Physics

Unit 2: Forces and Uniform Circular Motion

1. *Terms like Velocity, Force, Acceleration, Equilibrium, Inertia, apparent weight, Normal force, True Weight, Gravitational Force, Applied force, Tension, Uniform Circular Motion, Period, Revolution, radius, centripetal acceleration, centripetal force, banked and unbanked curves, satellites, orbit, weightlessness, artificial gravity, Kepler's Laws of Planetary Motion*
2. *Fundamental forces*
3. *Difference between g and G*
4. *static and kinetic frictional forces*
5. *List Newton's Three Laws of Motion.*
6. *difference between mass and weight*
7. *What forces do you draw on a freebody diagram?*
8. *How is centripetal force different from all the other forces we have studied?*
9. *A 100-N force acts on a 75-kg person. What is the acceleration of the person?*
10. *A 70-kg ice skater pushes on a box on smooth ice (no friction). He applies 200 N horizontally against the 50-kg box. What are the accelerations of the ice skater and the box?*
11. *A 10-kg block rests on a frictionless plane inclined at 60°. What is the acceleration of the block as it slides down the incline?*
12. *A stoplight is suspended by two cables over a street. Weight of the light is 110 N and the cables make a 116° angle with each other. Find the tension in each cable.*
13. *A 100-kg man is standing on a bathroom scale while riding an elevator. What does the scale read when the elevator is accelerating upward at 5 m/s^2?*
14. *A 5000-kg car skids to a stop. μ_k = .5. What is the magnitude of the friction force?*
15. *Find the terminal velocity of a falling mouse in air ($A = 0.004\ m^2,\ m = 0.02\ kg,\ C = 0.5$).*
16. *Convert the angular measure of 40 degrees to radians.*
17. *A stone is in a sling and a boy whirls it around in a circle. If the centripetal acceleration is 50 m/s^2 and the radius of the circle is 10 cm, what is the speed of the stone?*
18. *Find the gravitational force of attraction between a 100-kg girl and a 200-kg boy sitting 0.5 meters apart.*
19. *What is the acceleration due to gravity at an altitude of $1 \times 10^6\ m$ above the earth's surface?* ***Note:*** *the radius of the earth is $6.36 \times 10^6\ m$.*
20. *Four people are having a tug-o-war game. Ashley pulls left with 20 N, Bert pulls left with 10 N, Charlie pulls right with 30 N, and Dannie pulls right with 5 N. What is the magnitude of the acceleration of the 5 kg rope and who wins the game?*
21. *A 10-g nut is hanging from a spring that has stretched 30 cm because a squirrel is pulling it down. If the squirrel is pulling with 300 N, what is the spring constant?*

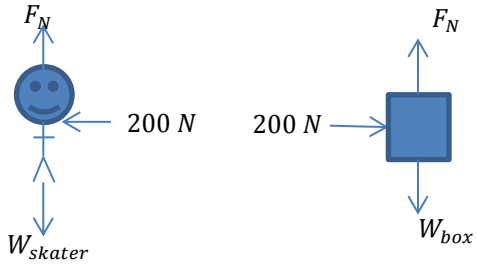
7. *Only forces acting on the object*

9. $F = ma$

$100\ N = 75\ kg\ (a)$

$a = \mathbf{1.33\ \frac{m}{s^2}}$

10.



$W_{skater} = 70\ kg\ \left(9.8\frac{m}{s^2}\right)$

$= 686\ N$

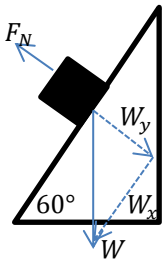
x	y
$-200\ N$	F_N $W = -686\ N$
$F = ma$ $-200\ N = 70\ kg\ (a)$ $a_{skater} = \mathbf{-2.86\ m/s^2}$	

$W_{box} = 50\ kg\ \left(9.8\frac{m}{s^2}\right)$

$= 490\ N$

x	y
$200\ N$	F_N $W = -490\ N$
$F = ma$ $200\ N = 50\ kg\ (a)$ $\mathbf{a_{box} = 4.0\ m/s^2}$	

11. $W = 10\ kg\ \left(9.8\frac{m}{s^2}\right) = 98\ N$



x	y
$W_x = -W\ sin\ 60°$	F_N $W_y = -W\ cos\ 60°$

Forces in x: $F = ma$

$-W\ sin\ 60° = ma$

$-98\ N\ sin\ 60° = 10\ kg\ (a)$

$a = \mathbf{-8.49\ \frac{m}{s^2}}$

12. *F_x:* $T_2\ cos\ 32° - T_1\ cos\ 32° = 0$

$T_2(.8480) - T_1(.8480) = 0$

$T_1 = T_2$

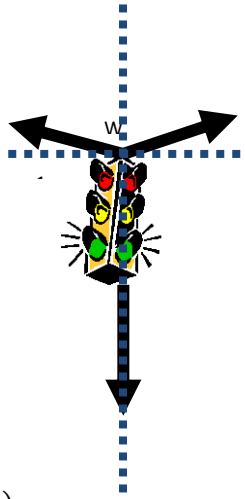
F_y: $-W + T_1\ sin\ 32° + T_2\ sin\ 32° = 0$

$-110\ N + T_1(.5299) + T_1(.5299) = 0$

$-110\ N + 1.0598\ T_1 = 0$

$1.0598\ T_1 = 110\ N$

$T_1 = T_2 = \mathbf{103.8\ N}$



13. $F_N - W = ma$

$F_N - (100\ kg)\left(9.8\frac{m}{s^2}\right) = (100\ kg)\left(5\frac{m}{s^2}\right)$

$F_N = \mathbf{1480\ N}$

14. $F_y: F_N - W = 0 \rightarrow F_N = W \rightarrow F_N =$

$(5000\ kg)\left(9.8\frac{m}{s^2}\right) = 49000\ N$

$F_x: f_k = \mu_k F_N = 0.5(49000\ N) = \mathbf{24500\ N}$

15. *Mouse:* $v = \sqrt{\frac{2mg}{\rho CA}}$

$v = \sqrt{\frac{2(0.02\ kg)\left(9.8\frac{m}{s^2}\right)}{\left(1.21\frac{kg}{m^3}\right)(0.5)(0.004\ m^2)}} = \mathbf{12.7\ \frac{m}{s}}$

16. $40°\left(\frac{\pi}{180°}\right) = \mathbf{\frac{2\pi}{9}}$

17. $a_c = \frac{v^2}{r}$

$50\frac{m}{s^2} = \frac{v^2}{0.10\ m}$

$v^2 = 5m^2/s^2$

$v = \mathbf{2.24\ m/s}$

18. $F_g = G\frac{mM}{r^2}$

$F_g = 6.67 \times 10^{-11}\frac{Nm^2}{kg^2}\frac{(100\ kg)(200\ kg)}{(0.5\ m)^2} = \mathbf{5.34 \times 10^{-6}\ N}$

19. $g = G\frac{M}{r^2}$

$g = \frac{\left(6.67\times10^{-11}\frac{Nm^2}{kg^2}\right)(5.98\times10^{24}\ kg)}{(1\times10^6\ m + 6.36\times10^6\ m)^2} = \mathbf{7.36\ m/s^2}$

20. $F_{net} = ma$

$-20\ N - 10\ N + 30\ N + 5\ N = (5\ kg)a$

$a = 1\ m/s^2$

since this is to the right Charlie and Dannie win

21. $kx - mg - F_{sq} = ma = 0$

$k(0.3\ m) - (0.01\ kg)\left(9.8\frac{m}{s^2}\right) - 300\ N = 0$

$k = 1000$