Gravity

1) The planet Mars has mass 6.4×10^{23} kilograms and radius 3.4×10^{6} meters. The acceleration of an object in free-fall near the surface of Mars is most nearly

(A) zero
(B) 1.0 m s^{-2}
(C) 1.9 m s^{-2}
(D) 3.7 m s^{-2}
(E) 9.8 m s^{-2}

2) A new planet is discovered that has twice the Earth's mass and twice the Earth's radius. On the surface of this new planet, a person who weighs 500 N on Earth would experience a gravitational force of

(A) 125 N
(B) 250 N
(C) 500 N
(D) 1000 N
(E) 2000 N

3) If Spacecraft X has twice the mass of Spacecraft Y, then true statements about X and Y include which of the following?

I. On Earth, X experiences twice the gravitational force that Y experiences.
II. On the Moon, X has twice the weight of Y.
III. When both are in the same circular orbit, X has twice the centripetal acceleration of Y.

(A) I only
(B) III only
(C) I and II only
(D) II and III only
(E) I, II, and III

4) Forces between two objects which are inversely proportional to the square of the distance between the objects include which of the following?

I. Gravitational force between two celestial bodies
II. Electrostatic force between two electrons
III. Nuclear force between two neutrons

(A) I only
(B) III only
(C) I and II only
(D) II and III only
(E) I, II, and III

5) A satellite of mass m and speed v moves in a stable, circular orbit around a planet of mass M. What is the radius of the satellite's orbit?

(A) $\frac{GM}{mv}$
(B) $\frac{Gv}{mM}$
(C) $\frac{GM}{v^2}$
(D) $\frac{GmM}{v}$
(E) $\frac{GmM}{v^2}$

6) An object has a weight W when it is on the surface of a planet of radius R. What will be the gravitational force on the object after it has been moved to a distance of $4R$ from the center of the planet?

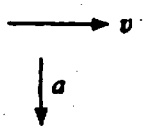
(A) $16W$
(B) $4W$
(C) W
(D) $\frac{1}{4}W$
(E) $\frac{1}{16}W$

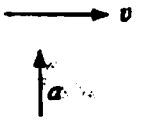
7) The two spheres pictured above have equal densities and are subject only to their mutual gravitational attraction. Which of the following quantities must have the same magnitude for both spheres?

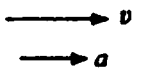
(A) Acceleration
(B) Velocity
(C) Kinetic energy
(D) Displacement from the center of mass
(E) Gravitational force

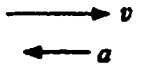
Circular Motion

1) An automobile moves at constant speed down one hill and up another hill along the smoothly curved surface shown above. Which of the following diagrams best represents the directions of the velocity and the acceleration of the automobile at the instant that it is at the lowest position, as shown?

(A) 

(B) 

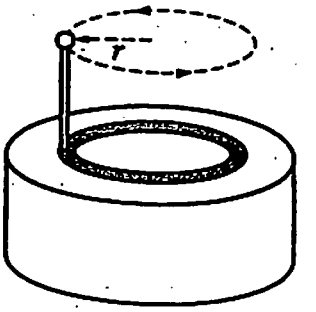
(C) 

(D) 

(E) 

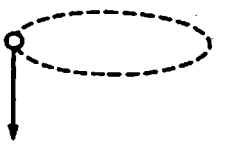
2) A car initially travels north and then turns to the left along a circular curve. This causes a package on the seat of the car to slide toward the right side of the car. Which of the following is true of the net force on the package while it is sliding?

(A) The force is directed away from the center of the circle.
(B) The force is directed north.
(C) There is not enough force directed north to keep the package from sliding.
(D) There is not enough force tangential to the car's path to keep the package from sliding.
(E) There is not enough force directed toward the center of the circle to keep the package from sliding.

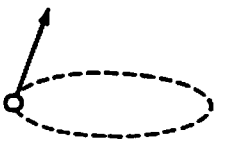


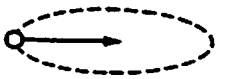
3) A steel ball supported by a stick rotates in a circle of radius r, as shown above. The direction of the net force acting on the ball when it is in the position shown is indicated by which of the following?

(A) 

(B) 

(C) 

(D) 

(E) 

4) A child has a toy tied to the end of a string and whirls the toy at constant speed in a horizontal circular path of radius R. The toy completes each revolution of its motion in a time period T. What is the magnitude of the acceleration of the toy?

(A) Zero

(B) $\frac{4\pi^2 R}{T^2}$

(C) $\frac{\pi R}{T^2}$

(D) g

(E) $2\pi g$