Grade Level Dynamics Problems

1. When a karate expert strikes a wooden block, the hand undergoes an acceleration of -6500 m/s^2. Medical data indicates the mass of the forearm and hand to be about 0.7 kg. What is the force exerted on the hand by the blocks? What is its direction?

2. When you drop a 0.4 kg apple, Earth exerts a force on it that accelerates it at 9.8 m/s^2 toward the Earth's surface. According to Newton's third law, the apple must exert an equal and opposite force on the Earth. What force does the Earth feel? If the mass of the Earth is $5.98 * 10^{24}$ kg, what's the magnitude of Earth's acceleration?

3. A 60 kg boy and a 40 kg girl use an elastic rope while engaged in a tug of war on an icy frictionless surface. If the acceleration of the girl toward the boy is 3 m/s^2, determine the magnitude of the acceleration of the boy toward the girl.

4. A 95 kg boxer has his first match in the Canal Zone ($g = 9.782\ m/s^2$) and his second match at the North Pole ($g = 9.832\ m/s^2$). What is his mass in the Canal Zone? What is his weight in the Canal zone? What is the mass at the North Pole? What is his weight at the North Pole?

****

5. The acceleration of a 925 kg car while braking is -12.2 m/s^2. What is the frictional force that brings the car to a stop?

6. An 873 kg dragster, starting from rest, attains a speed of 26.3 m/s in 0.59 seconds. Find the average acceleration of the dragster. What is the size of the average force on the dragster during this time interval? Assume the driver has a mass of 68 kg, what horizontal force does the seat exert on the driver?

7. After a day of testing race cars, you decide to take your own 1550 kg car onto the test track. While moving down the track at 10 m/s, you suddenly accelerate to 30 m/s in 10 sec. What is the average net force that you have applied to the car in the 10 second interval?

8. A race car has a mass of 710 kg. It starts from rest and travels 40 m in 3 seconds. The car is uniformly accelerated during the entire time. What net force is applied to it?

9. A force of -9000 N is used to stop a 1500 kg car traveling at 20 m/s. What braking distance is needed to bring the car to a halt?

10. A 4500 kg helicopter accelerates upward at 2 m/s^2. What lift force is exerted by the air on the propellers?

11. If 20 kg of groceries are lifted from the floor to the table with an acceleration of 5 m/s^2, how much force is exerted on the grocery bag? The maximum force a grocery sack can withstand and not rip is 250 N, will the sack hold?

12. A student stands on a bathroom scale in an elevator at rest on the 64^{th} floor of a building. The scale reads 836 N. As the elevator moves up, the scale reading increases to 935 N. What is the acceleration of the elevator during this time?

13. A $2.1 * 10^{-4}$ kg spider is suspended from a thin strand of spider web. The greatest tension the strand can withstand is $2.2 * 10^{-3}$ N. What is the maximum acceleration with which the spider can safely climb up the strand?

14. Safety engineers estimate that an elevator can hold 20 persons of 75 kg average mass. The elevator itself has a mass of 500 kg. Tensile strength tests show the cable supporting the elevator can tolerate a maximum force of $2.96 * 10^4$ N. What is the greatest acceleration the elevator's motor can produce without breaking the cable?
15. A 40 kg crate is pulled across the ice with a rope. A force of 100 N is applied at an angle of 30^o with the horizontal. The vertical component of the force in the rope is 50 N. Neglecting friction, calculate the acceleration of the crate and the upward force the ice exerts on the crate as it is pulled.
16. Joe pushes the handle of a 10 kg fertilizer spreader. The handle makes a 45^o with the horizontal. Joe wishes to accelerate the spreader from rest to 1.39 m/s in 1.5 seconds. The vertical component of Joe's applied force is 9.26 N. What force must Joe have applied to the handle?

****

17. If you use a horizontal force of 30 N to slide a 12 kg wooden crate across a floor at a constant velocity, what is the frictional force between the crate and the floor?
18. You are driving a 2500 kg car at a constant speed of 14 m/s along an icy, but straight and level road. You slam on the brakes and the wheels lock. Sending you sliding and skidding to a halt in a distance of 25 m. What is the magnitude of the frictional force between your tires and the icy road?
19. A sled of mass 50 kg is pulled along snow covered flat ground. The maximum static frictional force is 147 N, and the sliding frictional force is 49 N. What force will be needed to start the sled moving? What force is needed to keep the sled moving at a constant velocity? What force must be applied to accelerate the sled at 3 m/s^2?
20. A force of 40 N accelerates a 5 kg block at 6 m/s^2 along a horizontal surface. How large is the frictional force?
21. A 200 kg crate is pushed horizontally with a force of 700 N. If the frictional force is 392 N, calculate the acceleration of the crate.
22. Rachel pulls her 18 kg suitcase at a constant speed by pulling on a handle that makes an angle θ with the horizontal. The frictional force on the suitcase is 27 N and Rachel exerts a 43 N force on the handle. What is the normal force exerted on the suitcase by the ground?
23. You slide a 325 N trunk up a 20^o inclined plane with a constant velocity by exerting a force of 211 N parallel to the inclined plane. The normal force exerted on the trunk by the inclined plane is 305.4 N. What is the component of the trunk's weight parallel to the incline? What is the vector sum of your applied force, friction, and the parallel component of the trunk's weight? What is the size and direction of the frictional force?
24. What force would you have to exert on the trunk in the previous problem so that it would slide down the plane with a constant velocity?

1. 4550 N, upward	2. 3.92 N and $6.6 * 10^{-25}$ m/s^2	3. 2 m/s^2
4. 95 kg, 929 N, 95 kg, 934 N	5. 11285 N	6. 44.6 m/s^2, 38936 N, 3033 N
7. 3100 N	8. 6312 N	9. 33.3 m
10. 53100 N	11. 296 N, it will rip	12. 1.16 m/s^2
13. 0.68 m/s^2	14. 5 m/s^2	15. 2.17 m/s^2 and 342 N
16. 13.1 N	17. 30 N	18. 9800 N
19. 147 N, 49 N, 199 N	20. 10 N	21. 1.54 m/s^2
22. 143 N	23. 111 N, 0 N, 100 N down incline	24. 11 N