Exercises – Chapter 1

E.1 The dolphin's inertia carries it upward, even though its weight makes it accelerate downward and gradually stop rising.

E.2 There is no force keeping you moving forward.

E.3 Your feet accelerate upward rapidly when they hit the ground and the snow continues downward, leaving your feet behind.

E.4 As the toothbrush stops suddenly, the water's inertia keeps it going and it flies off the toothbrush.

E.5 Any collision in which the car accelerates forward, such as when the car is hit from behind by a faster moving car.

E.6 Nothing pushes on the driver, so the driver's inertia causes the driver to coast forward and collide with the steering wheel.

E.7 As it turns left, the car accelerates left. The loose objects remain behind and end up on the right side of the dashboard.

E.8 Your direction of travel changes all the time and a change in direction involves an acceleration

E.9 Backward, in the direction opposite your forward velocity.

E.10 The beans' inertias keep them from moving out of the way.

E.11 The anvil's large mass slows its acceleration, so the hot metal is squeezed between the moving hammer and the stationary anvil.

E.12 The sprinter must overcome inertia and accelerate during the first 100 m. During the second 100 m, the sprinter must simply maintain full speed.

E.13 The pad's inertia tends to keep it in place. If you pull the paper away too quickly, the pad won't be able to accelerate with the paper.

E.14 The ball's speed increases steadily, so there is no second during which its speed increases most.

E.15 Regardless of their horizontal components of velocity, all objects fall at the same rate. The ball and bullet descend together.

E.16 The acorn's average velocity during this second is less than 9.8 m/s.

E.17 The forward component of his velocity remains constant as he falls, and he follows an arc that carries him forward over the rocks.

E.18 He should kick the ball straight up.

E.19 In the absence of air effects, a ball hit at 45° above horizontal will travel farthest. A ball hit higher or lower won't travel as far.

E.20 She experiences zero net force.

E.21 Its magnitude must equal the suitcase's weight.

E.22 All three cars experience zero net force.

E.23 Zero net force.

E.24 The two push equally hard on one another (but in opposite directions).

E.25 The astronaut exerts an upward force of 850 N on the earth.

E.26 The car pushes you to the right with a force of 50 N.

E.27 Both forces have exactly the same magnitude.

E.28 The upward acceleration needed to stop the falling person is enough to injure them severely, whether the ground or a superhero exerts that force.

E.29 The wall exerts a support force to accelerate you backward.

E.30 You do positive work when you pull the kite in.

E.31 A person does more work. Movements that appear large compared to the ant's height still involve small distances and little work.

E.32 Yes, you are doing work whenever you push on the bread and it moves in the direction of that push.

E.33 Yes, it pushed the wall inward and the wall dented inward.

E.34 In both cases, you do work on the saw: when you push it away from you as it moves away from you and as you pull it toward you as it moves toward you.

E.35 As it rolls on the surface, it always accelerates downhill.

E.36 The steeper the roof, the larger the downhill force on the snow and debris and the more likely they are to slide off the roof.

E.37 Its greatest acceleration is at the steepest point; its greatest speed is at the bottom of the slide.

E.38 The downhill force pushes you in the direction opposite your motion and do negative work on you.

E.39 The kinetic energy becomes gravitational potential energy.

Problems – Chapter 1

P.1 3200 N.

P.2 It will take 6.15 seconds to reach 88.5 km/h.

P.3 11.13 m/s.

P.4 The rock will fall 16.7 meters during those 3 seconds.

P.5 Your Mars weight would be about 38% of your earth weight.

P.6 The basketball player's initial upward velocity is 3.1 m/s.

P.7 About 0.64 s (0.32 s on the way up and 0.32 s on the way down).

P.8 The sprinter's acceleration is 10 m/s2

P.9 48 N.

P.10 The 60-kg person weighs about 588 newtons.

P.11 About 0.20 s.

P.12 You will rise to a height of 0.20 meters.

P.13 4800 N

P.14 The boxcar will have to accelerate for 70 seconds to reach cruising speed.

P.15 9800 N.

P.16 It takes 9.8 million joules of work to raise a 20,000-kg block 50 meters upward.

