Name: _____ Date: _____ Period: _____

IB Physics SL Y1: Newton's Laws of Motion Problem Set

Problem 1:
An African elephant can reach heights of 13 feet and possess a mass of as much as 6000 kg. Determine the weight of an African elephant in Newtons and in pounds. (Given: 1.00 N = .225 pounds)

Problem 2:
About twenty percent of the National Football League weighs more than 300 pounds. At this weight, their Body Mass Index (BMI) places them at Grade 2 obesity, which is one step below morbid obesity. Determine the mass of a 300 pound (1330 N) football player.

Problem 3:
With fuel prices for combustible engine automobiles increasing, researchers and manufacturers have given more attention to the concept of an ultralight car. Using carbon composites, lighter steels and plastics, a fuel-efficient car can be manufactured at 540 kg. How much less does an ultralight car weigh compared to a 1450-kg Honda Accord (2007)?

Problem 4:
According to the National Center for Health Statistics, the average mass of an adult American male is 86 kg. Determine the mass and the weight of an 86-kg man on the moon where the gravitational field is one-sixth that of the Earth.

Problem 5:
The rising concern among athletic trainers and health advocates (and parents) regarding concussions and multiple concussions among high school football players has prompted numerous studies of the effectiveness of protective head gear and the forces and accelerations experienced by players. One study suggested that there is a 50% chance of concussions for impacts rated at 75 g's of acceleration (i.e., 75 multiplied by 9.8 m/s^2). (The average head impact results in 22 to 24 g's of acceleration.) If a player's head mass (with helmet) is 6.0 kg and considered to be a *free body*, then what net force would be required to produce an acceleration of 75 g's?

Problem 6:
Captain John Stapp of the U.S. Air Force tested the human limits of acceleration by riding on a rocket sled of his own design, known as the Gee Whiz. What net force would be required to accelerate the 82-kg Stapp at 450 m/s^2 (the highest acceleration tested by Stapp)?

Problem 7:
Sophia, whose mass is 52 kg, experienced a net force of 1800 N at the bottom of a roller coaster loop during her school's physics field trip to the local amusement park. Determine Sophia's acceleration at this location.

Problem 8:
The Top Thrill Dragster stratacoaster at Cedar Point Amusement Park in Ohio uses a hydraulic launching system to accelerate riders from 0 to 54 m/s (120 mi/hr) in 3.8 seconds before climbing a completely vertical 420-foot hill . Determine the net force required to accelerate an 86-kg man.

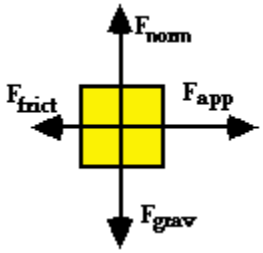
Problem 9:
a. Determine the net force required to accelerate a 540-kg ultralight car from 0 to 27 m/s (60 mph) in 10.0 seconds.
b. Determine the net force required to accelerate a 2160-kg Ford Expedition from 0 to 27 m/s (60 mph) in 10.0 seconds.

Problem 10:

Anna Litical and Noah Formula are experimenting with the effect of mass and net force upon the acceleration of a lab cart. They determine that a net force of F causes a cart with a mass of M to accelerate at 48 cm/s^2. What is the acceleration value of a cart with …

a. a mass of M when acted upon by a net force of 2F?
b. a mass of 2M when acted upon by a net force of F?
c. a mass of 2M when acted upon by a net force of 2F?
d. a mass of 4M when acted upon by a net force of 2F?
e. a mass of 2M when acted upon by a net force of 4F?

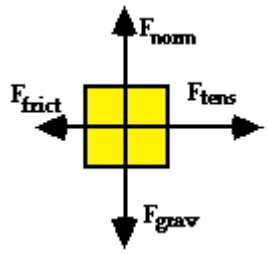
Problem 11:



Ethan is dragging a bag of grass from the garage to the street on the evening before garbage pick-up day. The diagram at the right is a free-body diagram. It uses arrows to represent the forces acting upon the bag. Each force is labeled according to type. The magnitude of the force is represented by the size of the arrow. Use the free body diagram to determine the net force acting upon the bag. The values of the individual forces are:

$F_{grav} = F_{norm} = 60.5$ N
$F_{app} = 40.2$ N
$F_{frict} = 5.7$ N.

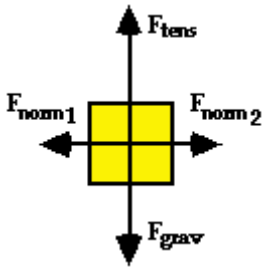
Problem 12:



Unfortunately for Vanessa, the wheels on her suitcase are not working. She pulls on the strap in an effort to budge it from rest and drag it to the curbside check-in desk. The free body diagram at the right depicts the forces acting upon the suitcase. Use force values to determine the net force, the mass and the acceleration of the suitcase. The values of the individual forces are:

$F_{grav} = F_{norm} = 207$ N
$F_{tens} = 182$ N
$F_{frict} = 166$ N.

Problem 13:



The shipment of the new physics supplies have arrived. They are placed on the freight elevator and transported up to the third floor for delivery to the physics rooms. The free body diagram at the right depicts the forces acting upon the freight elevator as it begins its ascent through the elevator shaft. Use force values to determine the net force, the mass and the acceleration of the elevator. The values of the individual forces are:

$F_{tens} = 2340$ N
$F_{grav} = 2120$ N
$F_{norm1} = F_{norm2} = 276$ N.

