Team Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Team Number:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Hovercraft Mentor Invitational 2017**

Please fill the circle completely on the answer sheet. Marks outside the answer bubble could be considered wrong answers. You may take apart the test but it must be put back together in correct order or 5 points will be deducted.

Tie breakers will be decided by the first team that gets the most correct in order.

1. \_\_\_\_\_\_If a substance A has a density of 3.0 g/cm3 and substance B has a density of 4.0 g/cm3, in order to obtain equal masses, the ratio of A to B must be:
   1. 1:3
   2. 4:3
   3. 3:4
   4. 1:4
2. \_\_\_\_\_\_\_If 50 cm3 of wood is floating on water and 50 cm3 of iron is totally submerged. Which has the greater buoyant force?
   1. The iron
   2. The wood
   3. Both have the same buoyant force
   4. Cannot be determined without their densities
3. \_\_\_\_\_\_\_As a rock sinks deeper and deeper into water of constant density, what happens to the buoyant force on the rock?
   1. It decreases
   2. It increases
   3. It remains constant
   4. It may increase or decrease, depending on the shape of the rock
4. \_\_\_\_\_\_Salt water has greater density than fresh water. A boat floats in both fresh water and salt water. Which substance exerts a greater buoyant force on the boat?
   1. Fresh water
   2. Salt water
   3. Both
   4. Impossible to be determined
5. \_\_\_\_\_\_Salt water is more dense than fresh water. A ship floats in both fresh and salt water. Compared to fresh water, the volume of water displaced in the salt water is:
   1. More
   2. Less
   3. The same
   4. Cannot be determined
6. \_\_\_\_\_\_\_A steel ball sinks in water but floats on mercury. Where is the buoyant force on the steel ball greater?
7. Floating on the mercury
8. Submerged in the water
9. The same
10. Cannot be determined
11. \_\_\_\_\_\_\_A 10 kg piece of aluminum sits at the bottom of a lake, next to a 10 kg piece of lead. Which has the greater buoyant force on it?
    1. The aluminum
    2. The lead
    3. Both are the same
    4. Cannot be determined without knowing their volumes
12. \_\_\_\_\_\_\_A piece of iron rests on the top of a piece of wood floating in a bath tub. If the iron is removed from the wood, what happens to the water level in the tub?
    1. It goes down
    2. It goes up
    3. It stays the same
    4. Cannot be determined
13. \_\_\_\_\_\_A piece of wood is floating in a bath tub. A second piece of wood sits on top of the first piece and does not touch the water. If the top piece is taken off and placed in the water, what happens to the water level in the tub?
    1. It goes down
    2. It goes up
    3. It stays the same
    4. Cannot be determined
14. \_\_\_\_\_\_Water flows through a pipe. The diameter of the pipe at point B is larger than at point A. Where is the speed of water the greatest?
    1. Point A
    2. Point B
    3. The same for both
    4. Cannot be determined
15. \_\_\_\_\_\_An ideal fluid flows at 12 m/s in a horizontal pipe. If the pipe widens to twice its original radius, what is the flow speed in the wider section?
    1. 12 m/s
    2. 6.0 m/s
    3. 4.0 m/s
    4. 3.0 m/s
16. \_\_\_\_\_\_\_An ideal fluid flows at 12 m/s in a horizontal pipe. If the pipe narrows to half its original radius, what is the flow speed in the narrower section?
    1. 12 m/s
    2. 24 m/s
    3. 36 m/s
    4. 48 m/s
17. \_\_\_\_\_Which one of the following is associated with the law of conservation of energy in fluids?
    1. Archimedes principle
    2. Bernoulli’s principle
    3. Pascal’s principle
    4. Equation of continuity
18. \_\_\_\_\_\_As the speed of a moving fluid increases, the pressure in the fluid:
    1. decreases
    2. increases
    3. remains constant
    4. may increase or decrease depending on velocity
19. \_\_\_\_\_\_Water flows through a pipe. The diameter of the pipe at point B is larger than point A. Where is water pressure the greatest?