P.17 14,700,000 J.

P.18 1000 kg of water releases 1.96 million joules of gravitational potential energy in descending 200 meters.

P.19 12.5 J.

P.20 You have done 400 joules of work on the wedge.

P.21 8000 N.

P.22 You have done 30,000 joules of work.

Exercises – Chapter 2

E.1 The angle by which the front, center seat would have to be rotated, as viewed from above, to have each seat's orientation.

E.2 The propellers have rotational inertia (as measured by their moments of inertia).

E.3 It would rotate about its center of mass, not its geometric center. It would appear to wobble as it turned.

E.4 A boomerang or horseshoe's center of mass is in the air between the two arms of the object.

E.5 The wheel has rotational inertia, as measured by its rotational mass, making it hard to start and stop spinning.

E.6 A force exerted directly toward or away from the axis of rotation produces zero torque about that axis of rotation.

E.7 A force exerted at the hinges produces no torque about them.

E.8 When you arm is pointing straight out in front of you, any weight force exerted on your hand is at right angles to the lever arm between your shoulder and hand and produces a large torque about your shoulder. On the other hand, when you arm is at your side, any weight force exerted on your hand is directed away from your shoulder and produces no torque about your shoulder.

E.9 The farther the water is from the water wheel's pivot, the more torque its weight produces on the wheel.

E.10 The string pulls on the outside edge of the yo-yo's spindle and at right angles to the lever arm between the yo-yo's rotational axis and the point at which the force acts. As a result, it produces a torque on the yo-yo about its rotational axis and causes the yo-yo to undergo angular acceleration.

E.11 Your force far from the hinges produces a large torque. To oppose this torque, the nut must exert a huge force near the hinges.

E.12 The closer the wire is to the axis of pliers' axis of rotation, the less effective any force from the wire is at producing a torque on the pliers and stopping its rotation.

E.13 The weights of your chest and your feet exert torques in opposite directions about your knees. They partially balance one another.

E.14 The longer the pole is, the greater its rotational mass and the more torque that is required to start it rotating significantly.

E.15 It reduces the car's rotational mass so that the car can undergo rapid angular accelerations and change directions quickly.

E.16 A modest force exerted far from the pivot produces an enormous force close to the pivot. Although the opener's handle must travel a long distance, it produces the huge force on the bottle cap that's required to pull that cap off the bottle.

E.17 By pushing far from the pivot, you exert more torque on the lid.

E.18 The farther out the limb that your weight is exerted on the branch, the larger the torque you produce on the limb and the more likely it is to begin rotating.

E.19 Your small effort exerted on the crowbar far from its pivot produces a large force on the box, located near the crowbar's pivot.

E.20 A modest upward force exerted on the handles far from the pivot can balance a large downward weight force exerted on the basket close to the pivot.

E.21 Skidding sideways does work against sliding friction, converting some of the skier's kinetic energy into thermal energy.

E.22 The work that the horse does on the cart is wasted in opposing friction. The work becomes thermal energy.

E.23 The pin's surface turns with the crust and doesn't slide across it.

E.24 If the sprinter's foot slides backward, then friction from the ground on the foot does negative work on the foot and extracts energy from the sprinter. That energy becomes thermal energy in the foot and ground.

E.25 The nearer the frictional force is to the pivot, the less torque it produces to slow the yo-yo's rotation. Slipperiness reduces friction.

E.26 The ground exerts a forward frictional force on the bicycle wheel.

E.27 A static frictional force from the pavement pushes you forward.

E.28 The forward force you exert on the sled must balance the backward force that friction exerts on the sled.

E.29 Pressing the wheels more tightly against the pavement increases the maximum force that static friction can exert on the wheels.

E.30 While you are traveling straight at constant speed, you are coasting and experience zero net force. It's only when you try to accelerate horizontally that you need a frictional force from the pavement and find yourself sliding on ice instead.

E.31 The chalk experiences sliding friction as you write and leaves visible wear chips on the blackboard.

E.32 When you land on a leaf pile, a modest upward force exerted for a long time stops you. When you land on