Physics 20 Lessons 1 to 23 Review

Kinematics

1. A worker drops a wrench from the top of a tower 80.0 m tall. With what velocity does the wrench strike the ground? (-39.6 m/s)

2. A physics student throws a softball straight up into the air. The ball was in the air for a total of 3.56 s before it was caught at its original position. (a) What was the initial velocity of the ball? (b) How high did it rise? (+17.5 m/s, 15.5 m)

3. A small sandbag is dropped from rest from a hovering hot-air balloon. After 2.0 s, what is the velocity of the sandbag and how far below the hot-air balloon is the sand bag? (-2.0×10^1 m/s, -2.0×10^1 m)

4. A ball thrown vertically upward is caught by the thrower after 5.0 s. (a) Find the initial velocity of the ball. (b) Find the maximum height it reaches. (+25 m/s, 31 m)

5. A peregrine falcon dives at a pigeon. The falcon starts downward from rest with free-fall acceleration. If the pigeon is 76.0 m below the initial position of the falcon, how long does it take the falcon to reach the pigeon? Assume that the pigeon remains at rest. (3.94 s)

6. A rocket moves upward, starting from rest with an acceleration of +29.4 m/s^2 for 4.00 s. It runs out of fuel at the end of the 4.00 s but does not stop. How high does it rise above the ground? (945 m)

7. A ball is thrown vertically upward with a speed of 25.0 m/s from a height of 2.0 m.
   a. How high does the ball rise? (31.9 m)
   b. How long does it take to reach its highest point? (2.55 s)
   c. How long does the ball take to hit the ground after it reaches its highest point? (2.63 s)
   d. What is the ball's velocity when it returns to the level from which it started? (-25.0 m/s)

8. Two cars are travelling along a straight line in the same direction, the lead car at 25 m/s and the other car at 35 m/s. At the moment the cars are 45 m apart, the lead driver applies the brakes, causing the car to have an acceleration of -2.0 m/s^2.
   a. How long does it take for the lead car to stop? (12 s)
   b. Assume that the driver of the chasing car applies the brakes at the same time as the driver of the lead car. What must the chasing car's minimum negative acceleration be to avoid hitting the lead car? (-3.1 m/s^2)
   c. How long does it take the chasing car to stop? (11 s)

Vectors

1. A girl delivering newspapers covers her route by travelling three blocks west, four blocks north, then six blocks east. (a) What is her resultant displacement? (b) What is the total distance she travels? (5 blocks @ 50^o N of E, 13 blocks)

2. A submarine dives 110.0 m at an angle of 10.0^o below the horizontal. What are the horizontal and vertical components of the submarine's displacement? (108 m, -19 m)

3. A quarterback takes the ball from the line of scrimmage, runs backward for 10.0 yards, then runs sideways parallel to the line of scrimmage for 15.0 yards. At this point, he throws a 50.0-yard forward pass straight down the field. What is the magnitude of the football's resultant displacement? (42.7 yards)

4. A golfer takes two putts to sink his ball in the hole once he is on the green. The first putt displaces the ball 6.00 m east, and the second putt displaces it 5.40 m south. What displacement would put the ball in the hole in one putt? (8.07 m @ 42.0^o S of E)

5. A kayaker paddles upstream in a river at 3.5 m/s relative to the water. Observers on shore note that he is moving at only 1.7 m/s upstream. Determine the velocity of the current in the river. (-1.8 m/s)

6. A jet-ski speeds across a river at 11 m/s relative to the water. The jet ski's heading is due south. The river is flowing west at a rate of 5.0 m/s. Determine the jet-ski's velocity relative to the shore. (12 m/s [24^o W of S])

7. An airplane travels due north for 100 km, then due west for 150 km, and then due south for 500 km.
   (a) Calculate the total displacement of the airplane. (1.6×10^2 km [18^o N of W])
   (b) The time the airplane takes to fly the three different parts of the trip are as follows: 20.0 minutes, 40.0 minutes, and 12.0 minutes. Calculate the velocities for each of the three segments of the trip. (3.0×10^2 km/h North, 2.2×10^2 km/h West, 2.5×10^2 km/h South)

