If required, use acceleration due to gravity g = 10 m/s^2 down. Unless specified, all motions are free of air resistance.
Questions 1- 45: 2 points each

1) Your pet hamster sits on a record player whose angular speed is constant. If he moves to a point twice as far from the center, then his linear speed
A) doubles.
B) halves.
C) remains the same.

2) If a turntable's rotational speed is doubled, then the linear speed of a pet hamster sitting on the edge of the record will
A) double.
B) halve.
C) remain the same.

3) Suppose the circumference of a bicycle wheel is 2 meters. If it rotates at 1 revolution per second when you are riding the bicycle, then your speed will be
A) 1 m/s.
B) 2 m/s.
C) 3 m/s.
D) 3.14 m/s.
E) 6.28 m/s.

4) An industrial flywheel has a greater rotational inertia when most of its mass is
A) nearest the rim.
B) nearest the axis.
C) uniformly spread out as in a disk.

5) Can an object have more than one center of gravity?
A) no
B) yes
C) it depends on the shape of the object

6) If a pipe effectively extends a wrench handle to 3 times its length, by how much will the torque increase for the same applied force?
A) 3 times
B) 6 times
C) 9 times
D) torque will not increase

7) A small boy places a rock under the middle of a long wood plank, sits near one end and his mother sits near the opposite end. To balance each other
A) the mother should move further away from the boy.
B) the boy should move closer to his mother.
C) both should move closer to the ends of the plank.
D) both should move closer to the middle of the plank.
E) None of the above choices would work.

8) When a twirling ice skater brings her arms inward, her rotational speed
A) increases.
B) decreases.
C) remains the same.

9) The center of gravity of a uniform circular disk of sheet metal is
A) at the center of the disk.
B) midway between the center and the outside.
C) two-thirds of the way between the center and the outside.
D) impossible to predict without knowing the metal density.

10) For a system in mechanical equilibrium
A) the resultant force must be zero.
B) the resultant torques must be zero.
C) the resultant forces and torques must both be zero.
D) the resultant forces and torques must be equal.

11) A huge rotating cloud of particles in space gravitate together to form an increasingly dense ball. As it shrinks in size, the cloud
A) rotates faster.
B) rotates slower.
C) rotates at the same speed.
D) cannot rotate.

12) Neglecting air resistance, which will roll from rest to the bottom of an incline first, an empty jar, or the same jar filled with peanut butter?
A) the filled jar
B) the empty jar
C) Both reach the bottom at the same time.
D) More information is needed.

13) To tighten a bolt, you push with a force of 80 N at the end of a wrench handle that is 0.25 m from the axis of the bolt. What torque are you exerting?
A) 20 Nm
B) 40 Nm
C) 60 Nm
D) 80 Nm

14) What is the tension of in a horizontal string that whirls a 2 kg toy in a circle of radius 2.5 m when it moves at 3 m/s on an icy surface?
A) 1.2 N
B) 2.4 N
C) 7.2 N
D) 4.2 N

15) What is the force of friction that keeps a 75 kg person sitting on the edge of a horizontal rotating platform when the person sits 2 m from the center of the platform and has a tangential speed of 3 m/s?
A) 50. 5 N
B) 37.5 N
C) 112.5 N

D) 337.5 N
16) The Earth's gravitational field extends
A) only above and beyond the Earth's surface and cancels inside the Earth.
B) both inside and outside the Earth and throughout the entire universe.

17) An asteroid exerts a 360 N gravitational force on a nearby spacecraft. If the spacecraft moves to a position three times as far from the center of the asteroid, the force will be
A) zero.
B) 40 N.
C) 120 N.
D) 360 N.
E) 1080 N.

18) If your mass, the mass of the Earth, and the mass of everything in the solar system were twice as much as it is now, yet everything stayed the same size, your weight on Earth would
A) be the same.
B) double.
C) quadruple.
D) be eight times as much as now.
E) none of these

19) If the radius of the Earth somehow decreased with no change in mass, your weight would
A) increase.
B) not change.
C) decrease.

20) The gravitational force between an object and Earth is also known as the object’s
A) mass.
B) weight.
C) volume.
D) area.

21) An object weighs 10N on Earth. If the same object is on the Moon (which has a smaller mass than the Earth), the gravitational force between the object and the Moon will be
A) less than 10 N
B) 10 N
C) greater than 10 N

22) When an elevator accelerates upward, your weight reading on a scale is
A) greater.
B) less.
C) zero.
D) the normal weight.