    1. Point A
    2. Point B
    3. The same for both
    4. Cannot be determined
20. \_\_\_\_\_\_\_When you blow some air above a paper strip, the paper rises. This is because:
    1. the air above the paper moves faster and the pressure is higher
    2. the air above the paper moves faster and the pressure is lower
    3. the air above the paper moves slower and the pressure is higher
    4. the air above the paper moves slower and the pressure is lower
21. \_\_\_\_\_\_A sky diver fall through the air at terminal velocity. The force of air resistance on him is
    1. equal to his weight
    2. half his weight
    3. twice his weight
    4. cannot be determined
22. \_\_\_\_\_\_Two Styrofoam balls, of radii R and 2R are released simultaneously from a tall tower. Which will reach the ground first?
    1. Both will reach at the same time
    2. The larger one
    3. The smaller one
    4. The result will depend on atmospheric pressure
23. \_\_\_\_\_\_When a small spherical rock of radius r falls through water, it experiences a drag force arv, where “v” is velocity, “a” is a constant proportional to the viscosity of the water. From this one can deduce that if a rock of diameter 2.0 mm falls with terminal velocity, “v”, then a rock of diameter 4.0 mm will fall with terminal velocity \_\_\_\_\_\_\_\_.
    1. V
    2. 1.4 V
    3. 2.0 V
    4. 4.0 V
24. \_\_\_\_\_Which has the greatest effect on the flow a fluid in a narrow pipe? If you made a 10% change in each of the quantities below, which would cause the greatest change in the flow rate?
    1. The fluid viscosity
    2. The length of the pipe
    3. The pressure difference
    4. The radius of the pipe
25. \_\_\_\_\_\_\_Two horizontal pipes are the same length, but pipe B has twice the diameter of pipe A. Water undergoes viscous flow in both pipes, subject to the same pressure difference across the lengths of the pipes. If the flow rate of pipe A is Q, what is the flow rate of pipe B?
    1. 2 Q
    2. 4 Q
    3. 8 Q
    4. 16 Q
26. \_\_\_\_\_\_\_A plastic block of the dimensions 2.00 cm x 3.00 cm x 4.00 cm has a mass of 30.0 g. What is its density?
    1. 0.80 g/cm3
    2. 1.20 g/cm3
    3. 1.25 g/cm3
    4. 1.60 g/cm3
27. \_\_\_\_\_\_A liquid has a specific gravity of 0.357. What is its density?
    1. 357 kg/m3
    2. 643 kg/m3
    3. 1000 kg/m3
    4. 3570 kg/m3
28. \_\_\_\_\_\_A brick weighs 50.0 N and measures 30.0 cm x 10.0 cm x 4.00 cm. What is the maximum pressure it can exert on a horizontal surface?
    1. 1.25 Pa
    2. 12.5 Pa
    3. 1.25 kPa
    4. 12.5 kPa
29. \_\_\_\_\_\_A 500 N weight sits on the small piston of a hydraulic machine. The small piston has an area of 2.0 cm2. If the large piston has an area of 40 cm2, how much weight can the large piston support?
    1. 25 N
    2. 500 N
    3. 10,000 N
    4. 40,000 N

1. \_\_\_\_\_\_In a hydraulic garage lift, the small piston has a radius of 5.0 cm and the large piston has a radius of 15 cm. What force must be applied on the small piston in order to lift a car weighing 20,000 N on the large piston?
   1. 6.7 x 103 N
   2. 5.0 x 103 N
   3. 2.9 x 103 N
   4. 2.2 x 103 N
2. \_\_\_\_\_\_A 13,000 N vehicle is to be lifted by a 25 cm diameter hydraulic piston. What force needs to be applied to a 5.0 cm diameter piston to accomplish this?
   1. 260 N
   2. 520 N
   3. 2600 N
   4. 5200 N
3. \_\_\_\_\_\_A block of metal weighs 40 N in air and 30 N in water. What is the buoyant force of the water?
   1. 10 N
   2. 30 N
   3. 40 N
   4. 70 N
4. \_\_\_\_\_\_An object has a volume of 4.0 m3 and weighs 40,000 N. What will its weight be in water?
