Frame of Reference & Coordinate System

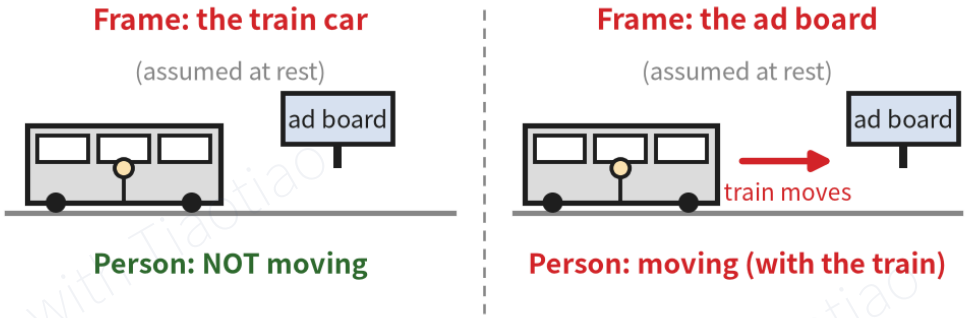
Physics with Tiaotiao 跳跳 · Kinematics · High School Physics

Study sheet for the video "Frame of Reference & Coordinate System": key ideas, practice questions, answers

Matches: NCERT Class 11 Ch 2 Motion in a Straight Line · FSc Part 1 Ch 3 Motion and Force · AS & A Level 9702 · WAEC/JAMB · HSC · AP Physics 1 Unit 1 · College Physics

Key ideas

Why we need a frame: without a **reference frame**, no kinematics problem can be studied. Whether you move depends not on you, but on the frame you choose.



Reference frame: an object (or system) chosen for studying motion and **assumed to be at rest**.
Physical meaning: to decide, in the problem you are studying, whether an object is moving or at rest.

Three key points

1. A frame is **not truly at rest**. It is only assumed to be at rest.
2. It can be **chosen freely**. In high school the default is the ground.
3. With a **different frame**, an object's state of motion is different.

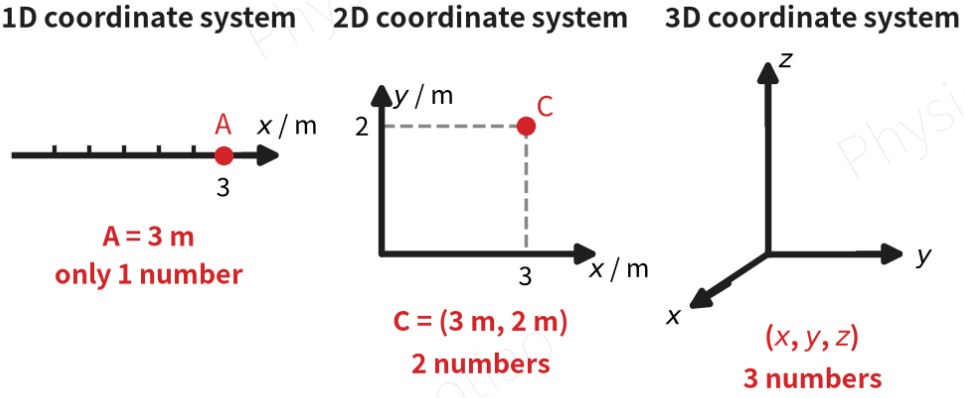
A "reference frame" is the same as the "reference object" from middle school.

Exam trick: to find which object is the frame, **see which one is not moving**. Find the verb, find its subject: whoever moves is not the frame, whoever doesn't move is.

Choosing a frame: pick the one that simplifies the problem. Example: with the Sun at the center (heliocentrism) the planets move in simple circles. With the Earth at the center (geocentrism) their paths are very complicated.

Coordinate system: also a reference frame, but one with a ruler, so it can give an object's position. In 1D (a straight line), **one number** is enough. A 2D system needs two numbers, a 3D system three.

Coordinates in physics must include **units**!



Practice

Try these before checking the answers on the next page.

1. An ancient poet once wrote: "Empty-handed, I hold a hoe; on foot, I ride a water buffalo. I walk on the bridge: the bridge flows, the water doesn't." In "the bridge flows, the water doesn't," "the bridge flows" should be understood as choosing which object as the reference frame? ( )

(The poet's wording: walking on the bridge, he sees the bridge seem to flow and the water stand still.)

A. Water B. Bridge C. Person D. Ground

Answer: _____ Which word is the verb, and who is its subject?

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2. Which of the following statements are correct? ( )

A. "The Sun rises in the east" uses Earth as the reference frame

B. "The Moon glides through the clouds" uses the clouds as the reference frame

C. "The little raft drifts down the river, the towering green mountains move past on both banks" use the same reference frame

D. The reference frame must be an object at rest relative to the ground

Answer: _____ Why are the others wrong?

