June 2012

45 The diagram below represents a setup for demonstrating motion.

When the lever is released, the support rod withdraws from ball B, allowing it to fall. At the same instant, the rod contacts ball A, propelling it horizontally to the left. Which statement describes the motion that is observed after the lever is released and the balls fall? [Neglect friction.]
(1) Ball A travels at constant velocity.
(2) Ball A hits the tabletop at the same time as ball B.
(3) Ball B hits the tabletop before ball A.
(4) Ball B travels with an increasing acceleration.

56–57 A toy rocket is launched twice into the air from level ground and returns to level ground. The rocket is first launched with initial speed \( v \) at an angle of 45° above the horizontal. It is launched the second time with the same initial speed, but with the launch angle increased to 60° above the horizontal. Describe how both the total horizontal distance the rocket travels and the time in the air are affected by the increase in launch angle. [Neglect friction.] [2]

June 2011

5 A soccer ball kicked on a level field has an initial vertical velocity component of 15.0 meters per second. Assuming the ball lands at the same height from which it was kicked, what is the total time the ball is in the air? [Neglect friction.]
(1) 0.654 s   (2) 1.53 s   (3) 3.06 s   (4) 6.12 s
11 Four identical projectiles are launched with the same initial speed, \( v \), but at various angles above the level ground. Which diagram represents the initial velocity of the projectile that will have the largest total horizontal displacement? [Neglect air resistance.]

![Diagram of four projectiles with different launch angles]

**June 2010**

6 As shown in the diagram below, a student standing on the roof of a 50.0-meter-high building kicks a stone at a horizontal speed of 4.00 meters per second.

![Diagram of a student kicking a stone]

How much time is required for the stone to reach the level ground below? [Neglect friction.]

(1) 3.19 s  
(2) 5.10 s  
(3) 10.2 s  
(4) 12.5 s

11 A ball is thrown vertically upward with an initial velocity of 29.4 meters per second. What is the maximum height reached by the ball? [Neglect friction.]

(1) 14.7 m  
(2) 29.4 m  
(3) 44.1 m  
(4) 88.1 m

14 Four projectiles, A, B, C, and D, were launched from, and returned to, level ground. The data table below shows the initial horizontal speed, initial vertical speed, and time of flight for each projectile.

<table>
<thead>
<tr>
<th>Projectile</th>
<th>Initial Horizontal Speed (m/s)</th>
<th>Initial Vertical Speed (m/s)</th>
<th>Time of Flight (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>40.0</td>
<td>29.4</td>
<td>6.00</td>
</tr>
<tr>
<td>B</td>
<td>60.0</td>
<td>19.6</td>
<td>4.00</td>
</tr>
<tr>
<td>C</td>
<td>50.0</td>
<td>24.5</td>
<td>5.00</td>
</tr>
<tr>
<td>D</td>
<td>80.0</td>
<td>19.6</td>
<td>4.00</td>
</tr>
</tbody>
</table>
Which projectile traveled the greatest horizontal distance? [Neglect friction.]

(1) A  (2) B  (3) C  (4) D

42 A student throws a baseball vertically upward and then catches it. If vertically upward is considered to be the positive direction, which graph best represents the relationship between velocity and time for the baseball? [Neglect friction.]

Base your answers to questions 51 through 53 on the information and graph below.
A machine fired several projectiles at the same angle, $\theta$ above the horizontal. Each projectile was fired with a different initial velocity, $v_i$. The graph below represents the relationship between the magnitude of the initial vertical velocity, $v_{iy}$, and the magnitude of the corresponding initial velocity, $v_i$, of these projectiles.

51 Determine the magnitude of the initial vertical velocity of the projectile, $v_{iy}$, when the magnitude of its initial velocity, $v_i$, was 40. meters per second. [1]
52 Determine the angle, $\theta$ above the horizontal at which the projectiles were fired. [1]

53 Calculate the magnitude of the initial horizontal velocity of the projectile, $v_{ix}$, when the magnitude of its initial velocity, $v$, was 40. meters per second. [Show all work, including the equation and substitution with units.] [2]

Directions (60–72): Record your answers in the spaces provided in your answer booklet.

Base your answers to questions 60 through 62 on the information below.
The path of a stunt car driven horizontally off a cliff is represented in the diagram below. After leaving the cliff, the car falls freely to point A in 0.50 second and to point B in 1.00 second.

60 Determine the magnitude of the horizontal component of the velocity of the car at point B. [Neglect friction.] [1]
61 Determine the magnitude of the vertical velocity of the car at point A. [1]

62 Calculate the magnitude of the vertical displacement, \( d_y \), of the car from point A to point B. [Neglect friction.] [Show all work, including the equation and substitution with units.] [2]

(Same diagram from January 2009):

Compared to the horizontal component of the car’s velocity at point A, the horizontal component of the car’s velocity at point B is
(1) smaller (2) greater (3) the same

June 2008

6 Two stones, A and B, are thrown horizontally from the top of a cliff. Stone A has an initial speed of 15 meters per second and stone B has an initial speed of 30 meters per second. Compared to the time it takes stone A to reach the ground, the time it takes stone B to reach the ground is
(1) the same (2) twice as great (3) half as great (4) four times as great

June 2007

Base your answers to questions 55 through 57 on the information and diagram below.
A projectile is launched into the air with an initial speed of \( v_i \) at a launch angle of 30° above the horizontal. The projectile lands on the ground 2.0 seconds later.

55 On the diagram above, sketch the ideal path of the projectile. [1]

56 How does the maximum altitude of the projectile change as the launch angle is increased from 30° to 45° above the horizontal? [Assume the same initial speed, \( v_i \).] [1]

57 How does the total horizontal distance traveled by the projectile change as the launch angle is increased from 30° to 45° above the horizontal? [Assume the same initial speed, \( v_i \).] [1]