   1. 40,000 N
   2. 39,200 N
   3. 9,800 N
   4. 800 N
5. \_\_\_\_\_\_A 4.00 kg cylinder of solid iron is supported by a string while submerged in water. What is the tension in the string? The specific gravity of iron is 7.86
   1. 2.50 N
   2. 19.6 N
   3. 23.7 N
   4. 34.2 N
6. \_\_\_\_\_\_\_The density of gold is 19.3 x 103 kg/m3, what buoyant force does a 0.60 kg gold crown experience when immersed in water?
   1. 3.0 x 10-5 N
   2. 3.0 x 10-4 N
   3. 3.0 x 10-2 N
   4. 0.30 N
7. \_\_\_\_\_\_A cylindrical rod of length 12 cm and diameter 2.0 cm will just barely float in water. What is its mass?
   1. 38 g
   2. 75 g
   3. 150 g
   4. 300 g
8. \_\_\_\_\_\_A rectangular box of negligible mass measures 5.0 m long, 1.0 m wide and 0.50 m high. How many kilograms can be loaded onto the box before it sinks in a lake?
   1. 0.5 x 103 kg
   2. 1.5 x 103 kg
   3. 2.5 x 103 kg
   4. 3.5 x 103 kg
9. \_\_\_\_\_\_A 1.0 m3 object floats n water with 20% of it above the waterline. What does the object weigh out of the water?
   1. 1,960 N
   2. 7,840 N
   3. 9,800 N
   4. 11,800 N
10. \_\_\_\_\_\_An object floats with half its volume beneath the surface of the water. The weight of the displaced water is 2000 N. What is the weight of the object?
    1. 1000 N
    2. 2000 N
    3. 4000 N
    4. Cannot be determined
11. \_\_\_\_\_\_A solid object floats in water with three-fourths of its volume beneath the surface. What is the objects density?
    1. 1333 kg/m3
    2. 1000 kg/m3
    3. 750 kg/m3
    4. 250 kg/m3
12. \_\_\_\_\_\_A 200 N object float with three-fourths of its volume beneath the surface of the water. What is the buoyant force on the object?
    1. 50 N
    2. 150 N
    3. 200 N
    4. 267 N
13. \_\_\_\_\_\_\_A liquid flows through a pipe of diameter 3.0 cm at 2.0 m/s. What is the flow rate?
    1. 1.4 x 10-3 m3/s
    2. 5.7 x 10-3 m3/s
    3. 14 m3/s
    4. 57 m3/s
14. \_\_\_\_\_\_\_A liquid flows through a 4.0 cm diameter pipe at 1.0 m/s. There is a 2.0 cm diameter restriction in the line. What is the velocity in this restriction?
    1. 0.25 m/s
    2. 0.50 m/s
    3. 2.0 m/s
    4. 4.0 m/s
15. \_\_\_\_\_\_\_Water flows at 12 m/s in a horizontal pipe with a pressure of 3.0 x 104 N/m2. If the pipe widens to twice its original radius, what is the pressure in the wider section?
    1. 3.0 x 104 N/m2
    2. 4.9 x 104 N/m2
    3. 7.4 x 104 N/m2
    4. 9.8 x 104 N/m2
16. \_\_\_\_\_\_How much pressure does it take for a pump to supply a drinking fountain with 300 kPa, if the fountain is 30.0 m above the pump?
    1. 294 kPa
    2. 300 kPa
    3. 594 kPa
    4. 675 kPa
17. \_\_\_\_\_\_A hole of radius 1.0 mm occurs in the bottom of a water storage tank that holds water at a depth of 15 m. At what rate will water flow out of a hole?
    1. 5.4 x 10-4 m3/s
    2. 5.4 x 10-5 m3/s
    3. 5.4 x 10-6 m3/s
    4. 5.4 x 10-7 m3/s
18. \_\_\_\_\_\_Water flow through a horizontal pipe of cross-sectional area 10.0 cm2 at a pressure of 0.250 atm. The flow rate is 1.00 x 10-3 m3/s. At a valve, the effective cross-sectional area of the pipe is reduced to 5.00 cm2. What is the pressure at the valve?
    1. 0.112 atm
    2. 0.157 atm
    3. 0.200 atm
    4. 0.235 atm
19. \_\_\_\_\_\_SAE No. 10 oil has a viscosity of 0.20 Pa-s. How long would it take to pour 4.0 L of oil through a funnel with a neck 15 cm and 2.0 cm in diameter? Assume the surface of the oil is kept 6 cm above the top of the neck, and neglect any drag effects due to the upper part of the funnel.
