Physics 200
Newton's Laws Practice Test (Stapleton)

Name: Answers

Conceptual Questions (mostly):

**Formulas:**

$\Delta x = x - x_0$

$v_{x\,Ave.} = \frac{\Delta x}{\Delta t}$

$a = \frac{\Delta v}{\Delta t}$

$\Delta x = \frac{1}{2}(v_{x0} + v_x)t$

$v_x = v_{x0} + at$

$\Delta x = v_{x0}\,t + \frac{1}{2}at^2$

$v_x{}^2 = v_{0x}{}^2 + 2a(\Delta x)$

$\sum F = F_{NET} = ma$

$w = mg$

$F_f = \mu F_N$

$g = 9.8\frac{m}{s^2}$

1. According to Newton, for every action there is an equal and opposite reaction. When an object freefalls toward the Earth, what could be considered to be the action? What could be the reaction?

   Action: The Earth pulls the object downward.

   Reaction: The object pulls the Earth upward (a little bit).

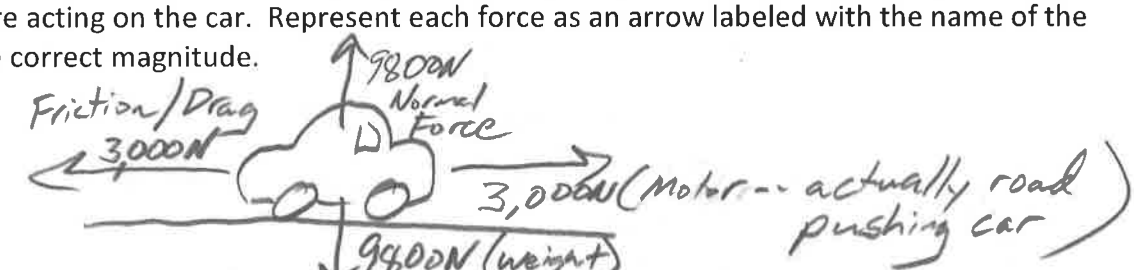
2. When a bullet is shot from a gun, the bullet moves very fast in one direction while the gun moves much more slowly in the other direction. According to Newton, actions and reactions are *equal* and opposite. In what sense is the bullet's action *equal* to the gun's reaction?

   The force pushing the bullet is equal to the force pushing the gun.

3. You're floating freely in outer space, and you have two seemingly identical boxes – box A and box B. Although the boxes look the same, one has much more mass than the other. Describe a test you could conduct in order to figure out which box has more mass, and explain how the results of the test would be different for the two boxes.

   Push or pull them. The one that resists more (and moves you more) has more mass.

4. A 1,000kg car is traveling to our right with a constant velocity. The car is being propelled by a 3,000N motor force. Draw a free-body diagram showing the car itself and all of the significant forces that are acting on the car. Represent each force as an arrow labeled with the name of the force and the correct magnitude.



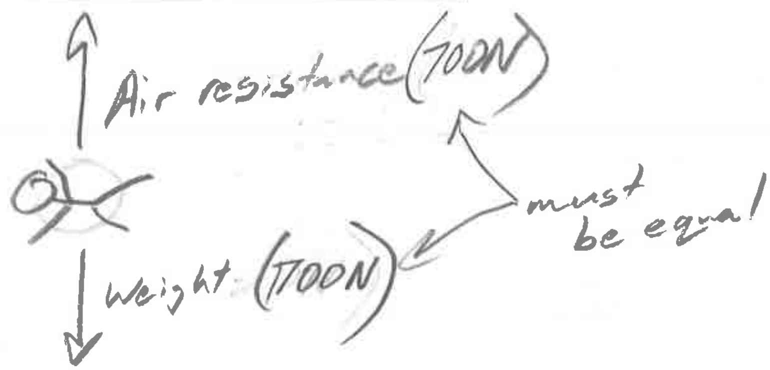

5. A small child and a team of Austrian weightlifters are fighting over a sturdy scarf. The child is pulling on one end, and the weightlifters are pulling on the other end. Neither side will let go. As you might expect, the child is being taken for quite a ride. Which end of the scarf has the most tension? Explain why.

   Neither. Newton's 3rd Law. The child's pull and the weightlifter's pull are an action/reaction pair.

