Review 2012

1. **Conceptual Questions Circle Motion/ projectile motion/ Impulsemomentum**

1) Is it possible for an object moving with a constant speed to accelerate? Explain.

A) No, if the speed is constant then the acceleration is equal to zero.
B) No, an object can accelerate only if there is a net force acting on it.
C) Yes, although the speed is constant, the direction of the velocity can be changing.
D) Yes, if an object is moving it can experience acceleration

2) An object moves in a circular path at a constant speed. Compare the direction of the object's velocity and acceleration vectors.

A) Both vectors point in the same direction.
B) The vectors point in opposite directions.
C) The vectors are perpendicular.
D) The question is meaningless, since the acceleration is zero.

3) When an object experiences uniform circular motion, the direction of the acceleration is

A) in the same direction as the velocity vector.
B) in the opposite direction of the velocity vector.
C) is directed toward the center of the circular path.
D) is directed away from the center of the circular path.

4) What type of acceleration does an object moving with constant speed in a circular path experience?

A) free fall
B) constant acceleration
C) linear acceleration
D) centripetal acceleration

5) When an object experiences uniform circular motion, the direction of the net force is

A) in the same direction as the motion of the object.
B) in the opposite direction of the motion of the object.
C) is directed toward the center of the circular path.
D) is directed away from the center of the circular path.

6) A roller coaster car is on a track that forms a circular loop in the vertical plane. If the car is to just maintain contact with track at the top of the loop, what is the minimum value for its centripetal acceleration at this point?

A) g downward
B) 0.5g downward
C) g upward
D) 2g upward

7) A pilot executes a vertical dive then follows a semi-circular arc until it is going straight

up. Just as the plane is at its lowest point, the force on him is

A) less than mg, and pointing up.
B) less than mg, and pointing down.
C) more than mg, and pointing up.
D) more than mg, and pointing down.

8) A coin of mass m rests on a turntable a distance r from the axis of rotation. The turntable rotates with a frequency of f. What is the minimum coefficient of static friction between the turntable and the coin if the coin is not to slip?

A) $(4\pi^2 f^2 r)/g$
B) $(4\pi^2 f r^2)/g$
C) $(4\pi f^2 r)/g$
D) $(4\pi f r^2)/g$

9) A car goes around a curve of radius r at a constant speed v. Then it goes around the same curve at half of the original speed. What is the centripetal force on the car as it goes around the curve for the second time, compared to the first time?

A) twice as big
B) four times as big
C) half as big
D) one-fourth as big

10) A car goes around a curve of radius r at a constant speed v. Then it goes around a curve of radius 2r at speed 2v. What is the centripetal force on the car as it goes around the second curve, compared to the first?

A) four times as big
B) twice as big
C) one-half as big
D) one-fourth as big

Quantitative Problems

1) An object moves with a constant speed of 30 m/s on a circular track of radius 150 m. What is the acceleration of the object?

A) zero
B) 0.17 m/s^2
C) 5.0 m/s^2
D) 6.0 m/s^2

2) The maximum speed around a level curve is 30.0 km/h. What is the maximum speed around a curve with twice the radius? (Assume all other factors remain unchanged.)

A) 42.4 km/h
B) 45.0 km/h
C) 60.0 km/h
D) 120 km/h

3) What is the centripetal acceleration of a point on the perimeter of a bicycle wheel of diameter 70 cm when the bike is moving 8.0 m/s?

A) 91 m/s^2
B) 1.8×10^2 m/s^2
C) 2.1×10^2 m/s^2
D) 2.7×10^2 m/s^2

4) A point on a wheel rotating at 5.00 rev/s is located 0.200 m from the axis. What is the centripetal acceleration?

A) 0.050 m/s^2
B) 1.35 m/s^2
C) 48.0 m/s^2
D) 198 m/s^2

5) How many revolutions per minute must a circular, rotating space station of radius 1000 m rotate to produce an artificial gravity of 9.80 m/s^2?

A) 0.65 rpm
B) 0.75 rpm
C) 0.85 rpm
D) 0.95 rpm

6) A 0.50-kg mass is attached to the end of a 1.0-m string. The system is whirled in a horizontal circular path. If the maximum tension that the string can withstand is 350 N. What is the maximum speed of the mass if the string is not to break?