Dynamics

1. Is it possible to have motion in the absence of a force? Explain. (Yes, constant velocity)

2. If an object is at rest, can we conclude that no external forces are acting on it? (No)

3. An object thrown into the air stops at the highest point in its path. Is it in equilibrium at this point? Explain. (No, gravity is pulling down)

4. State Newton's first law.

5. What physical quantity is a measure of the amount of inertia an object has? (mass)

6. A large crate is placed on the bed of a truck but not tied down.
   a. As the truck accelerates forward, the crate slides across the bed until it hits the tailgate. Explain what causes this. (The crate remained at rest while the truck accelerated under it.)
   b. If the driver slammed on the brakes, what could happen to the crate? (The crate continues forward and slams into the back of the cab.)

7. Earth is attracted to an object with a force equal to and opposite the force Earth exerts on the object. Explain why Earth's acceleration is not equal to and opposite that of the object.

8. Explain Newton's second law in terms of inertia.

9. An astronaut on the moon has a 110 kg crate and a 230 kg crate. How do the forces required to lift the crates straight up on the moon compare with the forces required to lift them on Earth?

10. A freight train has a mass of 1.5×10^7 kg. If the locomotive can exert a constant pull of 7.5×10^5 N, how long would it take to increase the speed of the train from rest to 85 km/h? (480 s)

11. A 5.0 kg bucket of water is raised from a well by a rope. If the upward acceleration of the bucket is 3.0 m/s^2, find the force exerted by the rope on the bucket of water. (64 N)

12. A boat moves through the water with two forces acting on it. One is a 2.10×10^3 N forward push by the motor, and the other is a 1.80×10^3 N resistive force due to the water.
   a. What is the acceleration of the 1200 kg boat? (0.25 m/s^2)
   b. If it starts from rest, how far will it move in 10.0 s? (12.5 m)
   c. What will its velocity be at the end of this time interval? (2.5 m/s)

13. A 75 kg person escapes from a burning building by jumping from a window 25 m above a catching net. Assuming that air resistance exerts a 95 N force on the person during the fall, determine the person's velocity just before hitting the net. (2.0×10^1 m/s)

14. The parachute on a race car that weighs 8820 N opens at the end of a quarter-mile run when the car is travelling 35 m/s. What total retarding force must be supplied by the parachute to stop the car in a distance of 1100 m? (-5.0×10^2 N)

15. A 1250 kg car is pulling a 325 kg trailer. Together, the car and trailer have an acceleration of 2.15 m/s^2 directly forward.
    a. Determine the net force on the car. (2690 N)
    b. Determine the net force on the trailer. (699 N)

16. A 0.150 kg baseball is thrown upward with an initial speed of 20.0 m/s.
    a. What is the force on the ball when it reaches half its maximum height? (–1.47 N)
    b. Disregarding air resistance, what is the force on the ball when it reaches its peak? (–1.47 N)

17. A 40.0 kg wagon is towed up a hill inclined at 18.5° with respect to the horizontal. The tow rope is parallel to the incline and exerts a force of 140 N on the wagon. Assume that the wagon starts from rest at the bottom of the hill, and disregard friction. How fast is the wagon going after moving 30.0 m up the hill? (4.9 m/s)

18. A clerk moves a box of cans down an aisle by pulling on a rope attached to the box. The clerk pulls with a force of 185.0 N at an angle of 25.0^o with the horizontal. The box has a mass of 35.0 kg, and the coefficient of kinetic friction between box and floor is 0.450. Find the acceleration of the box. (1.4 m/s^2)

19. A girl coasts down a hill on a sled, reaching the horizontal bottom with a speed of 7.0 m/s. The coefficient of friction between the sled's runners and the snow is 0.050, and the girl and sled together weigh 645 N. How far does the sled travel before coming to rest? (5.0×10^1 m)