    1. 46 s
    2. 52 s
    3. 84 s
    4. 105 s
20. \_\_\_\_\_\_Suppose that the build-up of fatty tissue on the wall of an artery decreased the radius by 10%. By how much would the pressure provided by the heart have to be increased to maintain a constant blood flow?
    1. 48 %
    2. 52 %
    3. 46 %
    4. 54 %
21. \_\_\_\_\_\_\_A freight car moves along a frictionless level railroad track at constant speed. The car is open on top. A large load of coal is suddenly dumped into the car. What happens to the velocity of the car?
    1. It decreases
    2. It increases
    3. It stays the same
    4. Cannot be determined
22. \_\_\_\_\_\_A child falls sideways off a sled while sledding on frictionless ice. What happens to the velocity of the sled?
    1. It decreases
    2. It increases
    3. It stays the same
    4. Cannot be determined
23. \_\_\_\_\_\_A rubber ball and a lump of putty have equal mass. They are thrown with equal speed against a wall. The ball bounces back with nearly the same speed with which it hit. The putty sticks to the wall. Which objects experiences the greater momentum change?
    1. The ball
    2. The putty
    3. Both are the same
    4. Cannot be determined
24. \_\_\_\_\_\_\_A sailboat of mass m is moving with a momentum p. How would you represent its kinetic energy in terms of these two quantities?
    1. P2/ (2m)
    2. 1/ 2 mp2
    3. mp
    4. mp/2
25. \_\_\_\_\_\_\_\_If you pitch a baseball with twice the kinetic energy you gave it in the previous pitch, the magnitude of its momentum is
    1. the same
    2. 1.41 time as much
    3. doubled
    4. 4 times as much
26. \_\_\_\_\_\_\_Which of the following is an accurate statement?
    1. The momentum of a projectile is constant.
    2. The momentum of a moving object is constant.
    3. If an object is acted on by a non-zero net external force, its momentum will not remain constant.
    4. If the kinetic energy of an object is doubled, its momentum will also double.
27. \_\_\_\_\_\_\_A small car meshes with a large truck in a head-on collision. Which of the following statement concerning the magnitude of the average collision force is correct?
    1. The truck experiences the greater average force.
    2. The small car experiences the greater average force.
    3. The small car and the truck experience the same average force.
    4. It is impossible to tell since the masses and velocities are not given.
28. \_\_\_\_\_\_Two equal mass balls (one read and the other blue) are dropped from the same height, and rebound off the floor. The red ball rebounds to a higher position. Which ball is subjected to the greater magnitude of impulse during the collision with the floor?
    1. It impossible to tell since the time intervals and forces are unknown.
    2. Both balls were subjected to the same magnitude impulse
    3. The blue ball
    4. The red ball
29. \_\_\_\_\_\_A Ping-pong ball moving east at a speed of 4 m/s collides with a stationary bowling ball. The Ping-pong ball bounces back to the west, and the bowling ball moves very slowly to the east. Which object experiences the greater magnitude impulse during the collision?
    1. Neither; both experienced the same magnitude impulse
    2. The Ping-pong ball
    3. The bowling ball
    4. It’s impossible to tell since the velocities after the collision are unknown.
30. \_\_\_\_\_\_Two objects collide and bounce off each other. Linear momentum:
    1. is definitely conserved
    2. is definitely not conserved
    3. is conserved only if the collision is elastic
    4. is conserved only if the environment is frictionless
31. \_\_\_\_\_\_\_A 3.0 kg object moves to the right at 4.0 m/s. It collides head-on with a 6.0 kg object moving to the left at 2.0 m/s. Which statement is correct?