A) 700 m/s
B) 26 m/s
C) 19 m/s
D) 13 m/s

7) A stone, of mass m, is attached to a strong string and whirled in a vertical circle of radius r. At the exact bottom of the path the tension in the string is 3 times the stone's weight. The stone's speed at this point is given by

A) $2(gr)^{1/2}$.
B) $(2gr)^{1/2}$.
C) $(gr)^{1/2}$.
D) 2gr.

8) A jet plane flying 600 m/s experiences an acceleration of 4g when pulling out of the dive. What is the radius of curvature of the loop in which the plane is flying?

A) 640 m
B) 1200 m
C) 7100 m
D) 9200 m

9) A pilot makes an outside vertical loop (in which the center of the loop is beneath him) of radius 3200 m. At the top of his loop he is pushing down on his seat with only one-half of his normal weight. How fast is he going?

A) 5.0 m/s B) 25 m/s C) 125 m/s D) 625 m/s

10) A car traveling 20 m/s rounds an 80-m radius horizontal curve with the tires on the verge of slipping. How fast can this car round a second curve of radius 320 m? (Assume the same coefficient of friction between the car's tires and each road surface.)

A) 20 m/s B) 40 m/s C) 80 m/s D) 160 m/s

11) A car is negotiating a flat curve of radius 50 m with a speed of 20 m/s. The centripetal force provided by friction is 1.2×10^4 N. What is the mass of the car?

A) 500 kg B) 1000 kg C) 1500 kg D) 2000 kg

12) A car goes around a flat curve of radius 50 m at a speed of 14 m/s. What must be the minimum coefficient of friction between the tires and the road for the car to make the turn?

A) 0.20 B) 0.40 C) 0.60 D) 0.80

13) A car is moving with a constant speed v around a level curve. The coefficient of friction between the tires and the road is 0.40. What is the minimum radius of the curve if the car is to stay on the road?

A) $0.40v^2/g$ B) v^2/g C) $2.5v^2/g$ D) $2v^2/g$

Solutions

1. C
2. C
3. C
4. D
5. C
6. A
7. C
8. A
9. D
10. B

1. D
2. A

3. B
4. D
5. D
6. B
7. B
8. D
9. C
10. B
11. C
12. B
13. C

Projectile Motion:

1. A Horizontal Projectile Motion

1. Erica kicks a soccer ball 12 m/s at horizontally from the edge of the roof of a building which is 30.0mhigh.
a.When does it strike the ground?

b. With what velocity does the ball strike the ground?

2. A car drives straight off the edge of a cliff that is 54 m high. The police at the scene of the accident note that the point of impact is 130 m from the base of the cliff. How fast was the car traveling when it went over the cliff?

3. A ball thrown horizontally at 22.2 m/s from the roof of a building lands 36 m from the base of the building. How tall is the building?

4. A boy kicked a can horizontally from a 6.5 m high rock with a speed of 4.0 m/s. How far from the base of the rock the can land?

5. A pilot flying a constant 215 km/h horizontally in a low-flying helicopter, wants to drop secret documents into his contact"s open car which is traveling 155 km/h in the same direction on a level highway 78.0 m below. At what angle (to the horizontal) should the car be in his sights when the packet is released?

6. A ski jumper travels down a slope and leaves the ski track moving in the horizontal direction with a speed of 25 m/s. The landing incline falls off with a slope of 33º.
a. How long is the ski jumper air borne?
b. Where does the ski jumper land on the incline?

Projectile Motion

1. A daredevil decides to jump a canyon of width 10 m. To do so, he drives a motorcycle up an incline sloped at an angle of 15 degrees. What minimum speed must he have in order to clear the canyon?

2. A ball is kicked from a point 38.9 m away from the goal. The crossbar is 3.05 m high. If the ball leaves the ground with a speed of 20.4 m/s at an angle of 52.2º to the horizontal

a. By how much does the ball clear or fall short of clearing the crossbar?

b. What is the vertical velocity of the ball at the time it reaches the crossbar?

3. A rocket is accelerating vertically upward at 30 m/s^2 near Earth's surface. A bolt separates from the rocket. What is the acceleration of the bolt?

4. Water is leaving a hose at 6.8 m/s. If the target is 2 m away horizontally, What angle should the water have initially?

