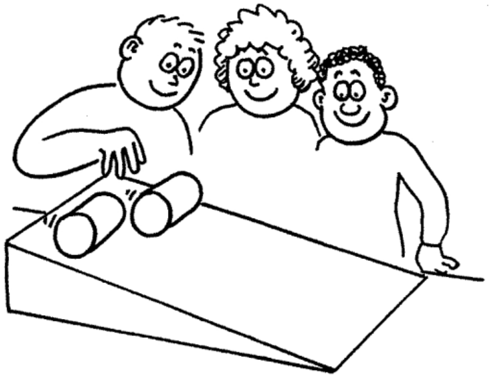

Which will roll down a hill faster, a can of regular fruit juice or a can of frozen fruit juice?

✔ **1. Regular fruit juice**
2. Frozen fruit juice
3. Depends on the relative sizes and weights of the cans

Answer: 1. Regular fruit juice

The regular fruit juice has an appreciably greater acceleration down an incline than the can of frozen juice: Because the regular juice is a liquid and is not made to roll with the can, as the solid juice does. Most of the liquid effectively slides down the incline inside the rolling can. The can of liquid therefore has very little rotational inertia compared to its mass.
The solid juice, on the other hand, is made to rotate, giving the can more rotational inertia.

Review for Exam 1

- Exam 1 is next Fri Feb 28 (next week)

- On Chapters 2 through 8 inclusive

- Bring No. 2 Pencil for Bubble-Sheet, calculators not required

- 35 multiple-choice questions

- No “cheat sheets”, notes, cell phones, smart watches, or other devices allowed.

- I will hold office hours (1220N) on Mon 2/24 (11:00 am – 12:30 pm); Tue 2/25 (4:00 – 5:30 pm); Fri 2/28 (11:15 – noon)
(out of town, Wed, Thu)

Recall…

- Chapter 2: Newton's 1st law, inertia, equilibrium (sum of forces = 0)

- Chapter 3: Linear motion, speed, velocity (= speed with direction), acceleration(= rate of change of velocity), free-fall motion ($a = g$)

- Chapter 4: N's 2nd law, Fnet = ma, weight = mg, weight vs mass, friction, non-free fall and air resistance, terminal velocity

- Chapter 5: N's 3rd law, action-reaction, vectors

- Chapter 6: Momentum(= mv), Impulse=$F\,t$ = change in momentum, external vs internal forces, momentum conservation when Fnet on system =0, collisions

- Chapter 7: Energy, Kinetic energy = $\frac{1}{2} m v^2$, Potential energy, Grav. PE = mgh, Work = $F\,d$, change in KE = Work, Power = Work/time, Total energy conservation, machines

- Chapter 8: Rotation, linear/tangential speed vs angular/rotational speed, $v = r\,\omega$, rotational inertia I, torque = F x lever arm, angular momentum = $I\,\omega$, ang mom conservation, CM/CG, stability, centripetal vs centrifugal force

Resources for studying:

- go through questions/exercise/examples we did during the lecture
- read and do exercises at end of chapters
- questions today and partial exam questions posted tonight
- email me if you have any questions or want to meet; office hrs

As an object freely falls downward, its

A) velocity increases

B) acceleration increases.

C) both of these

D) none of these.

A) It accelerates at either (i) a constant rate =g, if there is negligible air resistance or (ii) gradually less acceleration if there is air resistance.

When in a subway car that suddenly stops, you lurch forward. What's the best explanation for this?

A) Because of Newton's 1st law – you have inertia.

B) Because you have no acceleration

C) Because of action-reaction forces between the car and you

D) Because of the support force

Answer A: Newton's 1st law says that objects (you) tend to keep moving in a straight line; inertia resists changes in motion

When a rock thrown upwards falls back down and passes the same point it was thrown from,

a) its velocity is zero and its acceleration is zero

b) its velocity is zero and its acceleration is about 10 meters per second per second

c) its velocity is about 10 m/s and its acceleration is zero

d) its velocity is minus the initial velocity it was thrown up with and its acceleration is about 10 meters per second per second.

d)

Note, acc. in free-fall (on earth) is *always* g~10 m/s^2

According to Newton's law of inertia, a railroad car in motion should continue going forever even if its engine is turned off. We never observe this because railroad trains

A) move too slowly.
B) must go up and down hills.
C) are much too heavy.
D) always have forces that oppose their motion

Answer: D

How about if there was **no** friction and no air drag – then what would happen once the engine is turned off?

Then the train would be accelerating while the engine was on, and would stop accelerating once the engine is turned off – i.e would move at constant velocity.

