

11 Rotations

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Question box 11.1

F1 What number do you get when you divide the circumference of any circle by its radius?

F2 Assuming Earth's gravitation suddenly ceased (which is impossible, thankfully), in which direction would you float away? Can you estimate your velocity?

F3 How long is a complete rotation of the Earth? A whole day? And why is it important to start space rockets close to the equator? Why are they launched eastward?

key words excerpt

to cease - aufhören

centripetal acceleration – die Zentripetalbeschleunigung

radian – der Radiant

angular frequency – die Winkelgeschwindigkeit

tangential velocity – die Tangentialgeschwindigkeit

constant speed – die konstante Geschwindigkeit

toward the center – zum Mittelpunkt

acceleration vector – der Beschleunigungsvektor

Question box 11.2

F4 A solid and hollow cylinder equal in mass roll down an incline. Do they reach the bottom at the same time? If not, which is faster?

F5 The figure depicts two wheels equal in mass. Which is better suited for use as a flywheel and why?

F6 You have a stick. Is it easier to turn the stick along its longitudinal axis or along its transverse axis?

F7 ►L You hang a cuboid on a string as pictured. What happens if the cuboid is rotated?

key words excerpts

incline – die schiefe Ebene

flywheel – das Schwungrad

location of axis – die Lage der Achse

moment of inertia – das Trägheitsmoment, die Drehmasse

axis - die Achse

axis of rotation – die Drehachse

cuboid – der Quader

angular acceleration – die Winkelbeschleunigung

directly proportional – direkt proportional

perpendicular – das Lot, lotrecht

Question box 11.3

F8 You want to pull an unrolled spool of thread back to yourself by the thread. Is it possible? Is the length of the thread relevant?

F9 A screw is stuck. What can you use to get it out, a string or a pipe? Use physics to explain your answer.

F10 People say if your piece of bread-and-butter falls down, it always lands butter-side down. Is this really true?

key words excerpts

spool of thread – die Zwirnschleule

length – die Länge

in the direction of the vector – in Richtung des Vektors

in the direction of the force – in der Richtung der Kraft (= Wirkungslinie)

torque – das Drehmoment

Question box 11.4

F11 Figure 11.29 depicts an ice skater doing a pirouette. Why does she pull in her arms and one leg?

F12 Can a high diver completely stop his rotation before he hits water? Why are piked somersaults better rated than tucked somersaults?

F13 ►L Whenever there are weather catastrophes like El Niño or strong earth quakes, the Earth's rotation speed changes slightly. How can you explain this?

F14 The Hubble Telescope orbits 600 km above Earth. But how can it be positioned toward the stars if there is no torque in space?

F15 Is it possible for an astronaut to move from position a to position b in space without using anything if s/he isn't rotating? If so, would it go against the Conservation of Angular Momentum?

F16 How do cats always manage to land on their feet even if they start falling back first?

F17 Why does a helicopter need a tail rotor?

key words excerpt

angular momentum – der Drehimpuls
 rotating mass – rotierende Masse
 torque – das Drehmoment
 Conservation of Angular Momentum Principle – Erhaltung des Drehimpulses
 earth quake – das Erdbeben

Question box 11.5

F18 A hollow cylinder rolls more slowly down an incline than a solid one does if they are equal in mass (fig. 11.9, chapter. 11.2). Can you explain this phenomenon using Conservation of Energy?

F19 Tidal friction causes Earth's rotation to slow down. Its friction slows Earth by a mere 50 nanoseconds each day. How does this fit with the Conservation of Angular Momentum?

key words excerpt

hollow cylinder – der Hohlzylinder
 phenomenon – das Phänomen
 Conservation of Energy – die Energieerhaltung
 rotational energy – die Rotationsenergie
 closed system – das abgeschlossene System
 homogeneous - homogen
 angular velocity – die Winkelgeschwindigkeit
 tides – die Gezeiten
 tidal friction – die Gezeitenreibung
 Earth's rotation – die Erdrotation

Question box 11.6

F19 What is an Inertial frame of reference and what does Newton's first law of motion (aka Law of Inertia) say? Reread chapter 6.1 and 8.2 .

F20 Why do racers cut curves?

F21 Allo Diavolo was the first person to do a loop the loop on a bicycle in 1901. Explain why he didn't fall down when he was at the highest point.

F22 You sometimes see a cylinder spin ride at the fair. Riders are pressed up against the wall as the cylinder's

rotation speed increases, and often times the floor will drop out and everyone will stay pressed up against the wall off the ground. Which force do you see if you are watching your friend from outside the cylinder?

F23 They say that astronauts are weightless when they orbit Earth in space. Does that mean there is not any gravity where they are? Can they use rotation to produce artificial gravitation.

F24 What kind of curve would you observe if you were standing on a rotating platform when the ball was thrown? What would the person standing next to the platform see?

key words excerpt

Inertial frame of reference – das Inertialsystem
 centripetal force – die Zentripetalkraft
 centrifugal force- die Zentrifugalkraft
 static friction – die statische Reibung
 velocity – die Geschwindigkeit
 vector – der Vektor
 observer – der Beobachter
 to observe - beobachten
 loop the loop – der Looping
 inside/within - innen
 outside - außen
 gravity – die Gravitation
 perpendicular to – senkrecht auf
 parallel to – parallel zu
 rotating - rotierend
 pseudo force – die Scheinkraft
 weightlessness – die Schwerelosigkeit
 coriolis effect – die Corioliskraft

Question box 11.7

F26 What happens to the velocity of an object if force is applied either in the direction of movement or perpendicular to direction of movement?

F27 ►L Pistol and gun bullets are shot with spin. Why?

F28 ►L Is this statement true? Boomerangs are Aborigine hunting weapons which return to the hunter if he misses his target.

key words excerpt

(spinning) top – der Kreisel

precession – die Präzession

in direction of movement – in Bewegungsrichtung

perpendicular to direction of movement – quer zur Bewegungsrichtung

axis of rotation – die Rotationsachse

direction of rotation – die Rotationsrichtung

counter-clockwise. What about right and left train tracks wearing out differently and opposite river banks eroding differently due to the coriolis effect?

F39 ►L Derive the equation for tangential velocity. Use the general equation for speed.

Tool box Rotations

F29 ►L A car drives through a curve with a narrow radius of 15m. Which centripetal acceleration occurs at speeds of 30, 60, 90 und 120 km/h? Are any of these accelerations realistic, and if so, which?

F30 ►L What would happen to the spool of thread in fig. 11.18, if the effective line went through the contact area? Why does this occur?

F31 ►L The units for torque is the Newton meter. This is the same unit used for work. Is moment of force actually work?

F32 ►L Sketch the torque vectors for fig. 11.21.

F33 ►L People used to say that darker-skinned sprinters were so much better because they had longer heel bones. What does physics have to say about this assertion?

F34 ►L The ice skater folds her arms in and increases her angular speed. What about the angular momentum and rotational energy? Do they change?

F35 ►L Try to derive an equation for the inertial mass. Use the equation for kinetic energy and orbital speed. Also assume the rotating object consists of many small points of mass.

F36 ►L How much higher than the loop-the-loop does the ramp have to be for Allo Diavolo to get over it.

F37 ►L A space station has a radius of 90 m. How fast does it have to rotate for its centripetal force to equal 1 g? What effects could such artificial gravitation have?

F38 ►L Is it true that water in a sink in the northern hemisphere goes down the drain clockwise and water in the southern hemisphere goes down the drain