UNIVERSITY of DALLAS
THE CATHOLIC UNIVERSITY FOR INDEPENDENT THINKERS

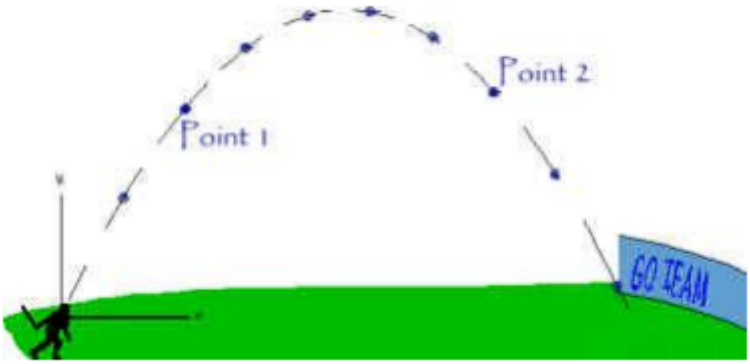
Department of Physics

Scholarship Exam

RULES: You have 50 minutes to take this exam. You may not use any books, online resources, notes, or other individuals in completing the exam. Best wishes.

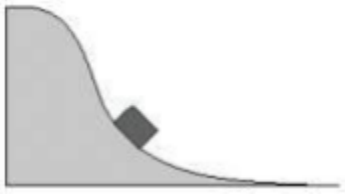
PART A. Conceptual Multiple Choice

1. The parabolic path of a baseball is shown in the diagram below. Ignoring air resistance, how does the acceleration of the baseball at point 1 compare with that at point 2?



(a) The acceleration is greater at point 1.
(b) The acceleration is smaller at point 1.
(c) The accelerations at the two points are equal but in opposite directions.
(d) The accelerations at the two points are equal and in the same directions.

2. As the block slides down a fixed, frictionless hill, as shown,



(a) its speed increases but its acceleration decreases.
(b) its speed decreases but its acceleration increases.
(c) both its speed and acceleration increase
(d) both its speed and acceleration decrease

3. One block of ice (#1) is released and slides down a plane of ice without friction. At the same instant, another block of ice (#2) is dropped from the same height and falls vertically. Which of the following statements is CORRECT?

(a) They reach the ground at the same time.
(b) Block #1 has less speed than Block #2 does at the bottom.
(c) Block #2 reaches the bottom first.
(d) Neither block has constant acceleration during its motion.

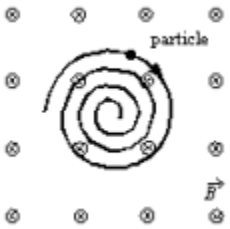
4. A bucket of water containing a cork held down to its bottom is dropped from the top of a building. The moment the bucket is released, the cork is also released so that it is free to float in the water. Right before the buckets hits the ground, the cork is

(a) at the top of the water.
(b) on the bottom of the bucket.
(c) somewhere in the middle of the bucket.
(d) in the air, outside the bucket.

5. A librarian returning a book to the very top shelf of the stacks drops the book. In one second, the book falls one section of the bookcase. By the end of three seconds, the book will have passed

(a) three sections.
(b) five sections.
(c) seven sections.
(d) nine sections.

6. A uniform magnetic field is directed into the page. A charged particle, moving in the plane of the page, follows a clockwise spiral of decreasing radius as shown. A reasonable explanation is:



(a) the charge is positive and slowing down.
(b) the charge is negative and slowing down.
(c) the charge is positive and speeding up.
(d) the charge is negative and speeding up.
(e) none of the above.

7. Suppose a tunnel is drilled directly through the Earth from one side to the other, as shown below, and then all the air is removed. If a bowling ball were dropped in the tunnel, you would expect it

(a) to fall to the center of the Earth and stop.
(b) to fall to the other side of the Earth and stop.
(c) to oscillate back and forth from one side of the Earth to the other.

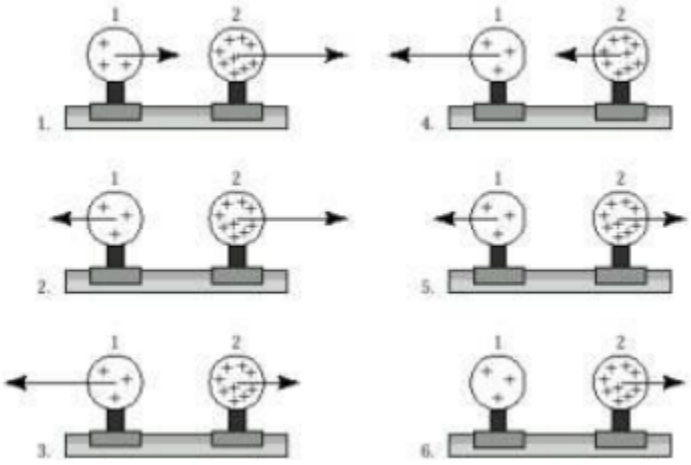
8. Which consumes more fuel, a car accelerating from 0 to 30 mph or from 30 to 60 mph?

(a) Going from 0 to 30 mph does because the car starts from rest.
(b) Going from 0 to 30 mph does because the car has to overcome more friction.
(c) Going from 30 to 60 mph does because kinetic depends on $\frac{1}{2}mv^2$.
(d) Going from 30 to 60 mph does because impulse is $F\Delta t$.