A skier covers a distance of 3 m in half a second. What is his average speed?

A) 1.5 m/s

B) 3 m/s

C) 6 m/s

D) 9 m/s

C) Average speed =distance/time = 3m/0.5s = 6 m/s

Half a second after starting from rest, a free-falling object will have a speed of about

a) 10 m/s

b) 20 m/s

c) 5 m/s

d) 0

e) None of these

c) In free fall, object gains about 10m/s every second. So, in half a second, gain 5 m/s.

What if the free-falling object is moving upward at a speed of 20 m/s. What is its speed half a second later?

15 m/s

A hockey puck is set in motion across a frozen pond. If ice friction and air resistance are neglected, the force required to keep the puck sliding at constant velocity is

A) equal to the product of its mass times its weight.

B) equal to its weight divided by its mass.

C) zero.

D) equal to its weight

Answer: C, since no acceleration – so no net force

Two balls are thrown from the same point high on a cliff. One is thrown upwards and the other is merely dropped from rest. Neglecting air resistance, which has the higher acceleration?

A) The ball thrown upwards

B) The ball dropped from rest

C) It depends on how fast the thrown ball was thrown

D) It’s the same for each

E) None of these

Answer: D, acceleration = g downwards

If a projectile is fired straight up at a speed of 10 m/s, the total time to return to its starting position is about

A) 2 seconds.
B) 10 seconds.
C) 20 seconds.
D) 1 second.
E) not enough information to estimate

Answer: A

Each second it loses about 10m/s so after 1s, it has zero velocity, i.e. is turning around. Then it gains 10m/s as it falls, so after another second (a total of 2 s) it has -10m/s i.e. same initial speed at which it began, hence returned to the same point.

A rock weighs 30 N on Earth. A second rock weighs 30 N on the moon. Which of the two rocks has the greater mass?

A) the one on the moon
B) the one on Earth
C) They have the same mass.
D) not enough information to say

A) Because weight =mg, and g least on moon, so m must be bigger to get the same weight of 30N

What horizontally-applied force will accelerate a 200-kg box at 1 m/s^2 across a floor against a friction force equal to its weight?

a) 200 N

b) 400 N

c) 2200 N

d) 2400 N

e) None of these

c)

Weight = mg = 2000 N. We're told friction = weight here.

$F_{net} = F_{applied}$ – friction = ma

So, $F_{applied}$ = ma + friction = 200 + 2000 = 2200 N

A girl pulls on a 10-kg wagon with a constant horizontal force of 30 N. If there are no other horizontal forces, what is the wagon's acceleration in meters per second per second?

A) 3.0
B) 0.3
C) 10
D) 300
E) 30

Answer: A, since $a = F/m = 30/10 = 3\ m/s^2$

A large person and a small person wish to parachute at equal terminal velocities. The larger person will have to

a) Jump first from the plane

b) Pull upward on the supporting strands to decrease the downward net force

c) Jump lightly

d) Get a larger parachute

d) If he does nothing, the larger person would accelerate for longer and have a larger terminal velocity. So he needs to do something to decrease this and effectively increase air resistance – i.e. get larger parachute.

Consider a large cannonball and a small ping-pong ball, each being dropped from the same point on a tree. Which experiences the greater air resistance force as it falls?

A) The ping-pong ball
B) The cannonball
C) The same on each

Answer: B – see detailed explanation in Lecture 3 questions about elephant vs feather, and iron ball vs wooden ball

A player catches a ball. Consider the action force to be the impact of the ball against the player's glove. The reaction to this force is

a) player's grip on the glove

b) Force the glove exerts on the ball

c) Friction of ground against player's shoes

d) Muscular effort in the player's arms

e) None of these

b)

A large heavy truck and a small baby carriage roll down a hill. Neglecting friction, at the bottom of the hill, the truck will have a greater

A) speed.
B) momentum.
C) acceleration.
D) all of these
E) none of these

Answer: B

They'll have same acceleration and same speed (if they started with the same speed). The truck will have more momentum as its mass is larger.

A car traveling at 100 km/hr strikes an unfortunate bug and splatters it. The force of impact is

a) greater on the bug

b) greater on the car

c) the same for both

c) The same for both – action/reaction

(Similarly, same momentum *change* for both)

Padded dashboards in cars are safer in an accident than nonpadded ones because an occupant hitting the padded dash has

A) increased momentum.
B) increased time of impact.
C) decreased impulse.
D) decreased time of impact.

Answer: B, same change of momentum to final zero, but done over a longer time means the force is less.

