HOVERCRAFT TEST - DIVISION B
Made for the 2017 SSSS by Zioly

-This test is composed of **three** sections:

-**Section I:** 20 multiple choice or T/F questions (two points if right, zero if wrong).

-**Section II:** 10 calculation problems. (4 pts each; points per problem are distributed as follows: 1 for writing the formulas used, 1 for showing all work, 1 for writing the correct answer and boxing it, and 1 for labelling the answer appropriately.

-Section III: 5 free response/critical thinking questions (4 pts each, all or nothing).

Testing Notes:

-All answers should be rounded to the nearest tenth and in SI units, unless otherwise noted.

-Use 9.81 for gravity.

-Be as thorough as you can when showing your work. Credit given or not given for the shown work is based upon the test proctor's best judgement.

-You have 50 minutes to complete this test.

Section I

Physics "Essentials"

1. Kinematics is a branch of:
    a. Physics
    b. Mechanics
    c. Mechanical physics
    d. Projectile motion

2. The difference between vectors and scalars is:
    a. Vectors have no direction and only a magnitude, which scalars have both
    b. Vectors have only direction and scalars have only magnitudes
    c. Vectors come from biology, which scalars come from physics
    d. Vectors have both magnitude and direction, while scalars only have magnitude

3. Which of the following is not a vector?
    a. Displacement
    b. Velocity
    c. Gravity
    d. Temperature

4. *The total linear momentum of an isolated system remains constant*. What is the name of this law?
    a. Law of conservation of momentum
    b. Law of linear momentum
    c. Law of constant linear momentum-shifts
    d. Newton's Third Law

5. Which of the following is not described in Newton's Second Law?
    a. a=m/F
    b. F=ma
    c. m=F/a
    d. a=F/m

Projectile Motion

6. A projectile has how many forces acting on it?
    - **a. 1**
    - b. 2
    - c. 3
    - d. 4+

7. What is that, or one of those, force(s) that is present upon a projectile?
    - a. The initial force acted upon the projectile
    - b. Air resistance
    - c. The object's inertia
    - **d. None of the above**

Momentum, Kinetic Energy, and Collisions

8. *The alteration of motion is proportional to the force impressed* was one of Newton's preliminary attempts at establishing:
    - a. The First Law of Motion
    - **b. The Second Law of Motion**
    - c. The Third Law of Motion
    - d. The measurement of a Newton
    - e.
9. Which of the following results in a change in momentum?
    - a. A 5 gram ball being caught.
    - b. An accelerating roadrunner
    - c. A snowball rolling at a constant rate, whilst accumulating more snow
    - **d. All of the above**

10. What is another term for "change in momentum?"
    - a. Force
    - b. Acceleration
    - **c. Impulse**
    - d. Momentum-shift

11. Which of the following objects has the most kinetic energy?
    a. A 65 gram egg travelling at 100 m/s
    b. A 145 gram baseball travelling at 25 m/s
    c. A 90 kilogram human travelling at 2 m/s
    d. A 6000 kilogram elephant not moving whatsoever

12. Which type of collision is demonstrated when two clay balls hurled at each other stick together and begin travelling with the same vector value?
    a. Perfectly inelastic collision
    b. Elastic collision
    c. Inelastic collision
    d. Compound collision

13. In a perfectly inelastic collision, what is conserved?
    a. Kinetic energy
    b. Momentum
    c. Both momentum and kinetic energy
    d. None of the above

History and Development of the Hovercraft

14. The first recorded design for an air-cushioned vehicle was by:
    a. Christopher Cockerell
    b. Emanuel Swedenborg
    c. John Ward
    d. John Thornycroft

15. Who built and tested a number of ground-effect vehicles in the mid-1870s?
    a. Christopher Cockerell
    b. Emanuel Swedenborg
    c. John Thornycroft
    d. John Ward

16. Hovercrafts are also known as ACVs; true or false?
    a. True
    b. False

17. The Saunders-Roe Nautical 1, or SR.N1 was:
    a. The first hovercraft ever made
    b. The first hovercraft to be patented
    c. The first hovercraft to cross the Pacific Ocean
    d. The first hovercraft to carry a man

