

AP Physics 1 Free Response Review Card Sort

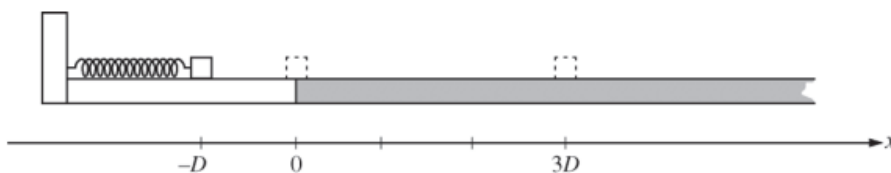
This card sort was made by Marta R. Stoeckel, but the problems in this card sort are all taken from released free-response on the AP Physics 1 exam available on [AP Central](#) and are the intellectual property of the College Board.

Constant Acceleration of a Particle Model (CAPM)	Force on a Particle Model (FPM)
Momentum Transfer Model (MTM)	Energy Transfer Model (ETM)
Projectile Motion of a Particle Model (PMPM)	Oscillating Particle Model (OPM)
Central Net Force Model (CNFM)	Angular Motion Model (AMM)
Force on an Extended Body Model (FEBM)	

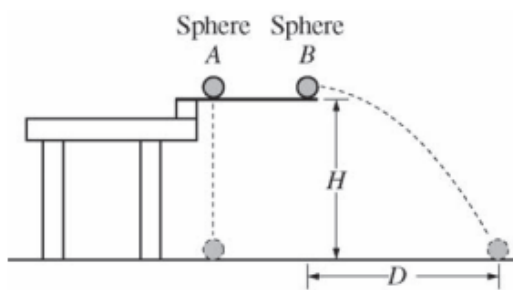


Note: Figure not drawn to scale.

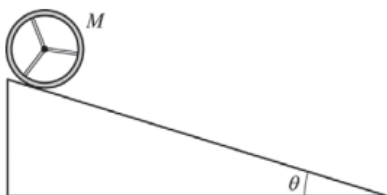
Two blocks are connected by a string of negligible mass that passes over massless pulleys that turn with negligible friction. The mass m_2 of block 2 is greater than the mass m_1 of block 1. The blocks are released from rest.



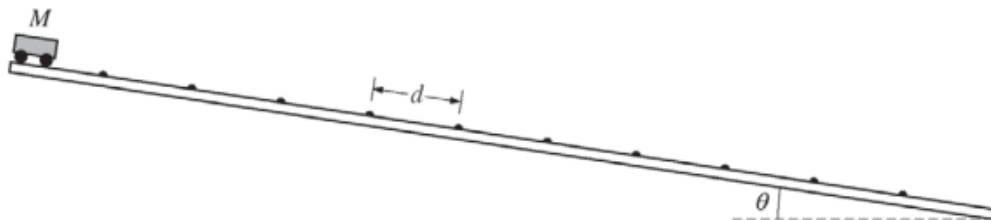
A block is initially at position $x = 0$ and in contact with an uncompressed spring of negligible mass. The block is pushed back along a frictionless surface from position $x = 0$ to $x = -D$, compressing the spring by an amount $\Delta x = D$. The block is then released. At $x = 0$, the block enters a rough part of the track and eventually comes to rest at position $x = 3D$. The coefficient of kinetic friction between the block and the rough track is μ .



Two identical spheres are released from a device at time $t = 0$ from the same height H . Sphere A has no initial velocity and falls straight down. Sphere B is given an initial horizontal velocity of magnitude v_0 and travels a horizontal distance D before it reaches the ground. The spheres reach the ground at the same time t_f .



A wooden wheel of mass M , consisting of a rim with spokes, rolls down a ramp that makes an angle θ with the horizontal. The ramp exerts a force of static friction on the wheel so that the wheel rolls without slipping.

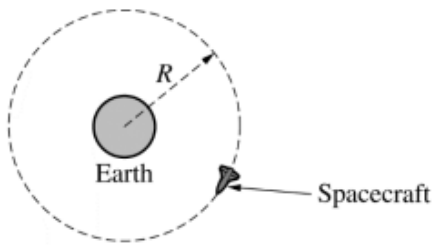


Note: Figure not drawn to scale.

