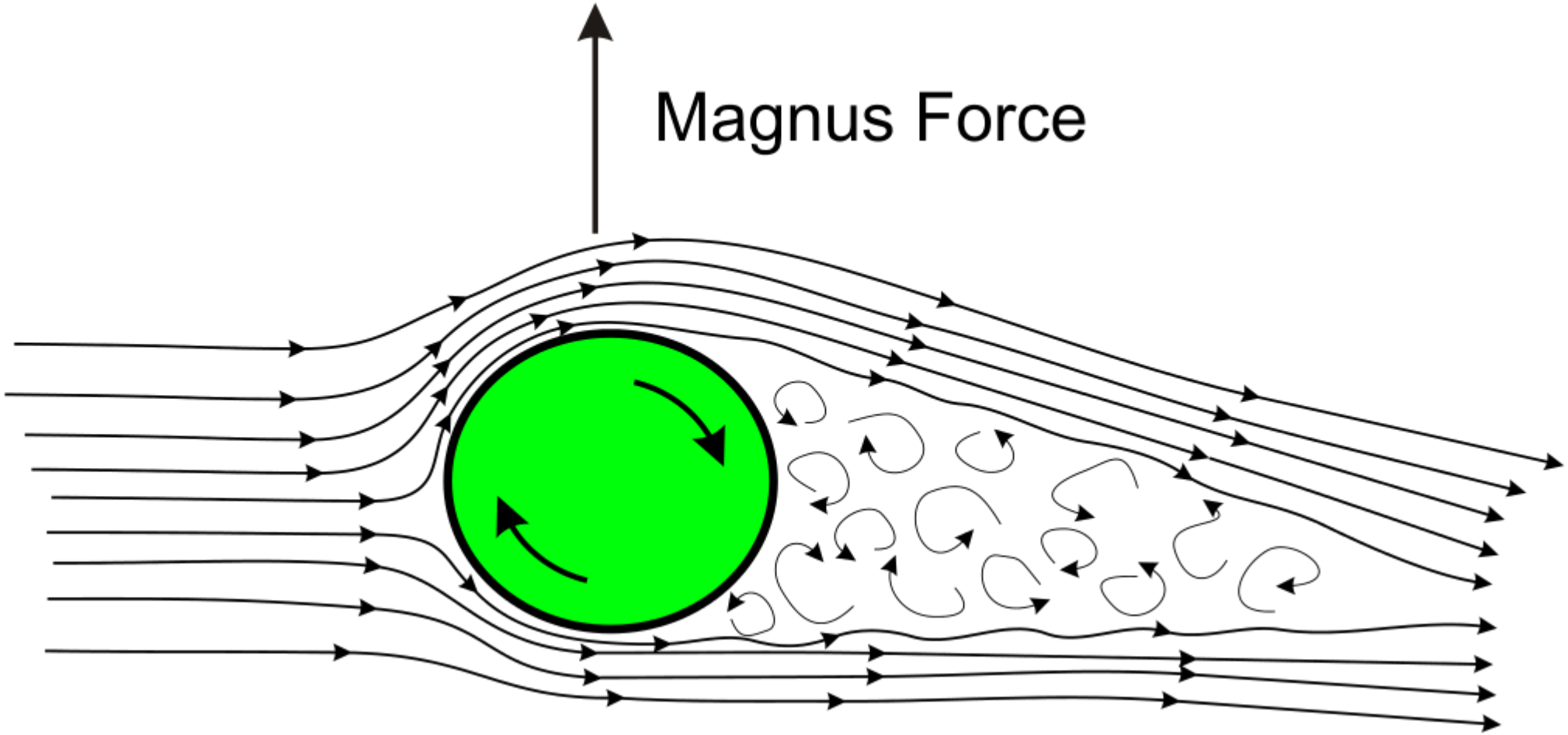
Object	Weight (N)	Area (m2)	Terminal Velocity (km/h)
Skydiver in free fall	801	0.84	201
Skydiver with open parachute	801	21.02	40
Baseball	1.42	4.19e(-3)	121
Golf ball	0.5	1.4e(-3)	116
Raindrop	3.34e(-4)	1.29e(-5)	32

