Unit 2 Dynamics

Short Answer

1. Describe how and why acceleration due to gravity varies around the globe.

   Acceleration due to gravity is dependent upon the distance from the center of the earth. The earth is shaped like an ellipse with the equator being father from the center than the poles. The closer you are to the center of the earth the greater your acceleration due to gravity will be.

2. A news reporter states that the winning entry in a giant pumpkin-growing contest "had a weight of 354 kg" Explain the error in this statement and provide values for both the weight and mass of the winning pumpkin.

   The reporter is mistaken when he states that the pumpkin has a weight of 354 kg, the pumpkin has a mass of 354kg and a weight of (354)(9.8)=3469.2 N. Mass is what an object is made up of (matter) while weight is how gravity acts on mass.

3. Explain why the coefficient of static friction is greater than the coefficient of kinetic friction.

   The coefficient of static friction is greater than that of kinetic friction because an object at rest has time for bonds to be formed these bonds are harder to break than those of a moving object in which bonds are constantly being formed and broken.

4. You are a passenger in a car that is driving on the highway at 100 km/h. Explain, in terms of inertia, what happens to you if the driver breaks suddenly?

   If the driver suddenly breaks your body is going to resist the change in motion unless acted on by an external force (seat belt) you will keep moving forward until the seat belt stops you.

5. If gold were sold by weight, at which of the two locations would you prefer to buy it: At a location on the equator at sea level or at the North Pole? If it were sold by mass, where would you prefer to buy it? Explain.

   I would want to by the gold at the location that is farthest from the center of the earth therefore having the lowest acceleration due to gravity giving the smallest weight. In this case I would like to buy the gold at the equator.

6. How do you determine the direction of the force of surface friction?

   Friction always acts in the opposite direction of the motion.

Problems

7. What is the mass of a sack of potatoes that weights 1.10 x 10^2 N?

   $f_g = 1.10 \times 10^2 N$
   $g = 9.8 m/s^2$
   $f_g = mg$

   $m = \frac{f_g}{g}$
   $m = \frac{110}{9.8} = 11.2\ kg$

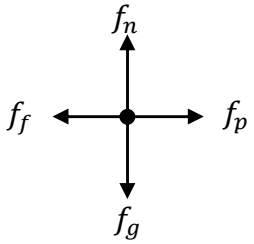
8. If you weight 541 N on earth, how much would you weight on the Moon(1.64 m/s^2)? Mars(3.72 m/s^2)?

   $f_g = 541N$
   $g_{moon} = 1.64 m/s^2$
   $g_{mars} = 3.72 m/s^2$
   $f_g = mg$
   $m = \frac{f_g}{g}$

   $m = \frac{541}{9.8} = 55.20kg$
   $f_g = mg$
   $f_{gmoon} = (55.20)(1.64) = 90.5N$
   $f_{gmars} = (55.20)(3.72) = 205N$

9. You must push with a force of 401 N in order to slide a 47 kg overstuffed chair across the carpet at a constant velocity. What is the coefficient of friction between the chair and the carpet?

   $f_p = 401\ N$
   $m = 47\ kg$
   $a = 0$
   $\mu = ?$



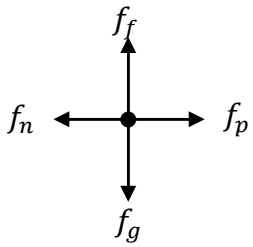
Vertical
$+f_n = ?$
$-f_g = mg$
$= (47)(9.8)$
$= 460.6N$
$f_{net} = ma$
$f_n - f_g = ma$
$f_n - f_g = 0$
$f_n = f_g$
$f_n = 460.6\ N$

Horizontal
$+f_p = 401\ N$
$-f_f = ?$
$f_{net} = ma$
$f_p - f_f = ma$
$f_p - f_f = 0$
$f_p = f_f$
$f_p = 401N$

$f_f = \mu f_n$
$\frac{f_f}{f_n} = \mu$
$\mu = \frac{401}{460.6}$
$\mu = 0.87$

10. You are pushing horizontally on a 3.0 kg block of wood, pressing it against a wall. If the coefficient of static friction between the block and the wall is 0.60, how much force must you exert on the block to prevent it from sliding down the wall?

