Physics 20 Unit 2 Outcomes

- Apply Newton's 1st Law to explain inertia
- Apply Newton's 2nd Law to quantitatively describe net force, mass, acceleration; explain that a nonzero net force results in a change in velocity (acceleration)
- Apply Newton's 3rd Law to quantitatively describe the interaction of forces (magnitude and direction) between 2 objects
- Explain qualitatively and quantitatively the effects of force of friction on an object
- Calculate resultant force by adding vector components graphically or otherwise
- Apply Newton's Laws of motion to solve problems in horizontal, vertical, and inclined planes, ignoring air resistance
- Assess/investigate technologies associated with Newton's Laws (injury-prevention devices in cars and sports)
- Describe qualitatively and quantitatively Newton's Law of Universal Gravitation and force of gravity (weight) locally and on other planets
- Explain the principles used to determine universal gravitational constant, G (Cavendish experiment)
- Define the term "field" as it applies to gravity
- Assess/investigate concepts related to gravity (tidal forces, weightlessness, shape of solar systems, galaxies)

1. A 0.500 kg object is thrown vertically upward with an average applied force of 8.20 N by a student. This force is applied through a displacement of 1.50 m.
   a) what is the average net force acting on the object?

   3.30N, up.

   b) What is the velocity of the object when it leaves the student's hand? Assume the initial velocity of the object is zero.

$a = -6.59\ m/s^2$ $v_f = 4.44\ m/s$, up.

2. An 85 /n object is pulled along a horizontal surface by a force of 32 N as shown in the diagram. The frictional force acting on this object is 14 N.

   a) What is the acceleration of the object?

$m = 8.66$ kg $a = 2.1\ m/s^2$

   b) What is the coefficient of friction between the surfaces?

$\mu = 0.16$.

3. A 2.5 kg object is pulled along a horizontal surface at a constant velocity of 2.0 m/s by a force of 3.0 N. What is the coefficient of friction between the surfaces?

$F_f = 3.0\,N.$ $\mu = 0.122$

4. A 1.20×10^3 kg car is travelling at a speed of 22.5 m/s when the brakes are applied. If the car comes to a stop in 112 m, what is the braking force?

$a = \frac{v_f^2 - v_i^2}{2d}$ $a = -2.26\,m/s^2$ $F = ma$ $F = -2.71 \times 10^3\,N.$

5. What is the mass of an object that has a weight of 50.0 N on Earth's surface?

$m = 5.10\,kg.$

6. A hockey puck is shot along the ice at a velocity of 11 m/s and it slides 25 m before it comes to a stop. What is the coefficient of friction between the puck and the ice?

0.154kg

$a = -2.42\,m/s^2$ $F_f = 0.372\,N$

$\mu = 0.25$

7. Two blocks (m_1 and m_2) are in contact with each other while sitting on a frictionless surface. A horizontal force of 85 N is applied to m_1.

$m_1 = 6.8$

$m_2 = 5.2$

a) What is the acceleration of the system?

$7.1\,m/s^2$

b) What is the force that m_1 exerts on m_2?

$37\,N.$

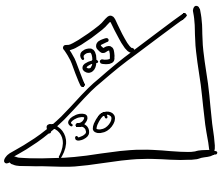
8. What is the tension in the cable of a 1.5×10^3 kg elevator that is
   a) Accelerating downward at a rate of 0.50 m/s^2

~~15465N~~ 13965

   b) Moving downward at a constant velocity of 1.0 m/s?

14715 N.

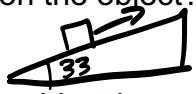
9. A 25.0 kg block slides down a 30.0° incline at a constant speed. What is the coefficient of friction between the block and the incline?



$F_{g_{||}} = F_f$

$\frac{mg\sin\theta}{mg} = \mu = \sin\theta = \sin 30 =$ 0.5 = μ

10. A 7.6 kg object is pulled up an incline. If the incline makes an angle of 33° with the horizontal, and the coefficient of friction is 0.20, what is the force of friction acting on the object?



$F_f = \mu F_N = \mu F_{g\perp} = 0.2(7.6)(9.81)\cos(33)$
$= 12.5\,N.$

11. A 15 kg object is suspended halfway between two walls by two wires. The wires each make an angle of 30° with the horizontal. What is the total tension force in each wire?

$\sin = \frac{opp}{hyp}$

$F_g = 15 \times 9.81$
$= 147\,N = F_g$

$\frac{F_g}{2 \times \sin 30} = F_T = 147\,N.$

12. An astronaut has a weight of 1.95×10^3 N when she is on the surface of a hypothetical planet that has a mass of 25 times, and a radius of 2.5 times that of the Earth. what is her mass?

$F_g = \frac{G m_1 m_2}{r^2}$ $\quad m = \frac{F_g (2.5 r_E)^2}{25 m_E \times G} = 49.6\ kg$

13. On the surface of Planet T, which has a mass of 7.90×10^{25}, an object has a weight of 112 N and a mass of 75.0 kg. What is the radius of this planet?

$r = \sqrt{\frac{G m_1 M_2}{F_g}} = \sqrt{\frac{G \times 7.90 \times 10^{25} \times 75}{112}} = 5.94 \times 10^7\,m.$

$3.00 \times 10^6\,m$

14. An object (mass = 525 kg) is ~~3.0 × 10⁶~~ m above the Earth's surface. The object is falling toward the Earth because of the Earth's gravitational force on it. What is the rate of acceleration when it is at this height?

$g = \frac{GM}{r^2} = \frac{G \times 5.98 \times 10^{24}}{(6371 \times 10^3 + 3 \times 10^6)^2} = 4.54\,m/s^2$

15. How far from the surface of the Earth is the gravitational field strength 6.13×10^{-1} N/kg?

$g = \frac{Gm}{r^2}$ $\quad r = \sqrt{\frac{Gm}{g}} = 2.5 \times 10^7\,m$

d from Earth $= 1.91 \times 10^7\,m$

16. Calculate the gravitational field strength at a point in space where the weight of an object is 7.22×10^2 N and its mass is 1.10×10^2 kg.

$g = \frac{F_g}{m} = 6.56\ m/s^2$

17. The gravitational force between the Earth and the Sun is 3.57×10^{22} N. If the mass of the Earth is 5.98×10^{24} kg, and its orbital radius is 1.5×10^8 km, what is the mass of the sun?

$m = \frac{F_g r^2}{GM} = \frac{3.57 \times 10^{22} \times (1.5 \times 10^8)^2}{G \times 5.98 \times 10^{24}} = 2.01 \times 10^{30}\ kg$

18. Based on the previous question, what would the gravitational force be if the mass of the sun doubled, the mass of earth was quartered, and the orbital radius was tripled?

$F_g = 3.57 \times 10^{22}\,N$

$m_1 \to 2m$
$m_2 \to \frac{1}{4}m$
$r \to 3r$

$F_g' = \frac{2 \times \frac{1}{4}}{9} F_g$
$= \frac{1}{18} F_g = 1.98 \times 10^{21}\,N$