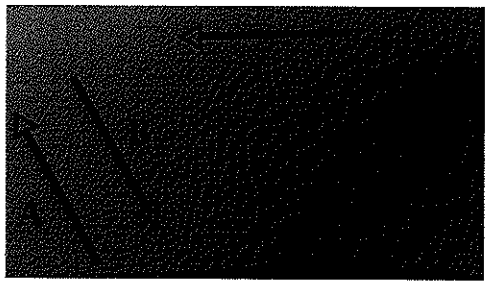
Team Name_____ Team #_____

Your names_____

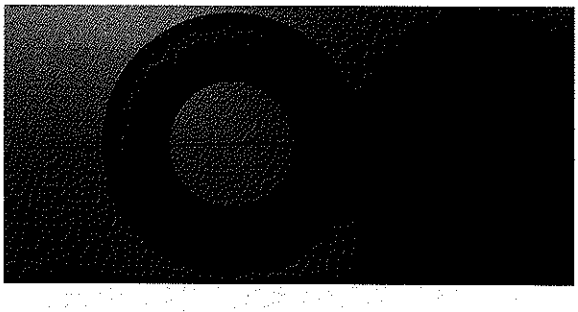
20170204 Hovercraft (test) – Huntley Invitational

1) Below is a diagram of four forces of equal magnitude. Do any three of them look as if they will leave a body's velocity unchanged when all three act on the body? If so, which three?

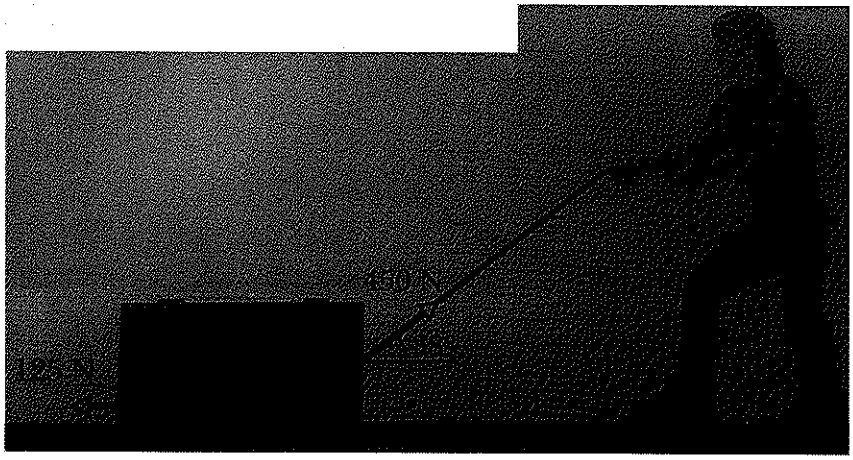


2) Suppose that a 1 kg body accelerates at 4.00 m/s^2 at 160° from the positive direction of the *x* axis, owing to two forces, one of which is $\mathbf{F_1} = (2.50\ N)\mathbf{i} + (4.60\ N)\mathbf{j}$. What is the other force in unit-vector notation?

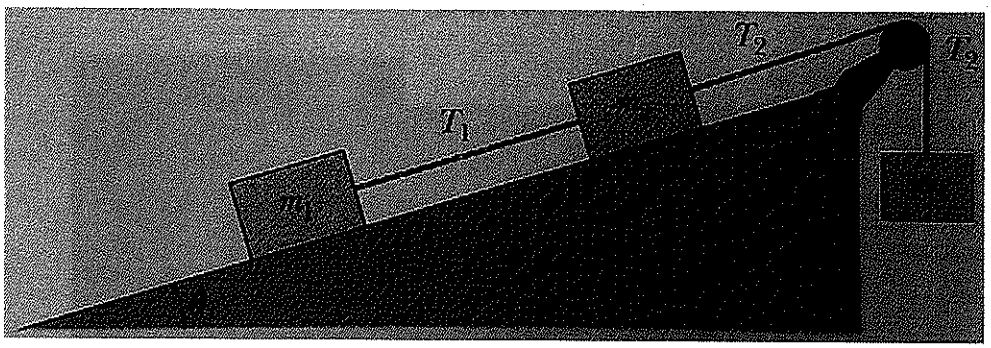
3) A 12 kg tire is to be pulled by three ropes. One force ($\mathbf{F_1}$, with magnitude 50 N) is indicated. Orient the other two forces $\mathbf{F_2}$ and $\mathbf{F_3}$ so that the magnitude of the resulting acceleration of the tire is least, and find the magnitude of the acceleration if (a) $F_2 = 30\ N$, $F_3 = 20\ N$; (b) $F_2 = 30\ N$, $F_3 = 10\ N$; (c) $F_2 = F_3 = 30\ N$



4) The worker below exerts a force of 450 N on the rope, which is inclined at 38° to the horizontal, and the floor exerts a horizontal force of 125 N that opposes the motion. Calculate the acceleration of the crate (a) if its mass is 310 kg and (b) if the weight is 310 N.