$m = 3.0\ kg$
$\mu = 0.60$
$f_p = ?$



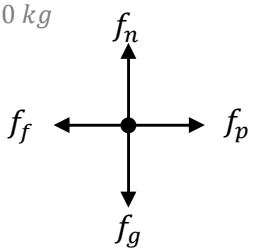
Vertical
$+f_f = ?$
$-f_g = mg$
$= (3.0)(9.8)$
$= 29.4N$
$f_{net} = ma$
$f_f - f_g = ma$
$f_f - f_g = 0$
$f_f = f_g$
$f_f = 29.4\ N$

$f_f = \mu f_n$
$\frac{f_f}{\mu} = f_n$
$f_n = \frac{29.4}{0.60}$
$f_n = 49\ N$

Horizontal
$+f_p = ?$
$-f_n = 49$
$f_{net} = ma$
$f_p - f_n = ma$
$f_p - f_n = 0$
$f_p = f_n$
$f_p = 49N$

11. You are helping a friend push a piano across the floor. It has a mass of 450 kg.
    a. Calculate the normal force supporting the piano.

$m = 450\ kg$



Vertical
$+f_n = ?$
$-f_g = mg$
$= (450)(9.8)$
$= 4410N$

$f_{net} = ma$
$f_n - f_g = ma$
$f_n - f_g = 0$
$f_n = f_g$
$f_n = 4410\ N$

    b. If the coefficient of static friction between the floor and the piano is 0.35, calculate the minimum amount of force needed to start the piano moving.

$f_f = \mu f_n$
$f_f = (0.35)(4410)$
$f_f = 1543.5N$

Horizontal
$+f_p = ?$
$-f_f = 1543.5N$
$f_{net} = ma$
$f_p - f_f = ma$

$f_p - f_f = 0$
$f_p = f_f$
$f_p = 1543.5N$

    c. Once the piano is moving, a horizontal force of 1.1 x 10^3 N is necessary to keep it moving at a constant speed. Determine the coefficient of kinetic friction.

Horizontal
$+f_p = 1100\ N$
$-f_f = ?$
$f_{net} = ma$
$f_p - f_f = ma$

$f_p - f_f = 0$
$f_p = f_f$
$f_f = 1100N$

$f_f = \mu f_n$
$\frac{f_f}{f_n} = \mu$
$\mu = \frac{1100}{4410}$
$\mu = 0.25$

    d. Once moving, what force must be applied to the piano to accelerate it at 3.0 m/s^2?

$f_f = \mu f_n$
$f_f = (0.25)(4410)$
$f_f = 1102.5N$

Horizontal
$+f_p = ?\ N$
$-f_f = 1102.5N$
$f_{net} = ma$
$f_p - f_f = ma$

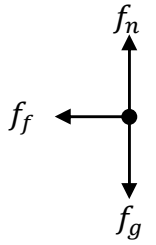
$f_p - f_f = (450)(3.0)$
$f_p = 1350 + 1102.5$
$f_p = 2452.5N$

12. A force of 9000 N is used to stop a 1500 kg car travelling at 20.0 m/s. What braking distance is needed to bring the car to a halt?

$f_f = 9000N$
$m = 1500\ kg$
$v_i = 20.0\ m/s$
$v_f = 0\ m/s$
$d = ?$

Horizontal
$-f_f = 9000N$
$f_{net} = ma$
$-f_f = ma$
$-\frac{f_f}{m} = a$
$a = -\frac{9000}{1500} = -6\ m/s^2$

$v_f^2 = v_i^2 + 2ad$
$d = \frac{v_f^2 - v_i^2}{2a}$
$d = \frac{0 - 20.0^2}{2(-6)} = 33.3m$
$d = 30\ m$



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

$f_{tmax} = 250N$
$m = 20kg$
$a = 5m/s^2$

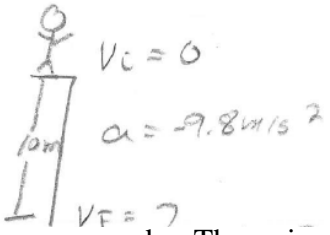
Vertical
$+f_t = ?$
$-f_g = mg$
$= (20)(9.8)$
$= 196N$

$f_{net} = ma$
$f_t - f_g = ma$
$f_t - 196 = (20)(5)$
$f_t = 100 + 196$
$f_f = 296\ N$

The bag will break; force of tension found is greater than the max tension the bag can withstand.