18. Who engineered the SR.N1?
    a. Christopher Cockerell
    b. Emanuel Swedenborg
    c. Saunders Roe
    d. John Thornycroft

Miscellaneous

19. A car is driving in circles. You are given the car's speed and the diameter of the circular path it's driving in. What are the last variable(s), if any, to calculate the centripetal force keeping the car driving in a circle?
    a. Both acceleration and mass
    b. Acceleration
    c. Mass
    d. None of the above

20. Using Hooke's Law, in a perfect spring displaying SHM, the total distance travelled by the tip of the spring in one cycle?
    a. 1x
    b. 2x
    c. 3x
    d. 4x

Section II

21. How much force is required to accelerate a 94.85 kg man to 1G?

F=ma **a=1G**
F=94.85*9.81 **a=9.81m/s**
F=930.4785
F~930.5 Newtons

22. A 6 kilogram block is pushed with a force of 12 N. After 8 seconds, the block is going 49 m/s. What was the speed of the block before it was pushed?

m=6 **F=12** **Δt=8** **v_8=49** **v_0=?** **Δx=N/A**

F=ma
12=6a
2=a

$v=v_0+at$
$49=v_0+2*8$
$49=v_0+16$
$33=v_0$
v_0=33 meters/second

23. Refer to the situation above. How many meters did the block travel in the 8 seconds between being pushed and going 49 m/s?

a=N/A **Δt=8** **v_8=49** **v_0=33** **Δx=?**

$\Delta x=\frac{1}{2}(v_0+v_f)*t$
$\Delta x=\frac{1}{2}(33+49)*8$
$\Delta x=\frac{1}{2}(82)*8$
$\Delta x=41*8$
Δx=328 meters

24. A ball is thrown into the air with a starting velocity of 13 m/s. Assuming no air resistance, what is the kinetic energy of the ball on impact on the ground, in terms of m?

$a=-9.81$ $v_0=13$ $v_f=0$ $\Delta x=?$ $\Delta t=N/A$

$v^2=v_0^2+2a\Delta x$ $v_0=0$ $v_f=?$ $\Delta x=-8.6$ $a=-9.81$ $\Delta t=N/A$

$0^2=13^2+2*-9.81*\Delta x$
$0=169-19.62*\Delta x$
$-169=-19.62*\Delta x$
$8.613659\ldots=\Delta x$
$\Delta x\sim 8.6m$

$v^2=v_0^2+2a\Delta x$
$v^2=0^2+2*-9.81*-8.6$
$v^2=0+2*-9.81*8.6$
$v^2=168.732$
$v=12.989688$
$v\sim 13m/s$

$KE=mv^2/2$
$KE=m*13^2/2$
$KE=m*169/2$
$KE=m*84.5$
<u>$KE=84.5m$ joules</u>

25. A mortar fires a shell at a 75 degree angle to the flat ground, aimed straight at a 5 meter deep ditch, where enemy LEGO soldiers are hiding. Assuming no air resistance, how long will it take the mortar shell to reach its max height and fall back down to hit the LEGO soldiers if it's fired at 21 m/s?

$v_{0y}=v_0*\sin\theta$
$v_{0y}=21*\sin 75$
$v_{0y}=20.284442...$
$v_{0y}\sim 20.3m/s$ $a=-9.81$ $v_0=20.3$ $v_f=0$ $\Delta y=?$ $\Delta t=N/A$

$v^2=v_0^2+2a\Delta y$
$0^2=20.3^2+2*-9.81*\Delta y$
$0=412.09-19.62*\Delta y$
$-412.09=-19.62\Delta y$
$21.00356=\Delta y$
$\Delta y\sim 21m$

$a=-9.81$ $v_0=0$ $v_f=N/A$ $\Delta y=-26$ $\Delta t=?$

$\Delta y=v_0\Delta t+1/2at^2$
$-26=0\Delta t+½*-9.81*\Delta t$
$-26=½*-9.81*\Delta t$
$-26=-4.905\Delta t$
$5.300713=\Delta t$
<u>$\Delta t\sim 5.3$ seconds</u>

26. True story: two Science Olympians from Washington state were in the Senate Building in Washington D.C. They were on the fourth floor passing time before they were going to meet Senator Maria Cantwell. They estimated that the height from which they could drop a 2.5 gram penny to the ground floor was roughly 10 meters. Assuming there is no air resistance, what would be the impulse delivered to the ground by the penny on collision, to the nearest thousandth?