5. A 5.0 kg brick lands 10.1 m from the base of a building. If it was given an initial velocity of 8.6 m/s [61º above the horizontal], how tall is the building?

6. A spear is thrown upward from a cliff 48 m above the ground. Given an initial speed of 24 m/s at an angle of 30º to the horizontal,

a. how long is the spear in flight?

b. what is the magnitude and direction of the spear's velocity just before it hits the ground?

7. A projectile is shot from the edge of a cliff 125 m above ground level with an initial speed of 65.0 m/s at an angle of 37º above the horizontal. Determine the the magnitude and the direction of the velocity at the maximum height.

Momentum Impulse

1.Which of the following statements are true about momentum?

a. Momentum is a vector quantity.

b. The standard unit on momentum is the Joule.

c. An object with mass will have momentum.

d. An object which is moving at a constant speed has momentum.

e. An object can be traveling eastward and slowing down; its momentum is westward.

f. Momentum is a conserved quantity; the momentum of an object is never changed.

g. The momentum of an object varies directly with the speed of the object.

h. Two objects of different mass are moving at the same speed; the more massive object will have the greatest momentum.

i. A less massive object can never have more momentum than a more massive object.

j. Two identical objects are moving in opposite directions at the same speed. The forward moving object will have the greatest momentum.

k. An object with a changing speed will have a changing momentum.

Answer: ADGHK

a. **TRUE**- Momentum is a vector quantity. Like all vector quantities, the momentum of an object is not fully described until the direction of the momentum is identified. Momentum, like other vector quantities, is subject to the rules of vector operations.

b. **FALSE**- The Joule is the unit of work and energy. The kg m/s is the standard unit of momentum.

c. **FALSE**- An object has momentum if it is moving. Having mass gives an object inertia. When that inertia is in motion, the object has momentum.

d. **TRUE**- This is true. However, one should be quick to note that the object does not have to have a constant speed in order to have momentum.

e. **FALSE**- The direction of an object's momentum vector is in the direction that the object is moving. If an object is traveling eastward, then it has an eastward momentum. If the object is slowing down, its momentum is still eastward. Only its acceleration would be westward.

f. **FALSE**- To say that momentum is a conserved quantity is to say that if a system of objects can be considered to be isolated from the impact of net external forces, then the total momentum of that system is conserved. In the absence of external forces, the total momentum of a system is not altered by a collision. However, the momentum of an individual object is altered as momentum is transferred between colliding objects.

g. **TRUE**- Momentum is calculated as the product of mass and velocity. As the speed of an object increases, so does its velocity. As a result, an increasing speed leads to an increasing momentum - a direct relationship.

h. **TRUE**- For the same speed (and thus velocity), a more massive object has a greater product of mass and velocity; it therefore has more momentum.

i. **FALSE**- A less massive object would have a greater momentum owing to a velocity which is greater than that of the more massive object. Momentum depends upon two quantities * mass and velocity. Both are equally important.

j. **FALSE**- When comparing the size of two momentum vectors, the direction is insignificant. The direction of any vector would never enter into a size comparison.

k. **TRUE**- Objects with a changing speed also have a changing velocity. As such, an object with a changing speed also has a changing momentum.

2. Which of the following are true about the relationship between momentum end energy?

a. Momentum is a form of energy.

b. If an object has momentum, then it must also have mechanical energy.

c. If an object does not have momentum, then it definitely does not have mechanical energy either.

d. Object A has more momentum than object B. Therefore, object A will also have more kinetic energy.

e. Two objects of varying mass have the same momentum. The least massive of the two objects will have the greatest kinetic energy.

Answer: BE

a. **FALSE**- No. Momentum is momentum and energy is energy. Momentum is **NOT**a form of energy; it is simply a quantity which proves to be useful in the analysis of situations involving forces and impulses.

b. **TRUE**- If an object has momentum, then it is moving. If it is moving, then it has kinetic energy. And if an object has kinetic energy, then it definitely has mechanical energy.

c. **FALSE**- If an object does NOT have momentum, then it definitely does **NOT**have kinetic energy. However, it could have some potential energy and thus have mechanical energy.

d. **FALSE**- Consider Object A with a mass of 10 kg and a velocity of 3 m/s. And consider Object B with a mass of 2 kg and a velocity of 10 m/s. Object A clearly has more momentum. However, Object B has the greatest kinetic energy. The kinetic energy of A is 45 J and the kinetic energy of B is 100 J.

e. **TRUE**- When comparing the momentum of two objects to each other, one must consider both mass and velocity; both are of equal importance when determining the momentum value of an object. When comparing the kinetic energy of two objects, the velocity of an object is of double importance. So if two objects of different mass have the same momentum, then the object with the least mass has a greater velocity. This greater velocity will tip the scales in favor of the least massive object when a kinetic energy comparison is made.