A 2-kg chunk of putty moving at 2 m/s collides with and sticks to a 6-kg bowling ball initially at rest. The bowling ball and putty then move with a speed of

a) 0

b) 0.5 m/s

c) 1 m/s

d) 2 m/s

e) More than 2 m/s

b) Momentum before = momentum after

(2kg)(2m/s) +0 = ((2+6)kg) v

So v=4/8 = 0.5 m/s

Two cars of mass m move at equal speeds v towards each other. What is their combined momentum after they meet?

a) 0

b) mv

c) 2mv

d) None of these

a) Net momentum after =net mom. before = 0

Assuming they don't rebound from each other, how much of the kinetic energy was transformed to heat and sound?

All of it!

If a monkey floating in outer space throws his hat away, the hat and the monkey will both

A) move away from each other at the same speed.
B) move a short distance and then slow down.
C) move a short distance and then go faster.
D) move away from each other, but at different speeds.
E) come to a stop after a few minutes.

Answer: D

Momentum conservation: mom. before = mom after = 0

So monkey’s momentum is equal and opposite to hat’s, but he has bigger mass, so smaller speed.

A ball rolling down an incline has its minimum speed

A) half way down the incline.

B) at the end the incline.

C) near the top of the incline.

D) impossible to predict without knowing the ball's mass

E) impossible to predict without knowing the size of the ball

c) Near top, it has max potential energy, and min kinetic energy. PE gets transformed to KE as it rolls, so speed increases.

A 1000-kg car and a 2000-kg car are hoisted the same distance. Raising the more massive car requires

A) Less work
B) Twice as much work
C) Four times as much work
D) As much work
E) More than four times as much work

Answer: B. Work done = gain in potential energy = mgh. So twice the mass means twice the PE, means twice the work

A car moving at 100 km/hr skids 40 m with locked brakes. How far will the car skid with locked brakes if it were traveling at 50 km/hr?

A) 5 m

B) 10 m

C) 20 m

D) 40 m

E) 80 m

F) 160 m

B)

At 50 km/h it has half the speed so 1/4 times the KE..

Work done by brakes = F.d = Δ KE, so need 1/4 times the distance, i.e. 1/4 x 40 m = 10 m.

A feather and a coin will have equal accelerations when falling in a vacuum because

A) the force of gravity is the same for each in a vacuum.

B) the force of gravity does not act in a vacuum.

C) the ratio of each object's weight to its mass is the same.

D) their velocities are the same.

E) none of these.

C)

Which has greater kinetic energy, an adult running at 3 mi/hr or a child of half the mass running at 6 mi/hr?

A) the adult

B) the child

C) Both have the same kinetic energy.

D) More information is needed about the distance traveled.

B) KE = ½ mv^2, so for child, mass halved but v doubled means KE is doubled.

A huge rotating cloud of particles in space gravitate together to form an increasingly dense ball. As it shrinks in size the cloud

A) rotates slower.

B) rotates faster.

C) rotates at the same speed.

D) cannot rotate.

B) Ang mom is conserved, so if shrinks so that I decreases, then ang speed must increase

Consider a string with several rocks tied along its length at equally spaced intervals. You whirl the string overhead so that the rocks follow circular paths. Compared to a rock in the middle of the string, a rock at the outer end moves

A) half as fast.
B) twice as fast.
C) at the same linear speed.

Answer: B

They have the same angular (rotational) speed, but the one twice as far from the center has twice as large linear (tangential) speed.

A small boy places a rock under the middle of a of a long wood plank, sits near one end and his mother sits near the opposite end. To balance each other,

A) both should move closer to the ends of the plank.
B) the boy should move closer to his mother.
C) the mother should move further away from the boy.
D) both should move closer to the middle of the plank.
E) None of the above choices would work.

Answer: E

The mother has greater weight, so to balance the torque = F x leverarm of that of the boy's, the lever arm to the mother must be smaller.

If the polar icecaps melted, the resulting water would spread over the entire earth. This new mass distribution would tend to make the length of a day

A) shorter.
B) shorter at first, then longer.
C) stay the same.
D) longer at first, then shorter.
E) longer.

Answer:E, the ice would on average be further away from the axis of rotation compared to when it was at the poles only. So the rotational inertia of the earth will have increased. To conserve angular momentum, then the rotational speed of earth would decrease, so the earth's day would be longer.

When doing somersaults, you'll more easily rotate when your body is

A) straight with both arms at your sides.

B) straight with both arms above your head.

C) balled up.

D) no difference

C) Since want to decrease rotational inertia, pull in your mass close to your axis of rotation