Δx=-10 v_0=0 v_f=? a=-9.81 Δt=N/A m=0.0025

$v^2=v_0^2+2a\Delta x$
$v^2=0^2+2*-9.81*-10$
$v^2=0+196.2$
$v^2=196.2$
v=14.007141…
v~14m/s

J=Δp
J=0.0025*14-0.0025*0
<u>J=0.035 Newtons*seconds</u>

27. After getting pushed on a frictionless surface by 10N of force, a block begins accelerating 12m/s^2. What is the normal force exerted on it by a surface when the block is sitting motionless?

F=ma
10=m*12
%=m

F_N=mg
F_N=%*9.81
F_N=8.175
<u>F_N~8.2 Newtons</u>

28. The friction coefficient between a surface and a 7 kilogram block sitting on top of the surface is 1.42. If the block is pushed with a force of 112 N, how many long will the block travel before coming to a complete stop?

$F_k=\mu F_N$
$F_k=\mu mg$
F_k=1.42*7*9.81
F_k=97.5114N

$a=F_{net}/m$
$a=(F-F_k)/m$
a=(112-97.5114)/7
a=14.4886/7
a=2.0698
<u>a~2.1 meters/second^2</u>

29. A 6 kg block is sitting on a table. It's connected to a cord sitting on a frictionless pulley on the edge of the table. The cord hanging over the table is holding up a 3 kg block. What is the coefficient of static friction that the table must have to keep the blocks stationary?

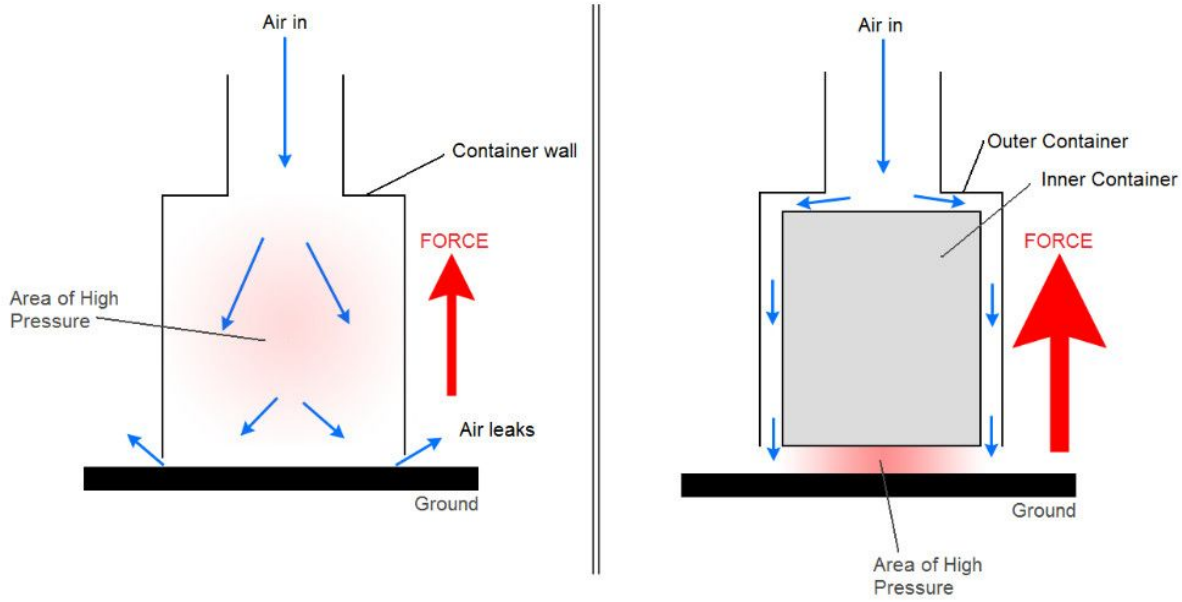
F_N>=>F
$m_1 g\mu$>=>$m_2 a$
6*9.81*μ>=>3*9.81
58.86*μ>=>29.43
μ>=>0.5