A long track, inclined at an angle θ to the horizontal, has small speed bumps on it. The bumps are evenly spaced a distance d apart. The track is actually much longer than shown, with over 100 bumps. A cart of mass M is released from rest at the top of the track. A student notices that after reaching the 40th bump the cart's average speed

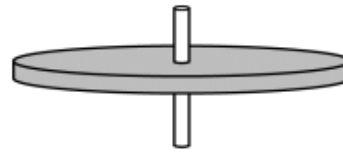
between successive bumps no longer increases, reaching a maximum value v_{avg} . This means that the time interval taken from one bump to the next bump becomes a constant.

A new kind of toy ball is advertised to “bounce perfectly elastically” off hard surfaces. A student suspects, however, that no collision can be perfectly elastic. The student hypothesizes that the collisions are very close to being perfectly elastic for low-speed collisions, but that they deviate more and more from being perfectly elastic as the collision speed increases.



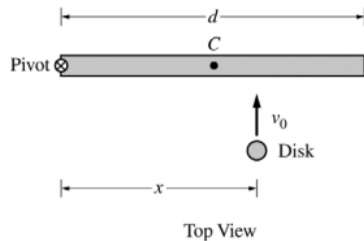
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A spacecraft of mass m is in a clockwise circular orbit of radius R around Earth. The mass of Earth is M_E .

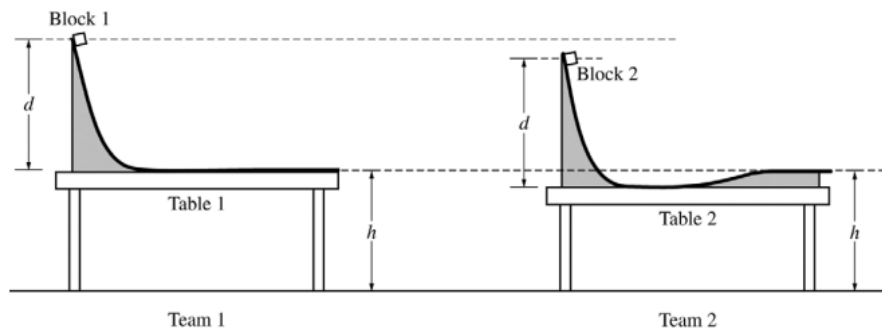


the disk exerts a constant torque on the disk.

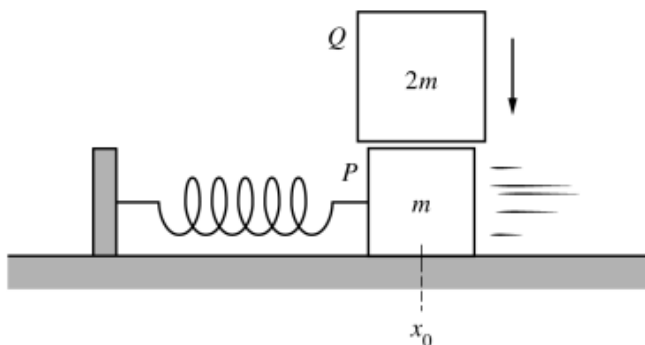
The disk shown spins about the axle at its center. A student's experiment reveals that, while the disk is spinning, friction between the axle and



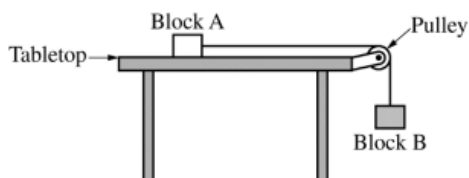
The left end of a rod of length d and rotational inertia I is attached to a frictionless horizontal surface by a frictionless pivot. Point C marks the center (midpoint) of the rod. The rod is initially motionless but is free to rotate around the pivot. A student will slide a disk of mass m_{disk} toward the rod with a velocity v_0 perpendicular to the rod, and the disk will stick to the rod a distance x from the pivot.



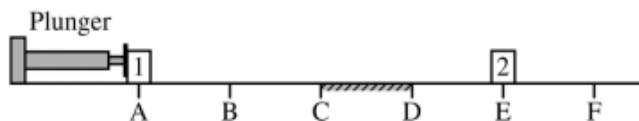
A physics class is asked to design a low-friction slide that will launch a block horizontally from the top of a lab table. Team 1 and team 2 assemble the slides as shown and use identical blocks 1 and 2, respectively. Both slides start and end at the same height d above the tabletop. However, team 2's table is lower than team 1's table. To compensate for the lower table, team 2 constructs the right end of the slide to rise above the tabletop so that the block leaves the slide horizontally at the same height h above the floor as does team 1's block.