3. Which of the following statements are true about impulse?

a. Impulse is a force.

b. Impulse is a vector quantity.

c. An object which is traveling east would experience a westward directed impulse in a collision.

d. Objects involved in collisions encounter impulses.

e. The Newton is the unit for impulse.

f. The kg•m/s is equivalent to the units on impulse.

g. An object which experiences a net impulse will definitely experience a momentum change.

h. In a collision, the net impulse experienced by an object is equal to its momentum change.

i. A force of 100 N acting for 0.1 seconds would provide an equivalent impulse as a force of 5 N acting for 2.0 seconds.

Answer: BDFGHI

a. **FALSE**- Impulse is **NOT** a force. Impulse is a quantity which depends upon both force and time to change the momentum of an object. Impulse is a force acting over time.
b. **TRUE**- Impulse is a vector quantity Like momentum, impulse is not fully described unless a direction is associated with it.
c. **FALSE**- An object which is traveling east could encounter a collision from the side, from behind (by a faster-moving object) or from the front. The direction of the impulse is dependent upon the direction of the force exerted upon the object. In each of these scenarios, the direction of the force would be different.
d. **TRUE**- In a collision, there is a collision force which endures for some amount of time. The combination of force and time is what is referred to as an impulse.
e. **FALSE**- The Newton is the unit of force. The standard metric unit of impulse is the N•s.
f. **TRUE**- The N•s is the unit of momentum. The Newton can be written as a kg•m/s^2. When substituted into the N•s expression, the result is the kg m/s.
g. **TRUE**- In a collision, there is a collision force which endures for some amount of time to cause an impulse. This impulse acts upon the object to change its velocity and thus its momentum.
h. **TRUE**- Yes!!! This is the impulse-momentum change theorem. The impulse encountered by an object in a collision causes and is equal to the momentum change experienced by that object.
i. **TRUE**- A force of 100 N for 0.10 s results in an impulse of 10 N•s. This 10 N•s impulse is equivalent to the impulse created by a force of 5 N for 2.0 seconds.

4. Which of the following statements are true about collisions?

a. Two colliding objects will exert equal forces upon each other even if their mass is significantly different.

b. During a collision, an object always encounters an impulse and a change in momentum.

c. During a collision, the impulse which an object experiences is equal to its velocity change.

d. The velocity change of two respective objects involved in a collision will always be equal.

e. While individual objects may change their velocity during a collision, the overall or total velocity of the colliding objects is conserved.

f. In a collision, the two colliding objects could have different acceleration values.

g. In a collision between two objects of identical mass, the acceleration values could be different.

h. Total momentum is always conserved between any two objects involved in a collision.

i. When a moving object collides with a stationary object of identical mass, the stationary object encounters the greater collision force.

j. When a moving object collides with a stationary object of identical mass, the stationary object encounters the greater momentum change.

k. A moving object collides with a stationary object; the stationary object has significantly less mass. The stationary object encounters the greater collision force.

l. A moving object collides with a stationary object; the stationary object has significantly less mass. The stationary object encounters the greater momentum change.