30. An astronaut-in-training is in a centrifuge to train to prevent G-LOC (g-induced loss of consciousness). The centrifuge diameter is 10 meters. How many Gs is the astronaut feeling if he/she is travelling at 25 m/s?

d=2r	**$a_r=v^2/r$**	**xg=a**
10=2r	**$a=25^2/5$**	**x9.81=125**
5=r	**a=625/5**	**x=12.7420999...**
	a=125m/s	**x~12.7 Gs**

Section III

1. Label each diagram with the theory each demonstrates.



Left: open plenum theory **Right: momentum curtain theory**

2. Refer to the diagrams above. Which one is better for lifting a hovercraft? Why?

The momentum curtain theory is better for lifting a hovercraft because in the open plenum chamber design, the area of high pressure that is supposed to supply the force to lift the hovercraft off the ground is very large and requires a very powerful fan to lift it. That and the fact that it leaks air makes it very inefficient. The momentum curtain design traps air in the smaller high pressure area, due to the fast streams of air pushing the craft upwards.

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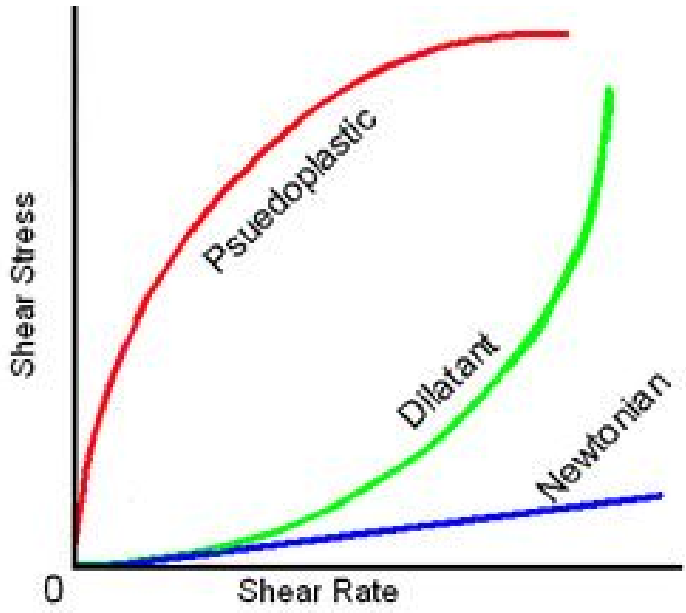
3. In terms of the surfaces it's able to traverse and the stratas it can travel in, the hovercraft is considered what?

Amphibious

4. Is walking faster than a full speed, modern, in-flight airplane possible? Why or why not?

Yes, walking faster than a full speed plane is possible, as all you would have to do is be inside the plane and walk in the same direction that the plane is travelling. This is because your perception of your speed is less than what it actually is. You feel as if you're at normal walking speed, when really, your actual speed is a compounded speed of you speed and the plane's speed, as your movement in relation to the earth is the plane's speed + your own.

5. Given this graph, explain what pseudoplastics, dilatants, and Newtonian fluids are. Which one is ketchup?



Dilatant fluids, also known as shear thickening fluids, are liquids or solutions whose viscosity increases as stress is applied.

Pseudoplastic fluids, also known as shear thinning fluids, are liquids or solutions whose viscosity decreases as stress is applied.

Newtonian fluids are liquids or solutions whose viscosity is proportional to shear stress applied.