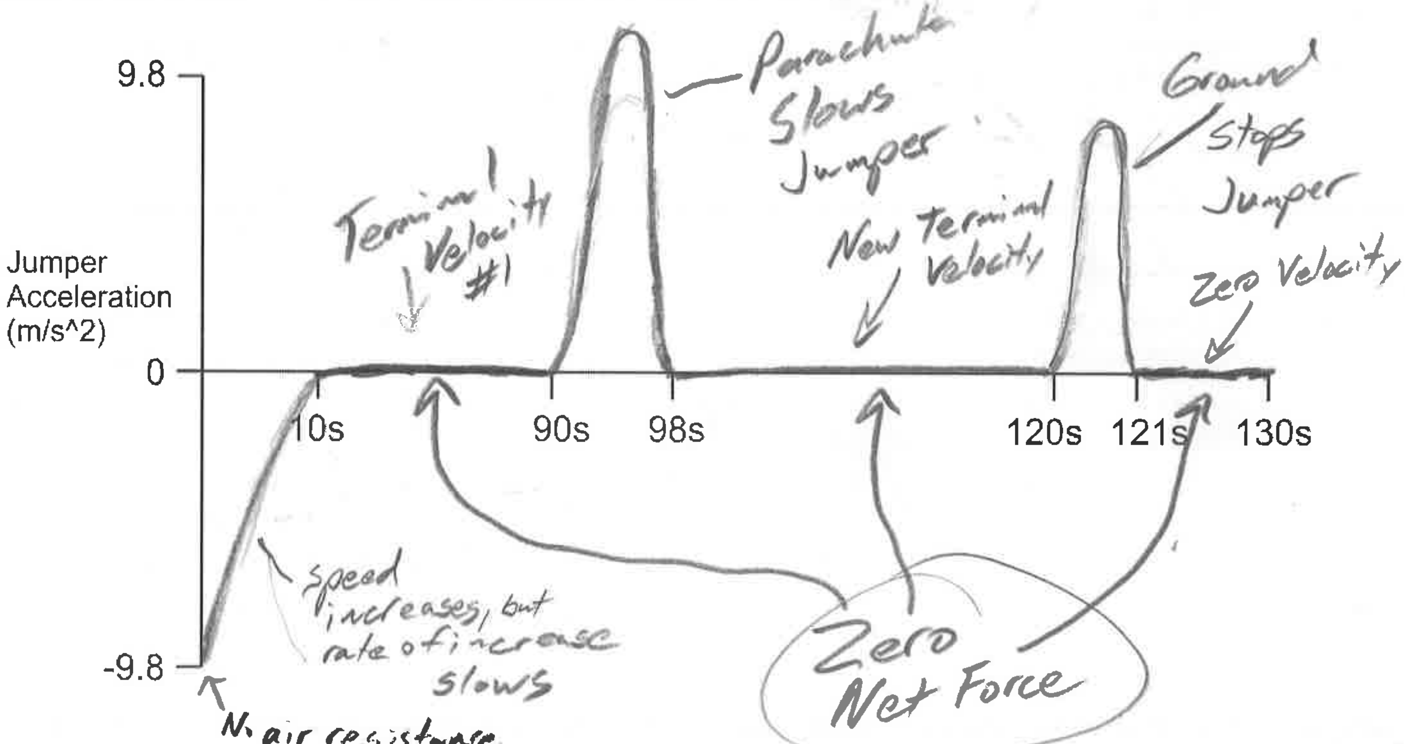
6-8. Objects falling through the atmosphere accelerate until they reach a terminal velocity. The table below is a timeline detailing a base jumper's descent after jumping off of a very high platform. This table contains important information about the jumper's two terminal velocities.

| Time | Event |
| --- | --- |
| 0s | Jumper steps off of platform |
| 10s | Jumper reaches a **terminal velocity of -55m/s** |
| 90s | Jumper pulls chute cord. Parachute deploys. |
| 98s | Jumper reaches a new **terminal velocity of -3m/s** |
| 120s | Jumper's feet touch down |
| 121s | Jumper comes to rest |

6. Draw a diagram showing the forces acting on an object that is falling at terminal velocity. Label the forces with reasonable magnitudes.




7. On the graph below, create a rough sketch showing how the jumper's acceleration changed over time. Only the initial acceleration needs to have the proper value. You are not expected to calculate actual accelerations. **The time axis is clearly out of proportion.




8. On the graph above, indicate every time period when the jumper's net force was zero.

Problems:

1. What is the weight of an 80kg astronaut on the surface of Uranus, where the acceleration due to gravity is 10.67g?

8,370N

2. A 4kg box is sitting motionless on a table. What force is the table exerting on the box?

39.2N upward

3. A 2.5kg quadcopter is accelerating upward at a rate of $2m/s^2$. What force is being generated by the quadcopter's propellers?

29.5N

4. A 70kg porpoise is hanging motionless from a rope with a breaking strenth of 900N. Using the rope, Gunter wants to lift the porpoise 5 meters in as short a time as possible (without breaking the rope)? Assuming that Gunter can generate enough power, what is the shortest possible time in which this could be done without breaking the rope?

$a = 3.06 m/s^2$

$t = 1.81s$

5. Fred's actual weight is 800N. Fred is standing on a bathroom scale in a helicopter. Fred wants the scale to read 1,100N. What specific instructions should Fred give the pilot regarding how to fly the helicopter so that the scale will read 1,100N?

Accelerate upward at $3.68 m/s^2$

6. A 0.4kg Newton sled is accelerated across a tile floor by a 9N average force exerted by rubber bands over a distance of 0.1m. After the sled travels this distance, the rubber bands stop pushing and the sled decelerates, eventually coming to rest. The sled's coefficient of kinetic friction on this surface is $\mu_k = 0.6$.

a. What is the sled's weight? 3.92N

b. What force of friction is acting on the sled as it accelerates? 2.35N

c. What net force is acting on the sled as it accelerates? 6.65N

d. What is the acceleration of the sled over this distance? 16.6 m/s²

e. What is the sled's maximum velocity? 1.82 m/s

f. What net force acts on the sled as it decelerates? -2.35N

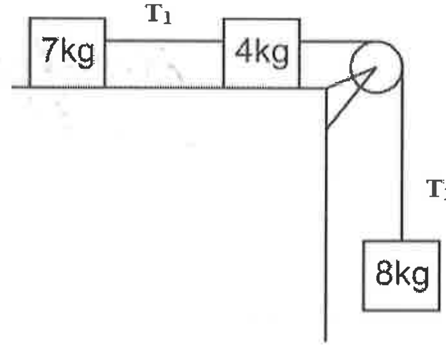
g. What is the sled's acceleration as it slows to a stop? -5.9 m/s²

h. How far does the sled travel during its deceleration period? 0.28m

7. The diagram below shows three masses connected by two segments of massless rope. One segment passes over a frictionless pulley. The coefficient of kinetic friction of the upper masses on the surface is $\mu_k = 0.2$,

a. Find the acceleration of the objects.

$a = 3$ m/s²




b. What are the tensions in the two segments of rope?

$T_1 = 54.4$N

$T_2 = 34.7$N