5) Shown below is a frictionless inclined plane. If $\theta = 20°$, $m_1 = 2.00$ kg, $m_2 = 1.00$ kg, and $m_3 = 3.00$ kg, find T_1 and T_2, and the acceleration of the blocks.

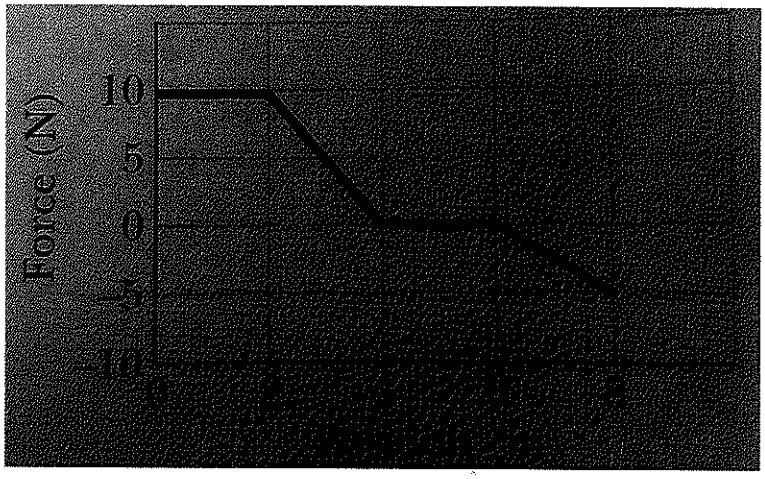


6) Assume that the standard kilogram mass would weigh exactly 9.80 N at sea level on the Earth's equator if the Earth did not rotate. Then take into account the fact that the Earth does rotate, so that this mass moves in a circle of radius 6.40×10^6 m (the Earth's radius) at a constant speed of 465 m/s. (a) Determine the centripetal force needed to keep the standard mass moving in its circular path. (b) Determine the force exerted by the standard mass on a spring balance from which it is suspended at the equator (that force is its "apparent weight").

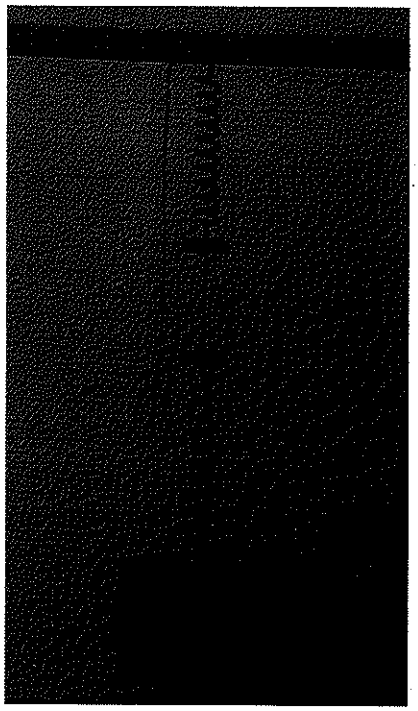
7) A third baseman wishes to throw to first base, 127 ft distant. His best throwing speed is 85 mi/hr. (a) If he throws the ball horizontally 3.0 ft above the ground, how far from first base will it hit the ground? (b) At what upward angle must the third baseman throw the ball if the first baseman is to catch it 3.0 ft above the ground? (c) What will be the time of flight in that case?

8) A floating ice block is pushed through a displacement $\mathbf{d} = (15\text{ m})\mathbf{i} - (12\text{ m})\mathbf{j}$ along a straight embankment by rushing water, which exerts a force $\mathbf{F} = (210\text{ N})\mathbf{i} - (150\text{ N})\mathbf{j}$ on the block. How much work does the force do on the block during the displacement?

9) A 5.0 kg block moves in a straight line on a horizontal frictionless surface under the influence of a force that varies with position as shown below. How much work is done by the force as the block moves from the origin to $x = 8.0$ m?