    1. The total momentum both before and after the collision is 24 kg • m/s
    2. The total momentum before the collision is 24 kg • m/s and after is 0 kg • m/s
    3. The total momentum both before and after the collision is zero
    4. None of above is true
32. \_\_\_\_\_\_A 100 kg football linebacker moving at 2.0 m/s tackles head on with an 80 kg halfback running at 3.0 m/s. Neglecting the effects due to digging in of cleats:
    1. the linebacker will drive the halfback backward
    2. the halfback will drive the linebacker backward
    3. neither player will drive the other backward
    4. this is a simple example of elastic collision
33. \_\_\_\_\_Ignoring air resistance, the horizontal component of a projectile’s velocity:
    1. is zero
    2. remains constant
    3. continuously increases
    4. continuously decreases
34. \_\_\_\_\_A ball is thrown with a velocity of 20 m/s at an angle of 60\* above the horizontal. What is the horizontal component of its instantaneous velocity at the exact top of its trajectory?
    1. 10 m/s
    2. 17 m/s
    3. 20 m/s
    4. zero
35. \_\_\_\_\_Ignoring air resistance, the horizontal component of a projectile’s acceleration:
    1. is zero
    2. remains a non-zero constant
    3. continuously increases
    4. continuously decreases
36. ~~\_\_\_\_\_A soccer ball is kicked with a velocity of 25 m/s at an angle of 45\* above the horizontal. What is the vertical component of its acceleration as it travels along its trajectory?~~
    1. ~~9.80 m/s~~~~2~~ ~~downward~~
    2. ~~9.80 m/s~~~~2~~ ~~x sin 45\* downward~~
    3. ~~9.80 m/s~~~~2~~ ~~x sin 45\* upward~~
    4. ~~9.80 m/s~~~~2~~ ~~x sin 45\* upward~~
37. \_\_\_\_\_If the acceleration vector of an object is directed anti-parallel to the velocity vector:
    1. the object is turning
    2. the object is speeding up
    3. the object is slowing down
    4. the object is moving in the negative x-direction
38. \_\_\_\_\_\_If the acceleration of an object is always directed perpendicular to its velocity:
    1. the object is speeding up
    2. the object is slowing down
    3. the object is turning
    4. this situation is not physically possible
39. \_\_\_\_\_\_At what angle should a water gun be aimed in order for the water to land with the greatest horizontal range?
    1. 0°
    2. 30°
    3. 45°
    4. 60°
40. \_\_\_\_\_\_You are throwing a ball for the second time. If the ball leaves your hand with twice the velocity it had on your first throw, its horizontal range R (compared to your 1st throw) would be:
    1. 1.4 times as much
    2. half as much
    3. twice as much
    4. four times as much
41. \_\_\_\_\_A ball is throw at an original speed of 8.0 m/s at and angle of 35° above the horizontal. What is the speed of the ball when it returns to the same horizontal level?
    1. 4.0 m/s
    2. 8.0 m/s
    3. 16 m/s
    4. 9.8 m/s
42. \_\_\_\_\_\_\_When a football in a field goal attempt reaches its maximum height, how does its speed compare to its initial speed?
    1. It is zero
    2. It is less than its initial speed
    3. It is equal to its initial speed
    4. It is greater than its initial speed
43. \_\_\_\_\_\_A stone is thrown horizontally from the top of a tower at the same instant a ball is dropped vertically. Which object is traveling faster when it hits the level ground below?
    1. It is impossible to tell from the information
    2. The ball
    3. The stone
    4. Neither, since both are traveling at the same speed
44. \_\_\_\_\_\_\_A bullet is fried horizontally, and at the same instant a second bullet is dropped from the same height. Ignore air resistance. Compare the times of the fall of the two bullets.
    1. The fired bullet hits first
    2. The dropped bullet hits first
    3. They hit at the same time
    4. You cannot tell without knowing the masses
45. \_\_\_\_\_\_It’s more difficult to start moving a heavy carton from rest than it is to keep pushing it with constant velocity, because:
    1. the normal force is greater when the carton is at rest
    2. μs < μk
    3. initially, the normal force is not perpendicular to the applied force
    4. μk < μs
46. \_\_\_\_\_\_A horizontal force accelerates a box from rest across a horizontal surface (friction is present) at a constant rate. The experiment is repeated and all conditions remain the same with the exception that the horizontal force is doubled. What happens to the box’s acceleration?