2. Example: drop an object



2. Example: drop an object





See Bourg et al. Chapter 6

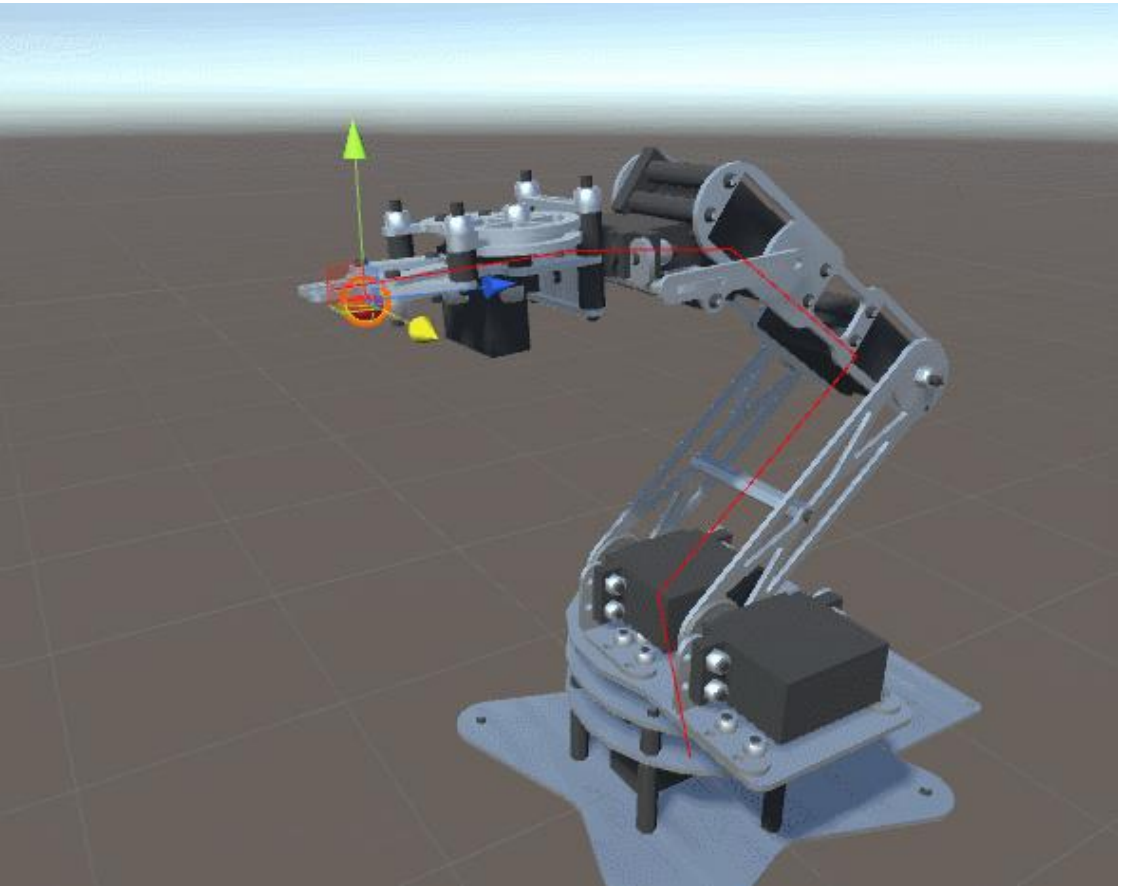
2. Other physics examples

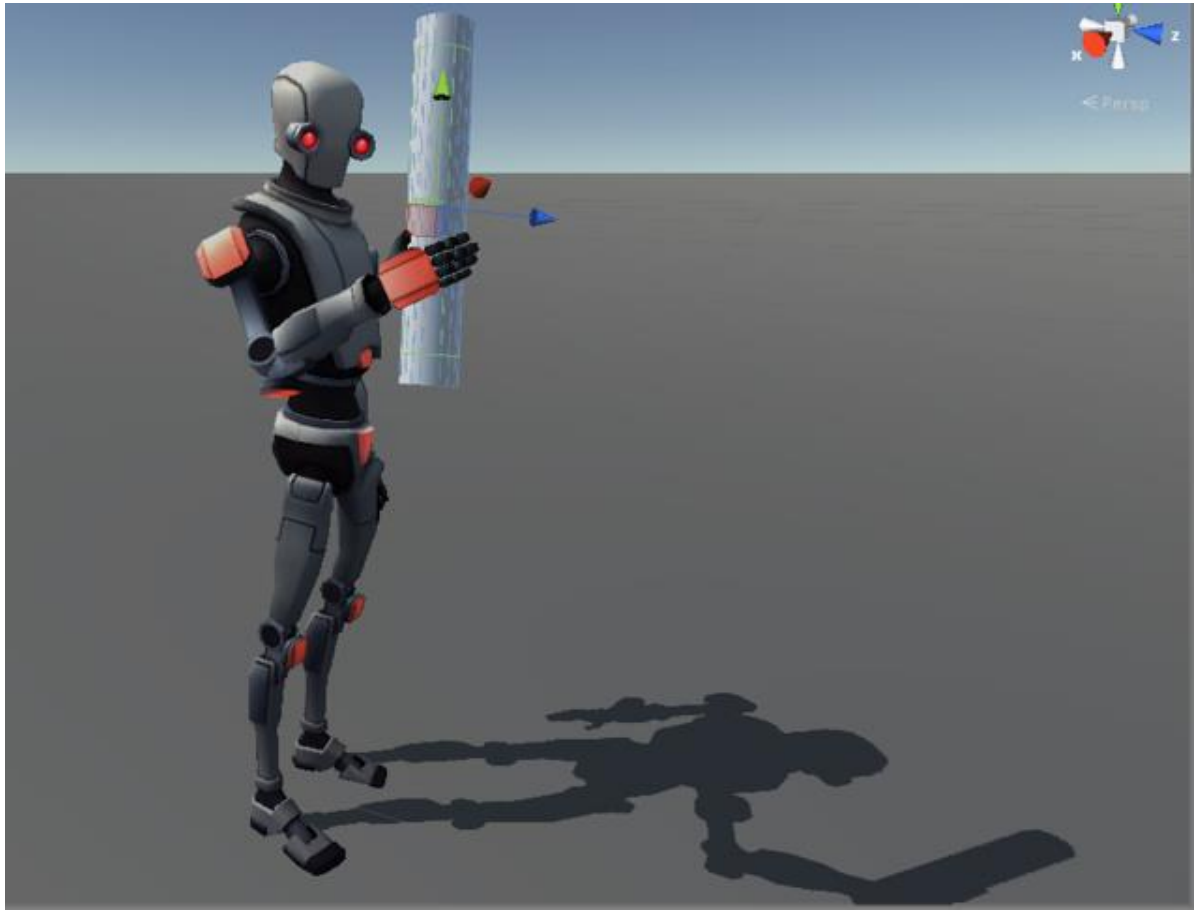
2013
https://www.youtube.com/watch?v=p5uhnSw8_Xw
2018
https://www.youtube.com/watch?v=xvyGpBKevLM
https://www.youtube.com/watch?v=S-oXeHGare4

audio synthesis based on physics
https://www.youtube.com/watch?v=Gue12UjXd5U

DNN for character control
https://www.youtube.com/watch?v=oh2ExRftTIc&feature=youtu.be

3. What is character animation?





See https://www.alanzucconi.com/2017/04/10/robotic-arms/

4. Character animation + Physics

https://twitter.com/i/status/854339707337093121

https://store.steampowered.com/app/508440/Totally_Accurate_Battle_Simulator/

Questions?

Suplement:
Inertia and Moment (of inertia)