Problem 14:

It's Friday night and Skyler has been assigned the noble task of baby-sitting Casey, his 2-year old brother. He puts a crash helmet on Casey, places him in the red wagon and takes him on a stroll through the neighborhood. As Skyler starts across the street, he exerts a 52 N forward force on the wagon. There is a 24 N resistance force and the wagon and Casey have a combined weight of 304 N. Construct a free body diagram depicting the types of forces acting upon the wagon. Then determine the net force, mass and acceleration of the wagon.

Problem 15:
After a lead-off single in the 8th inning, Earl makes an effort to steal second base. As he hits the dirt on his head first dive, his 73.2 kg body encounters 249 N of friction force. Construct a free body diagram depicting the types of forces acting upon Earl. Then determine the net force and acceleration.

Problem 16:
Mira and Tariq are lab partners for the Pulley and Bricks Lab. They have determined that the 2.15-kg brick is experiencing a forward tension force of 9.54 N and a friction force of 8.69 N as it is accelerated across the table top. Construct a free body diagram depicting the types of forces acting upon the brick. Then determine the net force and acceleration of the brick.

Problem 17:
Moments after making the dreaded decision to jump out the door of the airplane, Darin's 82.5-kg body experiences 118 N of air resistance. Determine Darin's acceleration at this instant in time. HINT: begin by drawing a free body diagram and determine the net force.

Problem 18:
Kelli and Jarvis are members of the stage crew for the Variety Show. Between acts, they must quickly move a Baby Grand Piano onto stage. After the curtain closes, they exert a sudden forward force of 524 N to budge the piano from rest and get it up to speed. The 158-kg piano experiences 418 N of friction.
a. What is the piano's acceleration during this phase of its motion?
b. If Kelli and Jarvis maintain this forward force for 1.44 seconds, then what speed will the piano have?

Problem 19:
Skydiving tunnels have become popular attractions, appealing in part to those who would like a taste of the skydiving experience but are too overwhelmed by the fear of jumping out of a plane at several thousand feet. Skydiving tunnels are vertical wind tunnels through which air is blown at high speeds, allowing visitors to experience bodyflight. On Natalya's first adventure inside the tunnel, she changes her orientation and for an instant, her 46.8-kg body momentarily experiences an upward force of air resistance of 521 N. Determine Natalya's acceleration during this moment in time.

Problem 20:
A rope is used to pull a 2.89-kg bucket of water out of a deep well.
a. What is the acceleration of the bucket when the tension in the rope is 30.2 N?
b. If starting from rest, what speed will the bucket have after experiencing this force for 2.16 seconds?

Problem 21:
A 0.104-kg model rocket accelerates at 45.9 m/s^2 on takeoff. Determine the upward thrust experienced by the rocket.

Problem 22:
Brandon is the catcher for the Varsity baseball team. He exerts a forward force on the 0.145-kg baseball to bring it to rest from a speed of 38.2 m/s. During the process, his hand recoils a distance of 0.135 m. Determine the acceleration of the ball and the force which is applied to it by Brandon.

Problem 23:
Alejandra is attempting to drag her 32.6-kg Golden Retriever across the wooden floor by applying a horizontal force. What force must she apply to move the dog with a constant speed of 0.95 m/s? The coefficient of friction between the dog and the floor is 0.72.

Problem 24:
The coefficient of friction between the wheels of Dawson's 1985 Ford Coupe and the dry pavement is 0.85. Determine the acceleration which the 1300-kg Coupe experiences while skidding to a stop.

Problem 25:
Nicholas, Brianna, Dylan and Chloe are practicing their hockey on frozen Bluebird Lake. As Dylan and Chloe chase after the 0.162 kg puck, it decelerates from 10.5 m/s to 8.8 m/s in 14 seconds.
a. Determine the acceleration of the puck.
b. Determine the force of friction experienced by the puck.
c. Determine the coefficient of friction between the ice and the puck.

Problem 26:
Unbeknownst to most students, every time the school floors are waxed, the physics teachers get together to have a barrel of phun doing friction experiments in their socks (uhm - they do have clothes on; it's just that they don't have any shoes on their feet). On one occasion, Mr. London applies a horizontal force to accelerate Mr. Schneider (mass of 84 kg) rightward at a rate of 1.2 m/s^2. If the coefficient of friction between Mr. Schneider 's socks and the freshly waxed floors is 0.35, then with what force (in Newtons) must Mr. London be pulling?

Problem 27:
Dexter Eius is running through the cafeteria when he slips on some mashed potatoes and falls to the floor. (Let that be a lesson for Dexter.) Dexter lands in a puddle of milk and skids to a stop with an acceleration of -4.8 m/s^2. Dexter weighs 780 Newtons. Determine the coefficient of friction between Dexter and the *milky* floor.

Problem 28:
The Harrier Jump Jet is a fixed wing military jet designed for vertical takeoff and landing (VTOL). It is capable of rotating its jets from a horizontal to a vertical orientation in order to takeoff, land and conduct horizontal maneuvers. Determine the vertical thrust required to accelerate an 8600-kg Harrier upward at 0.40 m/s^2.

Problem 29:
While skydiving, Dee Selerate opens her parachute and her 53.4-kg body immediately accelerates upward for an instant at 8.66 m/s^2. Determine the upward force experienced by Dee during this instant.

Problem 30:
A 1370-kg car is skidding to a stop along a horizontal surface. The car decelerates from 27.6 m/s to a rest position in 3.15 seconds. Assuming negligible air resistance, determine the coefficient of friction between the car tires and the road surface.