    1. It increases to more than double its original value
    2. It increases to exactly double its original value
    3. It increases to less than double its original value
    4. It increases somewhat
47. \_\_\_\_\_A packing crate slides down an inclined ramp at constant velocity. Thus we can deduce that:
    1. a frictional force is acting on it
    2. a net downward force is acting on it
    3. it may be accelerating
    4. it is not acted on by appreciable gravitational force
48. \_\_\_\_\_\_A block of mass M slides down a frictionless plane inclined at an angle θ with the horizontal. The normal reaction force exerted by the plane on the block is:
    1. Mg
    2. Mg sin θ
    3. Mg cos θ
    4. Zero since the plane is frictionless
49. \_\_\_\_\_A block of mass M slides down a frictionless plane inclined at an angle θ with the horizontal. The normal reaction force exerted by the plane on the block is directed:
    1. parallel to the plane in the same direction as the movement of the block
    2. parallel to the plane in the opposite direction as the movement of the block
    3. perpendicular to the plane
    4. toward the center of the Earth
50. \_\_\_\_\_\_ A block of mass M slides down a frictionless plane inclined at an angle θ with the horizontal. The gravitational force is directed:
    1. parallel to the plane in the same direction as the movement of the block
    2. parallel to the plane in the opposite direction as the movement of the block
    3. perpendicular to the plane
    4. toward the center of the Earth
51. \_\_\_\_\_An object sits on a frictionless surface. A 16-N force is applied to the object and it accelerates at 2.0 m/s2. What is the mass of the object?
    1. 4.0 kg
    2. 8.0 kg
    3. 32 kg
    4. 78 kg
52. \_\_\_\_\_\_\_A sports car of mass 1000 kg can accelerate from rest to 27 m/s in 7.0 s. What is the average forward force on the car?
    1. 2.6 x 102 N
    2. 3.9 x 103 N
    3. 2.7 x 104 N
    4. 1.9 x 105 N
53. \_\_\_\_\_\_Starting form rest, a 4.0 kg body reaches a speed of 8.0 m/s in 2.0 s. What is the net force acting on the body?
    1. 4.0 N
    2. 8.0 N
    3. 16 N
    4. 32 N
54. \_\_\_\_\_\_\_If you push a 4.0 kg mass with the same force that you push a 10 kg mass from rest:
    1. the 10 kg mass accelerates 2.5 times faster than the 4.0 kg mass
    2. the 4.0 kg mass accelerates 2.5 time faster than the 10 kg mass
    3. both masses accelerate at the same rate
    4. none of the above is true
55. \_\_\_\_\_\_Sue and Sean are having a tug-of-war by pulling on opposite ends of a 5.0 kg rope Sue pulls with a 15 N force. What is Sean’s force if the rope accelerates toward Sue at 2.0m/s2?
    1. 3.0 N
    2. 5.0 N
    3. 25 N
    4. 50 N
56. \_\_\_\_\_\_A stack of books rests on a level frictionless surface. A force F acts on the stack and it accelerates at 3.0 m/s2. A 1.0 kg book is then added to the stack. The same force is applied and now the stack accelerates at 2.0 m/s2. What was the mass of the original stack?
    1. 1.0 kg
    2. 2.0 kg
    3. 3.0 kg
    4. none of the above
57. \_\_\_\_\_\_\_A person of weight 480 N stands on a scale in an elevator. What will the scale be reading when the elevator is accelerating downward at 4.00 m/s2?
    1. 196 N
    2. 284 N
    3. 676 N
    4. 480 N
58. \_\_\_\_\_\_\_Two horizontal forces act on a 5.0 kg mass. One force has a magnitude of 8.0 N and is directed due north. The second force toward the east has a magnitude of 6.0 N. What is the acceleration of the mass?
    1. 1.6 m/s2 due north
    2. 1.2 m/s2 due east
    3. 2.0 m/s2 at 53° N of E
    4. 2.0 m/s2 at 53 m E of N
59. \_\_\_\_\_\_\_A student pulls a box of books on a smooth horizontal floor with a force of 100 N in a direction of 37.0° above the horizontal. If the mass of the box and the books is 40.0 kg, what is the normal force on the box?
    1. 292 N
    2. 312 N
    3. 332 N
    4. 392 N
60. \_\_\_\_\_\_A 10 kg mass slides down a flat hill that makes an angle of 10° with the horizontal. If friction is negligible, what is the resultant force on the sled?
    1. 1.7 N
    2. 17 N
    3. 97 N
    4. 98 N