Projectiles, Uniform Circular Motion and Gravitation

1. An object is thrown horizontally at a velocity of 18 m/s from the top of a cliff. If the object hits the ground 100 m from the base of the cliff, how high is the cliff ? (151 m)

2. An object is thrown from the ground into the air at an angle of 40^o from the horizontal at a speed of 18 m/s.
    A. What is the maximum height achieved? (6.82 m)
    B. What is the maximum range achieved? (32.5 m)

3. A student standing 10.0 m from a tall building. If the student throws a ball at a velocity of 12 m/s at an angle of 35° to the horizontal, at what height will the ball hit the building? (assume the ball was thrown from ground level) (1 .92 m)

4. A student is standing on the top of a building and he throws an object into the air at a speed of 16 m/s at an angle of 25^o above the horizontal. If the building is 75 m tall, how far from the base of the building will the object hit the ground ? (67. 6 m)

5. The fastest recorded pitch in Major League Baseball, thrown by Nolan Ryan in 1974, was clocked at 162.3 km/h. If a pitch were thrown horizontally with this velocity, how far would the ball fall vertically by the time it reached home plate, 18.3 m away? (0.809 m)

6. A ball is fired from the ground with an initial speed of 1.70×10^3 m/s (approximately five times the speed of sound) at an initial angle of 55.0° to the horizontal. Neglecting air resistance, find (a) the ball's horizontal range and (b) the amount of time the ball is in motion. (2.77×10^5 m, 284 s)

7. A person standing at the edge of a seaside cliff kicks a stone over the edge with a horizontal speed of 18 m/s. The cliff edge is 52 m above the water. How long does it take for the stone to fall to the water? With what speed does it strike the water? (3.3 s, 36 m/s)

8. A daredevil is shot out of a cannon at 45.0° to the horizontal with an initial speed of 25.0 m/s. A net is positioned a horizontal distance of 50.0 m from the cannon. At what height above the cannon should the net be placed in order to catch the daredevil? (10.7 m)

9. A place kicker must kick a football from a point 36.0 m (about 40.0 yd) from the goal, and the ball must clear the crossbar, which is 3.05 m high. When kicked, the ball leaves the ground with a speed of 20.0 m/s at an angle of 53° to the horizontal.
   a. By how much does the ball clear or fall short of clearing the crossbar? (1.0 m)
   b. Does the ball approach the crossbar while still rising or while falling? (falling)

10. A spherical stone with a mass of 1.25 kg is attached to one end of a 90 cm string and is the swung in a horizontal circle. If the maximum force that the string can withstand before breaking is 450 N, what maximum speed can be attained by the stone? (18 m/s)

11. A satellite is located 1000 km above the surface of the Earth. How long would it take for the satellite to complete one orbit of the Earth? What is its speed? (6295 s, 7357 m/s)

12. Jupiter has a mass of 1.90×10^{27} kg and a radius of orbit of 7.78×10^{11} m. Saturn has a mass of 5.67×10^{26} kg and a radius of orbit of 1.43×10^{12} m. What is the gravitational force of attraction between Jupiter and Saturn when one of the planets is on the exact opposite side of the Sun from the other planet? (1.47×10^{19} N)

13. A hill has a radius of curvature of 60 m. With what maximum speed can a car go over the hill without leaving the ground? (24.3 m/s)

14. A satellite is orbiting the Earth with a period of 60 h. Determine the height of the satellite above the Earth's surface. (7.41×10^{7} m)

15. Two students with masses of 65 kg and 74 kg are standing 3.00 m apart. What is the gravitational force of attraction between the students? (3.56×10^{-8} N)

16. What would be the acceleration due to gravity on the Earth if Earth's mass was tripled and the radius was doubled? (7.36 m/s^2)

17. An object with a mass of 5.00 kg is swung 22 times in 57.5 s. If the diameter of the circle is 6.00 m, what is the tension in the rope? (86.7 N)