10) In the figure below, two identical springs, each with a relaxed length of 50 cm and a spring constant of 500 N/m, are connected by a short cord of length 10 cm. The upper spring is attached to the ceiling; a box that weighs 100 N hangs from the lower spring. Two additional cords, each 85 cm long, are also tied to the assembly; they are limp. (a) If the short cord is cut, so that the box then hangs from the springs and the two longer cords, does the box move up or down? (b) How far does the box move? (c) How much total work do the two spring forces (one directly, the other via a cord) do on the box during the move?



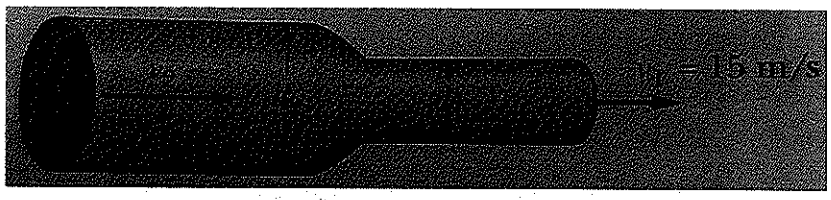
11) A force $\mathbf{F} = (3.00\ \text{N})\mathbf{i} + (7.00\ \text{N})\mathbf{j} + (7.00\ \text{N})\mathbf{k}$ acts on a 2.00 kg object which moves from an initial position of $\mathbf{d}_i = (3.00\ \text{m})\mathbf{i} - (2.00\ \text{m})\mathbf{j} + (5.00\ \text{m})\mathbf{k}$ to a final position of $\mathbf{d}_f = -(5.00\ \text{m})\mathbf{i} + (4.00\ \text{m})\mathbf{j} + (7.00\ \text{m})\mathbf{k}$ in 4.00 s. Find (a) the work done on the object by the force in the 4.00 s interval, (b) the average power due to the force during the 4.00 s interval, and (c) the angle between vectors $\mathbf{d}_i$ and $\mathbf{d}_f$.

12) The operator of a hovercraft is known as a _____.

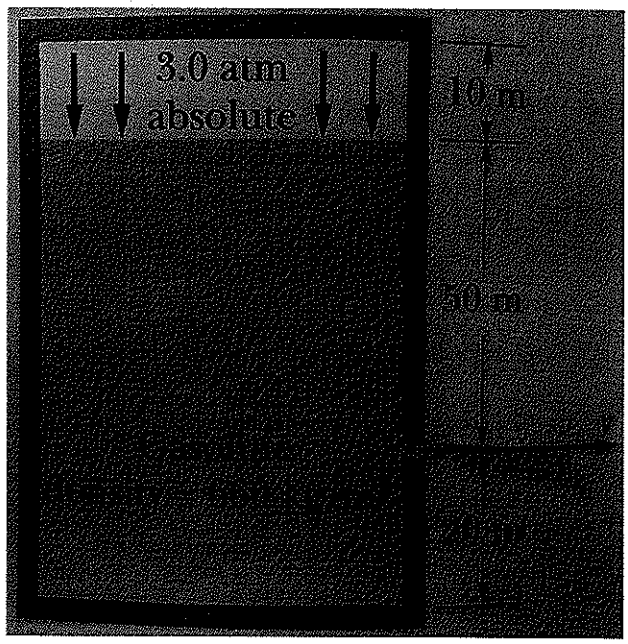
13) The name Hovercraft itself was a trademark owned by _____.

14) The idea of the modern hovercraft is most often associated with a British mechanical engineer Sir Christopher Cockerell. Cockerell's group was the first to develop the use of an _____ (name the shape) of air for maintaining the cushion, the first to develop a successful skirt, and the first to demonstrate a practical vehicle in continued use.

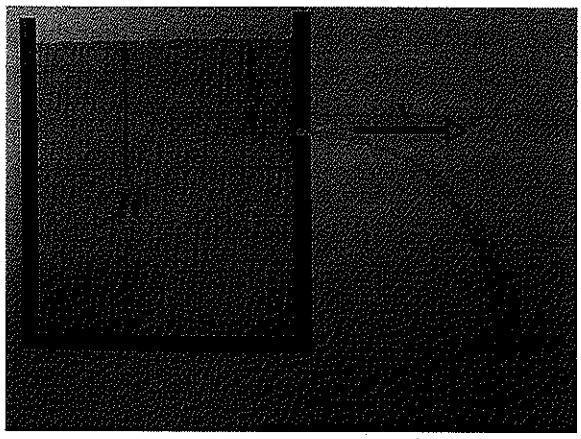
15) Water flows through a horizontal pipe and is delivered into the atmosphere at a speed of 15 m/s as shown below. The diameters of the left and right sections of the pipe are 5.0 cm and 3.0 cm, respectively. (a) What volume of water is delivered into the atmosphere during a 10 min period? (b) What is the flow speed of the water in the left section of the pipe? (c) What is the gauge pressure in the left section of the pipe?