23) When the elevator cable breaks, the elevator falls freely, so your weight reading is
A) greater.
B) less.
C) zero.
D) the normal weight.

24) If the masses of two planets are each somehow doubled, the force of gravity between them
A) doubles.
B) quadruples.
C) reduces by half.
D) reduces by one-quarter.

25) If the masses of two planets are each somehow doubled and also the distance between them is doubled, the force of gravity between them
A) doubles.
B) quadruples.
C) the same.
D) reduces by one-quarter.

26) Newton discovered
A) gravity.
B) that gravity is universal.

27) According to Newton, the greater the masses of interacting objects, the
A) less the gravitational force between them.
B) greater the gravitational force between them.
C) greater the force between them by the square of the masses.

28) What is the force of gravity on a 500 newton woman standing on the Earth's surface?
A) 50 N
B) 250 N
C) 500 N
D) 5000 N

29) An object is placed exactly halfway between the Earth and moon. Assume there are no other forces on the object except for the forces from the Earth and moon. The object will fall toward the
A) Earth.
B) moon.
C) neither of these

30) A weight watcher who normally weighs 400 N stands on top of a very tall ladder so she is one Earth radius above the Earth's surface. How much would she weigh there?
A) 0
B) 100 N
C) 200 N
D) 400 N

31) A rock is thrown upward at 60 degrees with respect to the horizontal. It follows a parabolic path. As it falls back, neglecting air drag, its vertical component of velocity
A) increases.
B) remains unchanged.
C) decreases.

32) Ignoring air resistance, at what angle should a slingshot be oriented for maximum horizontal range?
A) 45 degrees
B) 90 degrees
C) None of the above

33) An Earth satellite is simply a projectile
A) freely falling around the Earth.
B) floating motionless in space near the Earth.
C) approaching the Earth from outer space.

34) A projectile is fired horizontally in a region of no air resistance. The projectile maintains its horizontal component of velocity because
A) it is not acted on by any forces.
B) it is not acted on by any horizontal forces.
C) it has no vertical component of velocity to begin with.
D) the net force acting on it is zero.

35) At the instance a cannon fires a cannonball horizontally over a level range, another cannonball held at the side of the cannon is released and drops to the ground. Which ball, the one fired horizontally or the one dropped from rest, strikes the ground first?
A) the one fired horizontally
B) the one dropped from rest
C) both hit the ground at the same time
D) more information is needed to solve the problem

36) According to Kepler's laws, the paths of planets about the sun are
A) parabolas.
B) circles.
C) straight lines.
D) ellipses.
E) none of these

37) A projectile is launched at ground level at an angle of 15 degrees above the horizontal and lands a certain horizontal distance. What other projection angle for the same speed would produce the same horizontal distance?
A) 30 degrees
B) 45 degrees
C) 50 degrees
D) 75 degrees
E) 90 degrees

38) Roll a bowling ball off the edge of a table. As it falls, its horizontal component of velocity
A) decreases.
B) remains constant.
C) increases.

39) Throw an object upward at a 45 degree angle. With no gravity it will follow a straight-line path. But because of gravity, at the end of 1 second, it is
A) about 5 m below the straight line.
B) about 10 m below the straight line.
C) about 15 m below the straight line.

40) A projectile is launched vertically upward at 50 m/s. If air resistance is negligible, its speed upon returning to its starting point is
A) less than 50 m/s.
B) 50 m/s.
C) more than 50 m/s.
E) none of these

41) A bullet fired horizontally over level ground hits the ground in 0.5 second. If it had been fired with twice the speed in the same direction, it would have hit the ground in
A) less than 0.5 s.
B) more than 0.5 s.
C) 0.5 s.

42) An object is dropped and freely falls to the ground with an acceleration of 10 m/s/s . If it is thrown upward at an angle instead, its acceleration will be
A) 0 m/s/s.
B) 10 m/s/s downward.
C) 10 m/s/s upward.
D) larger than 10 m/s/s.