Block P of mass m is on a horizontal, frictionless surface and is attached to a spring with spring constant k . The block is oscillating with period T_P and amplitude A_P about the spring's equilibrium position x_0 . A second block Q of mass $2m$ is then dropped from rest and lands on block P at the instant it passes through the equilibrium position. Block Q immediately sticks to the top of block P , and the two-block system oscillates with a period T_{PQ} and amplitude A_{PQ} .



Block A , of mass m_A , rests on a horizontal tabletop. There is negligible friction between block A and the tabletop. Block B , of mass m_B , hangs from a light string that runs over a pulley and attaches to block A . The pulley has negligible mass and spins with negligible friction about its axle. The blocks are released from rest.



Identical blocks 1 and 2 are placed on a horizontal surface at points A and E, respectively. The surface is frictionless except for the region between points C and D, where the surface is rough. Beginning at time t_A , block 1 is pushed with a constant horizontal force from point A to point B by a mechanical plunger. Upon reaching point B, block 1 loses contact with the plunger

and continues moving to the right along the horizontal surface toward block 2. Block 1 collides with and sticks to block 2 at point E, after which the two-block system continues moving across the surface, eventually passing point F.

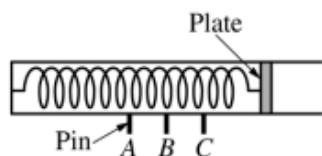


Figure 1. Uncompressed spring

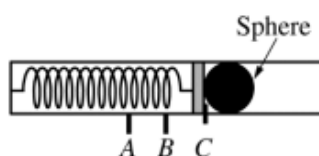
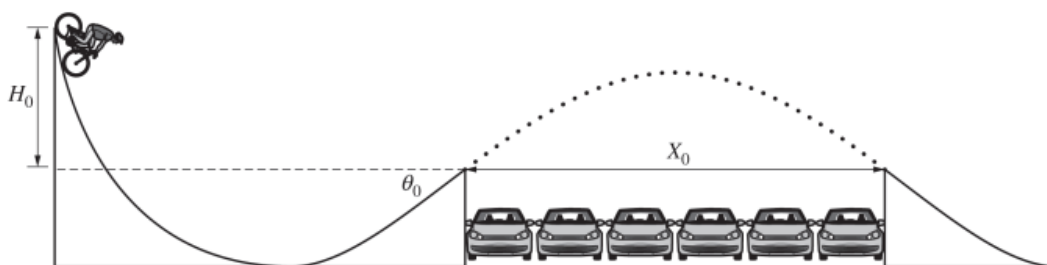


Figure 2. Compressed spring

A projectile launcher consists of a spring with an attached plate. When the spring is compressed, the plate can be held in place by a pin at any of the three positions, A, B, or C. The sphere is launched upon release of the pin.



Note: Figure not drawn to scale.

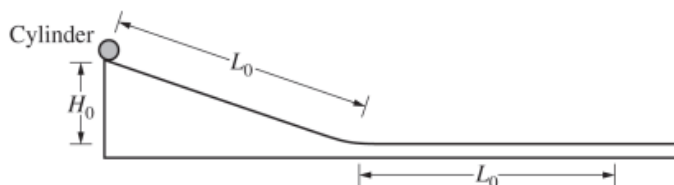
A stunt cyclist builds a ramp that will allow the cyclist to coast down the ramp and jump over several parked cars. To test the ramp, the cyclist starts from rest at the top of the ramp, leaves the ramp, jumps over six cars, and lands on a second ramp. The cyclist and the bicycle have a combined mass of m_o . Other key values are indicated on the diagram.



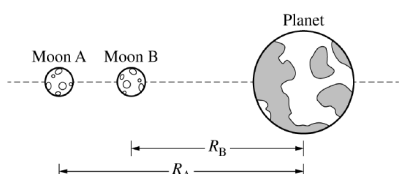
rod can be pulled without breaking.

A group of students is investigating how the thickness of a plastic rod affects the maximum force F_{max} with which the

A student of mass M_S , standing on a smooth surface, uses a stick to push a disk of mass M_D . The student exerts a constant horizontal force of magnitude F_H over the entire time interval from $t = 0$ to $t = t_f$ while pushing the disk. Assume there is negligible friction between the disk and the surface.