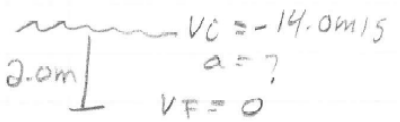
14. A 65 kg swimmer jumps off a 10.0 tower.

a. Find the swimmer's velocity when hitting the water.



$v_f^2 = v_i^2 + 2ad$
$v_f^2 = 0 + 2(-9.8)(-10)$
$v_f = \pm\sqrt{196} = \pm 14 = -14\ m/s$

b. The swimmer comes to a stop 2.0 m below the surface of the water. Find the average net force exerted on the swimmer over this 2.0 m.



$v_f^2 = v_i^2 + 2ad$
$a = \frac{v_f^2 - v_i^2}{2d}$
$a = \frac{0 - (-14)^2}{2(-2.0)} = 49m/s^2$

$f_{net} = ma$
$f_{net} = (65)(49)$
$f_{net} = 3185N = 3200N$

c. Find the force exerted by the water on the swimmer.

$f_w - f_g = ma$
$f_w = ma + f_g$
$f_w = (65)(49) + (65)(9.8)$
$f_w = 3822N = 3800N$

15. An exceptional standing jump would raise a person 0.80 m off the ground. To do this, what force must a 70.0 kg person exert against the ground? Assume the person lowers himself 0.20 m prior to jumping.

air
0.80m
$v_f = 0$
$a = -9.8m/s^2$
$v_i = ?$

$v_f^2 = v_i^2 + 2ad$
$v_f^2 - 2ad = v_i^2$
$v_i^2 = 0 - 2(-9.8)(0.80)$
$v_i = \sqrt{15.68} = 3.96\ m/s$

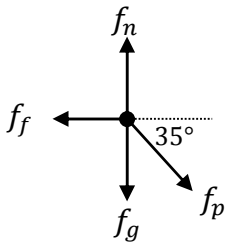
ground
0.20m
$v_f = 3.96m/s$
$a = ?$
$v_i = 0$

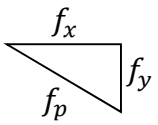
$v_f^2 = v_i^2 + 2ad$
$a = \frac{v_f^2 - v_i^2}{2d}$
$a = \frac{3.96^2 - (0)^2}{2(0.20)} = 39.2m/s^2$

$f_l - f_g = ma$
$f_l = ma + f_g$
$f_l = (70)(39.2) + (70)(9.8)$
$f_l = 3430N = 3400N$

16. A student pushes a 25 kg lawn mower with a force of 150 N. The Handle makes an angle of 35° to the horizontal.

a. Find the vertical and horizontal components of the applied force.





$sin35 = \frac{f_y}{150}$
$f_y = (\sin 35)(150)$
$f_y = 86.04\ N = 86N$

$cos35 = \frac{f_x}{150}$
$f_x = (\cos 35)(150)$
$f_x = 122.87N = 120N$

b. Calculate the normal force supporting the lawn mower while it is being pushed.

$+f_n = ?$
$-f_g = mg$
$= (25)(9.8)$
$= 245\ N$
$-f_y = 86.04N$

$f_n - f_y - f_g = ma$
$f_n - f_y - f_g = 0$
$f_n = f_g + f_y$
$f_n = 245 + 86$
$f_n = 331\ N = 330N$

c. Calculate the net force propelling the mower if a frictional force of 85 N exists.

$+f_x = 122.87N$
$-f_f = 85N$
$f_{net} = f_x - f_f$
$f_{net} = 122.87 - 85$
$f_{net} = 38N$

d. Calculate the horizontal acceleration of the lawn mower.

$f_{net} = ma$
$38 = (25)a$
$a = \frac{38}{25} = 1.5m/s^2$

e. What is the coefficient of friction between the mower and the grass?

$f_f = \mu f_n$
$\mu = \frac{f_f}{f_n}$

$\mu = \frac{85}{331}$
$\mu = 0.26$