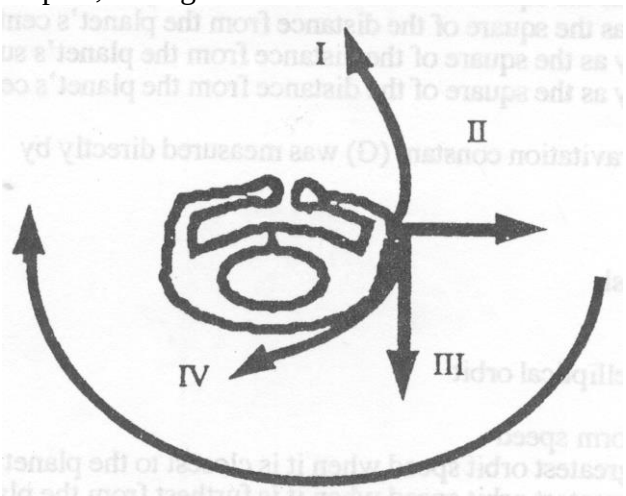
18. A merry-go-round is being turned with a frequency of 0.25 Hz. A child, with a mass of 40 kg, is sitting on the floor of the merry-go-round which has a coefficient of friction of 0.35. What is the maximum distance from the centre where the child can sit without being thrown off the merry-go-round? Explain why the child would be thrown off. (1.39 m)

19. Two masses, 2000 kg and 5000 kg, are placed 20 m apart. A third mass of 500 kg is placed in between the two large masses a distance of 5.0 m from the larger mass. What is the force acting on the 500 kg mass? (6.37×10^{-6} N toward the 5000 kg mass)

Multiple Choice Section

1. Use the following information to answer this question.

As an ice-dancer spins, a fringe on her costume sleeve becomes detached.



Direction of Rotation

The path it will follow, as viewed from above, will be

a) IV
b) I
c) III
d) II

2. Use the following information to answer this question.

A plastic food bag in the space shuttle Discovery appears to float motionless in the air as the shuttle orbits Earth. Several types of forces are possible. Some examples include

I) magnetic
II) gravitational
III) frictional
IV) centripetal
V) forces too small to be measured

The major force or forces acting on the food bag could be described as

a) III only
b) V only
c) II and IV
d) IV and III

3. The term which is defined as the gravitational force on a body is

a) mass
b) weight
c) inertia
d) acceleration due to gravity

4. The gravitational field around a planet varies

   a) directly as the square of the distance from the planet's surface
   b) directly as the square of the distance from the planet's centre
   c) inversely as the square of the distance from the planet's surface
   d) inversely as the square of the distance from the planet's centre

5. The universal gravitation constant (G) was measured directly by

   a) Kepler
   b) Newton
   c) Cavendish
   d) Brahe

6. A satellite in an elliptical orbit

   a) has uniform speed
   b) has the greatest orbit speed when it is closest to the planet it is orbiting
   c) has the greatest orbit speed when it is furthest from the planet it is orbiting
   d) cannot be explained by the universal law of gravitation

7. A proposed design for an Earth space station would involve it rotating. The most important reason for having a space station rotate is

   a) it would give the inhabitants a night/day sequence to keep their biological clocks stable
   b) it would give the inhabitants a more complete view of the Earth below
   c) it would give the inhabitants a complete view of the surrounding space so they could avoid being hit by space "junk"
   d) the centripetal acceleration of the station could simulate gravity for the inhabitants

8. For a satellite in a circular orbit around the Earth.

   a) the orbital velocity must be smaller for a large mass
   b) the orbital velocity will be the same for any mass
   c) the orbital velocity must be larger for a larger mass
   d) fuel must be carried to provide energy to maintain the orbital velocity

9. In order to launch a communications satellite and place it into a geosynchronous orbit around Earth, it is most important to control the

   a) altitude and speed of the satellite
   b) mass and size of the satellite
   c) size and shape of the satellite
   d) mass and altitude of the satellite

Multiple choice answers
1. C 2. C 3. B 4. D 5. C 6. B 7. D 8. B 9. A