1. B The equation for the centripetal acceleration is a = v 2/ r . That is, acceleration is inversely proportional to the radius of the circle. If the radius is doubled, then the acceleration is halved.

2. E From the formula a = v 2/ r , we can see that centripetal acceleration is directly proportional to the square of the instantaneous velocity. If the velocity is doubled, then the centripetal acceleration is multiplied by a factor of 4.

3. C The formula for centripetal acceleration is ac = v 2/ r . As you can see, mass has no influence on centripetal acceleration. If you got this question wrong, you were probably thinking of the formula for centripetal force: F = mv 2/ r . Much like the acceleration due to gravity, centripetal acceleration is independent of the mass of the accelerating object.

4. E The centripetal acceleration of the block is given by the equation a = 2/ R , where is the velocity of the bullet-block system after the collision. We can calculate the value for by applying the law of conservation of linear momentum. The momentum of the bullet before it strikes the block is p = mv . After it strikes the block, the bullet-block system has a momentum of . Setting these two equations equal to one another, we find:If we substitute into the equation , we find:

5. C The rotating wheel exerts a centripetal force on the pebble. That means that, initially, the pebble is drawn directly upward toward the center of the wheel.

6. A Newton’s Law of Universal Gravitation tells us that the gravitational force between two objects is directly proportional to the masses of those two objects, and inversely proportional to the square of the distance between them. If that distance is doubled, then the gravitational force is divided by four.

7. E Circumference and radius are related by the formula C = 2π r , so if the circumference of the earth were halved, so would the radius. The acceleration due to gravity at the surface of the earth is given by the formula:where M is the mass of the earth. This is just a different version Newton’s Law of Universal Gravitation, where both sides of the equation are divided by m , the mass of the falling object. From this formula, we can see that a is inversely proportional to r 2. If the value of a is normally g , the value of a when r is halved must be 4 g .

8. B To get a formula that relates orbital velocity and orbital radius, we need to equate the formulas for gravitational force and centripetal force, and then solve for v :From this formula, we can see that velocity is inversely proportional to the square root of r . If r is doubled, v is multiplied by .

9. A We can apply the law of conservation of energy to calculate that the object’s change in potential energy is equal to its change in kinetic energy. The potential energy of an object of mass m at a distance from a planet of mass M is U = – GMm/r . The change in potential energy for the object is:This change in potential energy represents the object’s total kinetic energy, KE = 1 /2 mv 2, when it hits the Earth. Equating change in potential energy and total kinetic energy, we can solve for v :

10. B Kepler’s Third Law tells us that T 2/ a 3 is a constant for every planet in a system. If we let xT be the value for the period of planet B ’s orbit, then we can solve for x using a bit of algebra: