Physics 1 Unit 3 – Forces Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

IB 2.2 Forces

**Forces**

1. What is the weight of a 8.9 kg dog? Express your answer in a) Newtons, and b) pounds. (1 lb = 4.448 N)
2. What are the mass and weight of a 63.5 kg astronaut when he is a) on earth and b) on the moon where the acceleration of gravity g = 1.62 m/s2?
3. A spring with a natural height of 57 mm is compressed by a 300. g mass to a new height of 51 mm. a) Find the spring constant in SI units. b) Find the length of the spring if the 300 g mass were replaced by a 400. g mass

**Newton’s Laws**

Answer the following questions and identify/explain the Newton’s Law(s) involved.

1. Why do you push harder on the pedals of a bicycle when first starting out than when moving at constant speed?
2. When a ping pong ball is dropped to the floor, it bounces back up. a) Is a force needed to make it bounce back up? b) If so, what exerts the force?
3. Why might your foot hurt if you kick a heavy desk or a wall?
4. Whiplash sometimes results from an automobile accident when the victim’s car is struck violently from the rear. Explain why the head of the victim seems to be thrown backward in this situation. Is it really?
5. A person stands holding a bag of groceries, leaning on a refrigerator. Identify as many action-reaction pairs as you can.



**Free Body Diagrams**

Draw a free body diagram for each situation described below. Specify your body of interest.

1. A vase sitting on a table.
2. A piñata is suspended from the ceiling with a rope.
3. An egg falls off the table. Consider the egg as it’s falling a) without air resistance and b) with air resistance.
4. A car is stopped at a stoplight.
5. For a basketball player a) just before leaving the ground on a jump and b) while in the air.
6. For a box on a level surface being pushed by a horizontal applied force, a) the table is frictionless and b) if the table is not frictionless.
7. For a box on an incline being pushed by a horizontal applied force, a) the incline is frictionless and b) if the incline is not frictionless.

**Forces and Kinematics**

1. What force is needed to accelerate 13.0 kg a child on a 42.0 kg sled at 1.15 m/s2?
2. A 20.0 kg box rests on a table. a) What is the weight of the box and the normal reaction force acting on it? b) A 10.0 kg box is placed on top of the 20.0 kg box. Determine the normal reaction force that the table exerts on the 20 kg box and the normal force that the 20.0 kg box exerts on the 10.0 kg box. c) Identify all action-reaction pairs.
3. What average force is required to stop an 1100 kg car in 8.0 seconds if it is traveling at 90 km/h?
4. A 0.140 kg baseball traveling at 45.0 m/s strikes the catcher’s mitt, which, in bringing the ball to rest, recoils backward 11.0 cm. What was the average force applied by the ball on the glove?
5. A person jumps from the roof of a house 4.5 m high. When he strikes the ground below, he bends his knees so that his torso decelerates over approximately 0.70 m. If the mass of his torso (excluding legs) is 45 kg, find a) his velocity just before his feet strike the ground, and b) the average force exerted on his torso by his legs during deceleration.