9. The traces below show two patterns of beats when sound waves of two different frequencies interfere. For which of the two is the difference in frequency between the two original waves greater?

(a) Pair 1
(b) Pair 2
(c) The frequencies are the same.

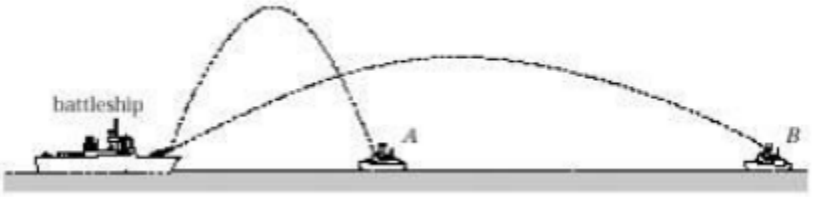
10. Two uniformly charged spheres are firmly fastened to and electrically insulated from frictionless pucks on an airtable. The charge on sphere 2 is three times the charge on sphere 1. Which force diagram correctly shows the magnitude and direction of the electrostatic forces?



(a) 1
(b) 2
(c) 3
(d) 4
(e) 5
(f) 6

PART B. Physical Explanations

1. A battleship simultaneously fires two shells at enemy ships, A and B. If the shells follow the parabolic trajectories shown, which ship gets hit first and why?



2. A homeowner pushes a lawn mower across a horizontal patch of grass with a constant speed by applying a force **P**. The arrows in the diagram correctly indicate the directions but not necessarily the magnitudes of the various forces on the lawn mower. Which of the following relations among the various force magnitudes, *W, f, N, P* is CORRECT and why?

   (a) $P < f$ and $N = W$

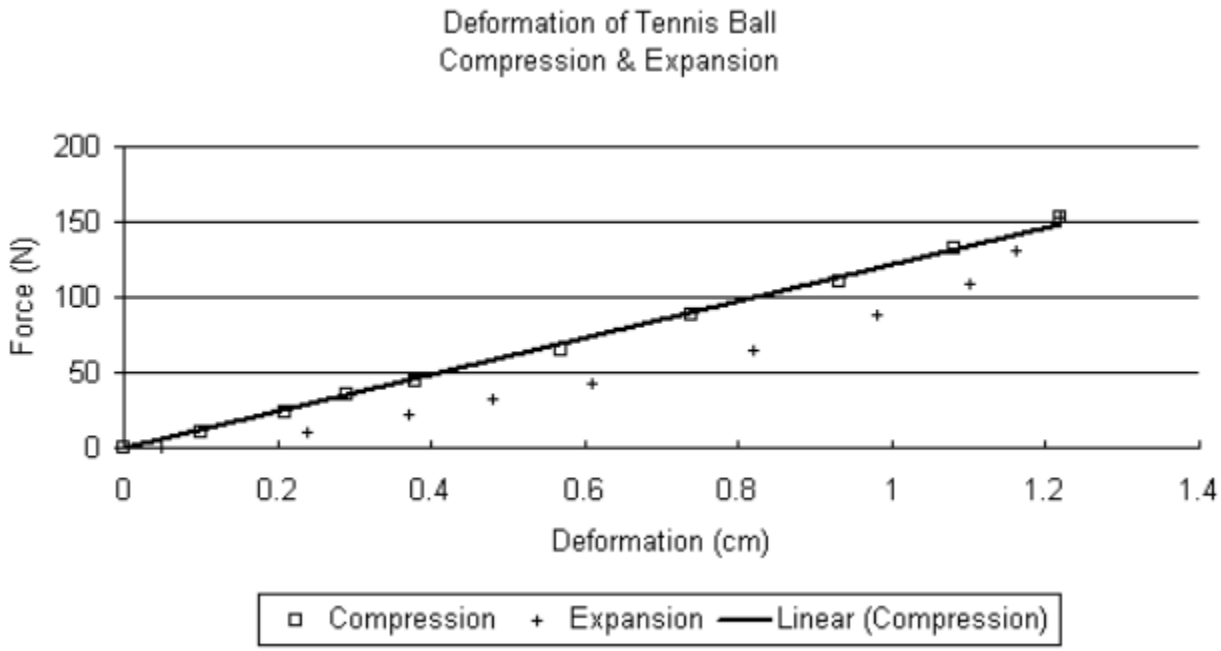
   (b) $P > f$ and $N > W$

   (c) $P > f$ and $N < W$

   (d) $P = f$ and $N > W$

   (e) None of the above

3. Shown below are actual data for the deformation of a tennis ball during compression and expansion as it strikes the racquet.



Determine the equivalent spring constant of the tennis ball during compression, which is shown as the solid line from 0 to 1.2 centimeters.

4. Why does a person jumping from a chair to the floor below bend her knees upon making contact with the floor? What physical principles does she unconsciously use?

5. According to the Equivalence Principle developed by Albert Einstein, there is no way to distinguish a reference frame in a gravitational field from one that is uniformly accelerating. All options in both cases will appear to the observer in the frame to fall with the same constant acceleration, as shown in the animation. What consequence does this principle have when applied to a ray of light?

Please submit this quiz with your Physics Departmental Scholarship application or email it to admissions@udallas.edu.