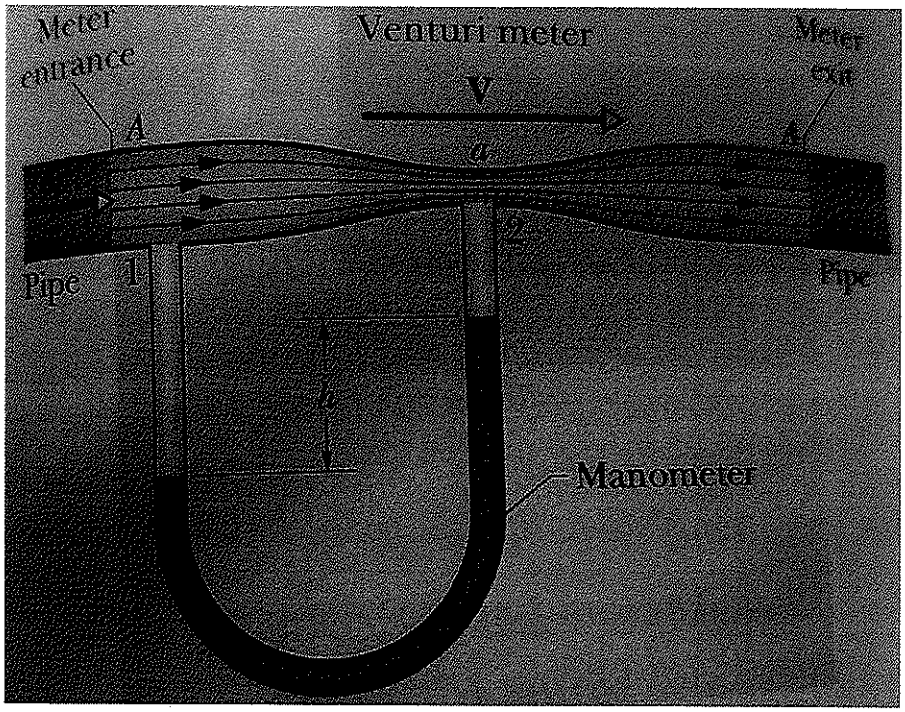
16) A sniper fires a rifle bullet into a gasoline tank, making a hole 50 m below the surface of the gasoline. The tank was sealed and is under 3.0 atm absolute pressure, as shown below. The stored gasoline has a density of 660 kg/m^3. At what speed *v*does the gasoline begin to shoot out of the hole?



17) A tank is filled with water to a height *H*. A hole is punched in one of he walls at a depth *h*below the water surface as shown below. (a) Could a hole be punched at another depth to produce a second stream that would have the same range? If so, at what depth? (b) At what depth should the hole be placed to make the emerging stream strike the ground at the maximum distance from the base of the tank?



18) A Venturi meter is used to measure the flow speed of a fluid in a pipe. The meter is connected between two sections of the pipe. The cross-sectional area *A* of the entrance and exit of the meter matches the pipe's cross-sectional area. Between the entrance and exit, the fluid flows from the pipe with speed *v* and then through a narrow "throat" of cross-sectional area *a* with speed *V*. A manometer connects the wider portion of the meter to the narrower portion. The change in the fluid's speed is accompanied by a change Δp in the fluid's pressure, which causes a height difference *h* of the liquid in the two arms of the manometer. Suppose that the fluid is water, that the cross-sectional areas are 10 in. in the pipe and 5.0 in in the throat, and that the pressure is 8.0 lb/in^2 in the pipe and 6.0 lb/in^2 in the throat. What is the rate of water flow in cubic feet per second?



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Your names_____

20170204 (answer sheet) – Huntley Invitational

1.	10. a) b) c)
2.	11. a) b) c)
3. a) b) c)	12.
4. a) b)	13.
5.	14.
6. a) b)	15. a) b) c)
7. a) b) c)	16.
8.	17. a) b)
9.	18.