1.3.1 Physical principles at play

- What is inertia (Newton's first (galileo))
- What is momentum (Newton's third)
- Conservation of momentum (elastic collisions)
- Conservation of energy (non-elastic collisions)

$$\vec{p} = m\,\vec{v}$$

See also

- Section 10-1 Feynmann
- Section 10-2 Feynmann
- Section 10-4 Feynmann

Source: https://en.wikipedia.org/wiki/Magnus_effect

Suplement:
Momentum and Torque

1.4.1 Physical Principles of Momentum and Torque

Momentum means
Angular Momentum

$$\vec{\tau} = cross(r, \vec{F})$$
$$\vec{L} = cross(r, \vec{p})$$

- intro of CROSS PRODUCT

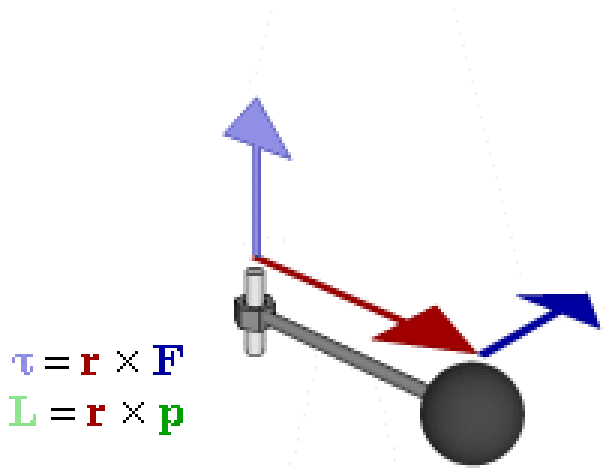
See also:

- section 18-1 Feynmann
- chapter 4 in Bourg et al

1.4.2 Torque examples in 2D

- ice skater

https://www.youtube.com/watch?v=VmeM0BNnGR0



Source:
https://en.wikipedia.org/wiki/Torque