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3. A ball falls from 5 m above the ground, bounces off the ground, and is caught 1 m above the ground. The origin is set 2 m directly below the release point, and downward is the positive direction of the axis. What are the position coordinates of the release point, the landing point, and the catch point, respectively? ( )

A. −2 m, 3 m, 2 m

B. −2 m, 2 m, 1 m

C. −2 m, −2 m, −1 m

D. 4 m, 0, 1 m

Answer: _____ Draw the axis here, or show your working:

Answers and explanations

Tap a blue time to jump to the part of the video that explains the question.

1. **A**. "Flows" has the bridge as its subject, so the bridge is moving. "Doesn't flow" has water as its subject, so the water is not moving. The one that is not moving is the frame: water.

Check: with the ground as the frame we would see the bridge still and the water flowing, the opposite of the poem. So the frame is not the ground.

▶ **Watch 9:29, Example 1**

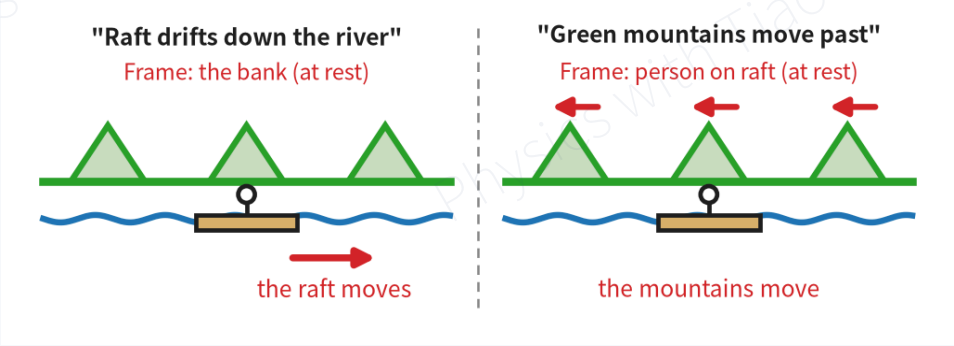
2. **A and B are correct. C and D are wrong.**

A. "Rises": the subject is the Sun, so the Sun moves. The mountain it rises from does not move. It is a mountain on Earth, so the frame is Earth.

B. "Glides through": the subject is the Moon, so the Moon moves. Only the clouds are left, so the frame is the clouds.

C. Wrong. First line: the raft moves, so the bank is at rest and is the frame. Second line: the mountains move relative to the people on the raft, like poles moving past a bus window. So the frame is the person on the raft. The two frames are different.

D. Wrong. A frame can be chosen freely. It can be moving or not.

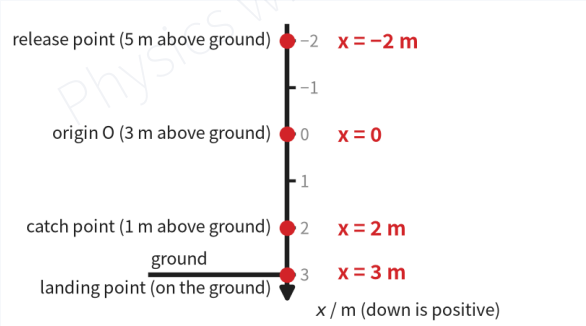


▶ **Watch 10:24, Example 2**

3. **A**. Downward is positive, so points above the origin O are negative and points below it are positive.

Release point: 2 m above O, so **−2 m**. Landing point: the ground is 5 − 2 = 3 m below O, so **3 m**. Catch point: 1 m above the ground, so 3 − 1 = 2 m below O, which gives **2 m**.

Remember the units: coordinates in physics always need them.



▶ **Watch 18:55, Example 3**

One-line summary

To find the frame, see who is not moving. A coordinate system is a frame with a ruler, and its coordinates need units.

Key terms

Term	Meaning	Chinese
reference frame, frame of reference	an object chosen to study motion and assumed to be at rest	参考系 cānkǎoxì
coordinate system	a reference frame with a ruler, used to give positions	坐标系 zuòbiāoxì
origin	the point where the coordinate is zero	原点 yuándiǎn
positive direction	the direction in which coordinates are positive	正方向 zhèngfāngxiàng
at rest	not moving relative to the frame	静止 jìngzhǐ
heliocentrism	the Sun at the center	日心说 rìxīnshuō
geocentrism	the Earth at the center	地心说 dìxīnshuō
1D, 2D, 3D	one, two or three number(s) are needed for a position	一维、二维、三维 yīwéi, èrwéi, sānwéi