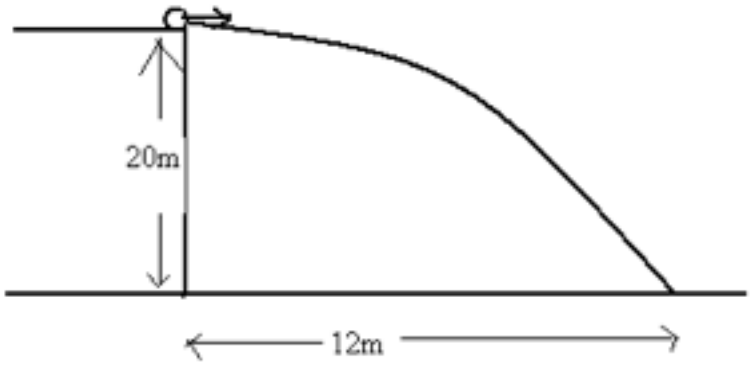
43) A gun with a muzzle velocity of 100 m/s is fired horizontally from a tower. Neglecting air resistance, how far downrange (horizontal distance) will the bullet be 1 second later?
A) 50 m
B) 10 m
C) 100 m
D) 500 m

44) Two projectiles are fired from ground level at equal speeds but different angles. One is fired at an angle of 30 degrees and the other at 60 degrees. The projectile to hit the ground first will be the one fired at (neglect air resistance)
A) 30 degrees.
B) 60 degrees.
C) Both hit at the same time.

45) After a rock thrown straight up reaches the top of its path and then falls a short distance, its acceleration is (neglect air resistance)
A) greater than when it was at the top of its path.
B) less than when it was at the top of its path.
C) the same as it was at the top of its path.

Questions 46 & 47: You must show your work clearly.

46) A child throws a ball horizontally over a cliff. The path of the ball is shown below. The ball lands 12m downrange (horizontal distance), and the elevation of the cliff is 20m.

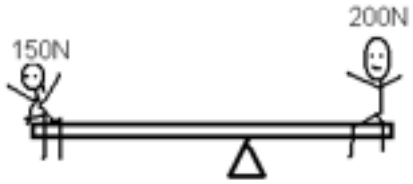


(a) What is the initial speed of the ball? (3 points)

(b) What is the horizontal speed of the ball when it hits the ground, just before it stops? (1 points)

(c) What is the vertical speed of the ball when it hits the ground, just before it stops? (1 point)

47) 150N child and a 200N child are on a seesaw as shown below.



(a)If the 150N child is 4 m from the fulcrum, how far the 200N child should be, to balance the seesaw? (2 points)

(b)If the 150N child now moves toward the fulcrum so that the distance to the fulcrum is now 3m, and the 200N child doesn't move, what is the torque produced by each child? (2 points)

(c)In part (b), what happens to the balance of the seesaw? (1 point)

Answers:
1) A
2) A
3) B
4) A
5) A
6) A
7) E
8) A
9) A
10) C
11) A
12) A
13) A
14) C
15) D
16) B
17) B
18) C
19) A
20) B
21) A
22) A
23) C
24) B
25) C
26) B
27) B
28) C
29) A
30) B
31) A
32) A
33) A
34) B
35) C
36) D
37) D
38) B

39) A
40) B
41) C
42) B
43) C
44) A
45) C

46)
a) We know:
Horizontal distance $d_h = 12$ m
Vertical distance $d_v = 20$ m

Horizontal distance is given by $d_h = V_h \ t$
$12 = V_h \ t$ ----- equation *

In order to find V_h first we need to find time t.

Using vertical distance equation $d_v = 5 \ t^2$
$20 = 5t^2$
$t = 2$ seconds

use this value in equation *
$12 \ V_h$ (2)
This gives horizontal speed $\underline{V_h = 6 \text{ m/s}}$

b) Because there are no horizontal forces, there is no horizontal acceleration. Therefore, horizontal speed constant and when the object hits the ground it is <u>6 m/s.</u>

c) it takes 2 seconds to hit the ground. In vertical direction, the object starts at zero

speed. So, one second later vertical speed is 10 m/s, and 2 seconds later it is <u>20 m/s</u>

47)
a) To balance the seesaw:
The torque provided by 150N child = torque provided by 200N child

150N x 4 m = 200N x d

d = 3 m

b) torque provided by 150N child = 150N x 3 m = 450 Nm

torque provided by 200N child = 200N x 3 m = 600 Nm

c) torques are not equal, so the right end (with larger torque) will go down.