

7 Combined motions

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Question box 7.1

F1 You are standing in the rain and the drops are falling vertically to the ground at 4 m/s. You start running at 3 m/s. How does the rain fall from your perspective?

F2 Indiana Jones escaping by boat. What is the best way for him to cross the river and get to the other shore? Which way is the shortest and which way is the fastest? Straight across, at an angle to the current, or against the current?

F3 A very fast bullet is fired straight out of a gun in the same instant as a stone is simply dropped from exactly the same height as the bullet was fired. Which of these objects will hit the ground first?

key words excerpt

frame of reference – das Bezugssystem

addition of vectors – die Addition von Vektoren

horizontal component – die horizontale Komponente

vertical component – die vertikale Komponente

Question box 7.2

F4 You throw a stone horizontally off the top of a hill. The stone falls 20 m down and 40 m far. How fast did you throw the stone?

F5 How far can a bullet fired from a high powered gun go before it starts falling to the ground?

F6 Super archers like Robin Hood or the elf Legolas would have a big problem in real life. The bus jump over the gap in the bridge from the film "Speed" is a Hollywood fairytale, too. Why?

key words excerpt

aim – das Ziel

bow – der Bogen

archers – der Bogenschütze

Question box 7.3

F8 ►L There is an explosion and a stone is thrown. After 6 seconds, it hits the ground. How high was the stone propelled? Is the height contingent on if the stone went straight up or at an angle (compare question 14, chapter 6.4.2)?

F9 The world record for egg tossing is 98,5 m according to the Guinness Book of World Records (and the egg was supposedly caught without breaking it). How fast do you have to throw the egg for it to go so far? And what is the optimal angle for the throw?

key words excerpt

at a slant – schräg

toss, throw – der Wurf

initial velocity – die Anfangsgeschwindigkeit

discarding speed – die Abwurfgeschwindigkeit

altitude – die Höhe

flying time – die Flugzeit

Question box 7.4

F10 When long jumping, you essentially throw your whole body. This means your center of gravity flies along a flight trajectory. The ideal angle of the jump should be 45°. Yet the best of the best high jumpers only jump at elevation angles of about 20°. Doesn't physics work here? Explain why long jumpers jump at such low angles.

F11 What about if you throw a ball. What is the ideal elevation angle? Is it 45° or not and why?

F12 The world record for javelin throwing is at about 98.5 meters. Coincidentally the world record for throwing eggs is the same. What velocity and elevation angle do you have when throwing your javelin/egg?

F13 ►L Why can you throw a baseball (heavier) farther than a tennis ball (lighter)? Doesn't this defy simple logic? Please explain.

key words excerpt

energy – die Energie

(linear) momentum – der Impuls

force – die Kraft

angle – der Winkel

center of gravity – der Körperschwerpunkt

trajectory – die Flugbahn

Task box

F14 ►L You throw a stone at 5 m/s horizontally off a tower and it falls 20 m far. How high is the tower? You throw another stone at 7 m/s horizontally off a tower 125 m high. How far does this stone fall?

F15 ►L A sniper has a gun with a muzzle velocity of 1000 m/s. How much higher does he need to set his aim if his target is at a distance of 100 m, 200 m or 300 m?

F16 ►L A supply aircraft air drops supplies. Where do the packages need to be dropped from in order to reach their target? What does the flight path look like from the pilot's perspective? What does the flight path look like from the supply camp worker's perspective?

F17 ►L Assume the elf Legolas had a bow that shot arrows at an elfish speed of 500 km/h instead of 200 km/h. What problem would this create?