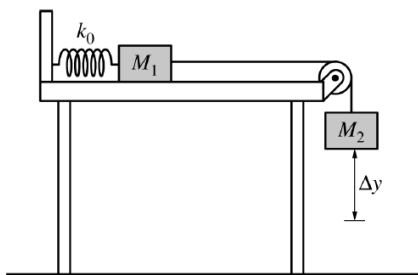


A cylinder of mass m_o is placed at the top of an incline of length L_o and height H_o and released from rest. The cylinder rolls without slipping down the incline and then continues rolling along a horizontal surface.



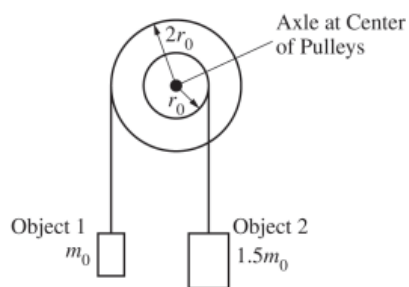
Note: Figure not drawn to scale.

Two identical moons, Moon A and Moon B, orbit a planet. The mass m_o of each moon is significant, but less than the mass m_p of the planet. At some point in their orbits, the planet and the two moons are aligned as shown in the figure..



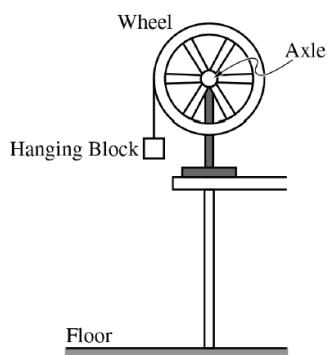
Two blocks are connected by a string that passes over a pulley. Block 1 is on a horizontal surface and is attached to a spring that is at its unstretched length. Frictional forces are negligible in the pulley's axle and

between the block and the surface. Block 2 is released from rest and moves downward a distance Δy before momentarily coming to rest.

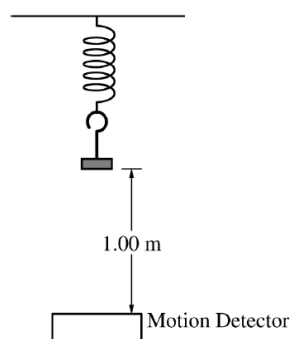


Two pulleys with different radii are attached to each other so that they rotate together about a horizontal axle through their common center. There is negligible friction in the axle. Object 1 hangs

from a light string wrapped around the larger pulley, while object 2 hangs from another light string wrapped around the smaller pulley.

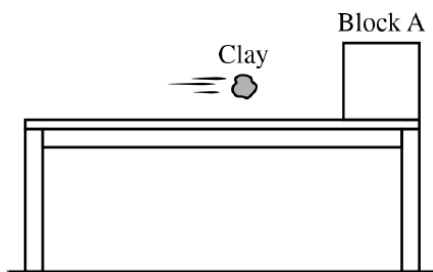


A wheel is mounted on a horizontal axle. A light string is attached to the wheel's rim and wrapped around it several times, and a small block is attached to the free end of the string. When the block is released from rest and begins to fall, the wheel begins to rotate with negligible friction.

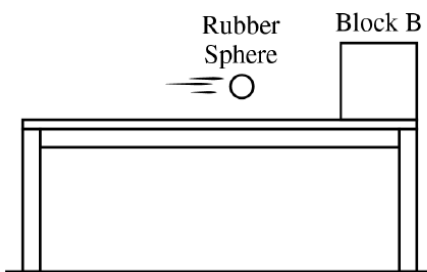


A spring of unknown spring constant k_0 is attached to a ceiling. A lightweight hanger is attached to the lower end of the spring, and a motion detector is placed on the floor facing directly upward under the hanger. A 0.50 kg object is placed on the hanger and allowed to come to rest at the equilibrium position. The spring is then

stretched a distance d_0 from equilibrium and released at time $t = 0$. The motion detector records the height of the bottom of the hanger as a function of time.



Case A: Clay and Block A
Before Collision



Case B: Rubber Sphere and Block B
Before Collision

A student has a piece of clay and a rubber sphere, both of the same mass. Both objects are thrown horizontally at the same speed at identical blocks, that are at rest at the edge of identical tables where friction between the blocks and the tables is negligible. After the collision, both blocks fall to the floor. In Case A, the clay sticks to Block A after the collision. In Case B, the rubber sphere bounces off of Block B after the collision.