Answer: ABF

a. **TRUE**- In any collision between two objects, the colliding objects exert equal and opposite force upon each other. This is simply Newton's law of action-reaction.
b. **TRUE**- In a collision, there is a collision force which endures for some amount of time to cause an impulse. This impulse acts upon the object to change its momentum.
c. **FALSE**- The impulse encountered by an object is equal to mass multiplied by velocity change - that is, momentum change.
d. **FALSE**- Two colliding objects will only experience the same velocity change if they have the same mass and the collision occurs in an isolated system. However, their momentum changes will be equal if the system is isolated from external forces.
e. **FALSE**- This statement is mistaking the term velocity for momentum. It is momentum which is conserved by an isolated system of two or more objects.
f. **TRUE**- Two colliding objects will exert equal forces upon each other. If the objects have different masses, then these equal forces will produce different accelerations.
g. **FALSE**- It the colliding objects have different masses, the equal force which they exert upon each other will lead to different acceleration values for the two objects.
h. **FALSE**- Total momentum is conserved only if the collision can be considered isolated from the influence of net external forces.
i. **FALSE**- In any collision, the colliding objects exert equal and opposite forces upon each other as the result of the collision interaction. There are no exceptions to this rule.
j. **FALSE**- In any collision, the colliding objects will experience equal (and opposite) momentum changes, provided that the collision occurs in an isolated system.
k. **FALSE**- In any collision, the colliding objects exert equal and opposite forces upon each other as the result of the collision interaction. There are no exceptions to this rule.
l. **FALSE**- In any collision, the colliding objects will experience equal (and opposite) momentum changes, provided that the collision occurs in an isolated system.

5. Which of the following statements are true about elastic and inelastic collisions?

a. Perfectly elastic and perfectly inelastic collisions are the two opposite extremes along a continuum; where a particular collision lies along the continuum is dependent upon the amount kinetic energy which is conserved by the two objects.

b. Most collisions tend to be partially to completely elastic.

c. Momentum is conserved in an elastic collision but not in an inelastic collision.

d. The kinetic energy of an object remains constant during an elastic collision.

e. Elastic collisions occur when the collision force is a non-contact force.

f. Most collisions are not inelastic because the collision forces cause energy of motion to be transformed into sound, light and thermal energy (to name a few).

g. A ball is dropped from rest and collides with the ground. The higher that the ball rises upon collision with the ground, the more elastic that the collision is.

h. A moving air track glider collides with a second stationary glider of identical mass. The first glider loses all of its kinetic energy during the collision as the second

glider is set in motion with the same original speed as the first glider. Since the first glider lost all of its kinetic energy, this is a perfectly inelastic collision.

i. The collision between a tennis ball and a tennis racket tends to be more elastic in nature than a collision between a halfback and linebacker in football.

Answer: AEFGI

a. **TRUE**- A perfectly elastic collision is a collision in which the total kinetic energy of the system of colliding objects is conserved. Such collisions are typically characterized by bouncing or repelling from a distance. In a perfectly inelastic collision (as it is sometimes called), the two colliding objects stick together and move as a single unit after the collision. Such collisions are characterized by large losses in the kinetic energy of the system.

b. **FALSE**- Few collisions are completely elastic. A completely elastic collision occurs only when the collision force is a non-contact force. Most collisions are either perfectly inelastic or partially inelastic.

c. **FALSE**- Momentum can be conserved in both elastic and inelastic collisions provided that the system of colliding objects is isolated from the influence of net external forces. It is kinetic energy that is conserved in a perfectly elastic collision.

d. **FALSE**- In a perfectly elastic collision, in an individual object may gain or lose kinetic energy. It is the system of colliding objects which conserves kinetic energy.

e. **TRUE**- Kinetic energy is lost from a system of colliding objects because the collision transforms kinetic energy into other forms of energy - sound, heat and light energy. When the colliding objects don't really collide in the usual sense (that is when the collision force is a non-contact force), the system of colliding objects does not lose its kinetic energy. Sound is only produced when atoms of one object make contact with atoms of another object. And objects only warm up (converting mechanical energy into thermal energy) when their surfaces meet and atoms at those surfaces are set into vibrational motion or some kind of motion.

f. **TRUE**- See above statement.

g. **TRUE**- If large amounts of kinetic energy are conserved when a ball collides with the ground, then the post-collision velocity is high compared to the pre-collision velocity. The ball will thus rise to a height which is nearer to its initial height.

h. **FALSE**- This is a perfectly elastic collision. Before the collision, all the kinetic energy is in the first glider. After the collision, the first glider has no kinetic energy; yet the second glider has the same mass and velocity as the first glider. As such, the second glider has the kinetic energy which the first glider once had.

i. **TRUE**- There is significant bounce in the collision between a tennis racket and tennis ball. There is typically little bounce in the collision between a halfback and a linebacker (though there are certainly exceptions to this one). Thus, the ball-racket collision tends to be more elastic.