Physics 11
Dynamics Unit Retest Solutions

	a.	b.	c.	d.
1.		X		
2.	X			
3.		X		
4.		X	X	
5.	X			
6.				X
7.		X		
8.		X		
9.			X	
10.	X			
11.		X		
12.			X	
13.		X		
14.			X	
15.	X			
16.		X		
17.	X			
18.		X		
19.	X			
20.	X			

1. **Problem**
   True or false? If an object is at rest, then there are no forces acting upon the object.

   a. True
   b. False

   Solution
   False. If an object is at rest, then the forces on it must be balanced. For example, a book at rest on a table is acted upon by gravity and the normal force from the desk.

2. **Problem**
   True or false? An object weighs less on the moon than it does on earth.

   a. True
   b. False

   Solution
   True. Weight is the force of gravity. The gravitational field strength on the moon is less than on earth, so objects weigh less on the moon.

3. **Problem**
   True or false? A ball is thrown upwards and rightwards. While it is in the air, the net force on the ball is directed upwards and rightwards.

   a. True
   b. False

   Solution
   False. The only force on the ball while it is in the air is the force of gravity, which points downward (assuming no air resistance).

4. **Problem**
   A box that weighs 100 N rests on a digital scale on the floor of an elevator. When would the scale measure a value less than 100 N? *Select all that apply.*

   a. moving upward with increasing speed.
   b. moving upward with decreasing speed.
   c. moving downward with increasing speed.
   d. moving downward with decreasing speed.

   Solution
   The force of gravity is always downward while the normal force provided by the scale always points upward. The scale measures the normal force on it. If the acceleration is upward, then the normal force must be greater (so the scale would measure a greater weight). If the acceleration is downward, then the normal force must be less (so the scale would measure a smaller weight).

   The acceleration is downward when the elevator is moving down with increasing speed and when the elevator is moving up with decreasing speed.

5. **Problem**
   A person of mass 94 kg pushes on a wall with 60 N of force. What is the magnitude of the force that the wall exerts on the person?

   a. 60 N
   b. 6.1 N
   c. 590 N
   d. 920 N

   Solution
   According to Newton's Third Law of Motion, the wall exerts an equal and opposite force on the person (the person's mass has nothing to do with the answer).

6. **Problem**
   A rocket moves through outer space with a constant velocity of 9.8 m/s toward the Andromeda galaxy. What is the net force acting on the rocket?

   a. A force equal to the gravity acting on it.
   b. A force equal to its weight on Earth, mg.
   c. Cannot be determined without more information.
   d. The net force is zero.

   Solution
   Since the rocket is moving with constant velocity, its acceleration is zero and the net force acting on the rocket must also be zero.

7. **Problem**
   A physics textbook of mass m is at rest on a flat table. Earth's gravity applies a downward force mg on the book, which we will call the action force. What is the reaction force?

   a. The table pushing down on the floor with force mg.
   b. The book pulling upward on the Earth with force mg.
   c. The table pushing up on the book with force mg.
   d. The book pushing down on the table with force mg.

   Solution
   Action-reaction force pairs are always between the same two objects. The reaction force to the Earth pulling down on the book is the book pulling upward on the Earth with force.

8. **Problem**
   A box, of mass M, is suspended by a string from the ceiling inside an elevator. The elevator is traveling downward with a constant speed. The tension in the string is

   a. less than Mg.
   b. equal to Mg.
   c. greater than Mg.
   d. impossible to determine without knowing the speed.

   Solution
   The elevator is moving with constant velocity so the acceleration is zero and the net force must also be zero. Therefore, the tension force must balance (equal) the gravitational force, Mg.

9. **Problem**
You place a 79.76-kg object on a spring scale. If the scale reads 812.8 N, what is the acceleration of gravity at that location?

a. $14.68\,\mathrm{m/s^2}$
b. $14.04\,\mathrm{m/s^2}$
c. $10.19\,\mathrm{m/s^2}$
d. $10.96\,\mathrm{m/s^2}$

Solution
The acceleration of gravity (g) is related to the mass (m) and weight (W) of objects by the equation $W = mg$. Solving for g, we get

$$g = \frac{W}{m} = \frac{812.8\,\mathrm{N}}{79.76\,\mathrm{kg}} = 10.19\,\mathrm{m/s^2}$$

10. **Problem**
An object of mass 6.0 kg accelerates at 11.0 m/s^2. What is the magnitude of the net force on the object?

a. 66 N
b. 50 N
c. 59 N
d. 76 N

Solution
According to Newton's Second Law of Motion

$$F = ma = (6\,\mathrm{kg})(11\,\mathrm{m/s^2}) = 66\,\mathrm{N}$$

11. **Problem**
An box is at rest on an inclined plane. The angle of incline is increased slowly. When the angle reaches $29.0°$, the box begins to slide. What is the coefficient of static friction between the box and the inclined plane?

a. 0.756
b. 0.554
c. 0.672
d. 0.828

Solution
On an inclined plane, the normal force is equal to the perpendicular component of the force of gravity:

$$F_N = mg\cos\theta$$

The friction force when the object starts to slide, the maximum static friction force is reached and it must be equal to the parallel component of the force of gravity:

$$F_f = \mu_s F_N = \mu_s mg\cos\theta = mg\sin\theta$$

Therefore, the coefficient of static friction, μ_s, is:

$$\mu_s = \frac{\sin\theta}{\cos\theta} = \tan\theta = \tan(29^\circ) = 0.554$$

12. **Problem**
    As the angle of an inclined plane increases, the parallel force _______ and the perpendicular force _______.

    a. decreases, decreases
    b. decreases, increases
    c. increases, decreases
    d. increases, increases

    Solution
    The parallel forces increases and the perpendicular force decreases.

13. **Problem**
    Two forces act on an object. A 98-N force acts at 0° and a 90-N force acts at 90°. What is the magnitude of the equilibrant?

    a. 138 N
    b. 133 N
    c. 74.2 N
    d. 109 N

    Solution
    Perpendicular forces are added using the Pythagorean theorem. The equilibrant has the same magnitude as the sum of the two forces.

$$F_{eq} = \sqrt{98N + 90N} = 133 \text{ N}$$

14. **Problem**
    Carly pulls on a box with 18.0 N of force. Debby pulls on the the same box at a right angle to Carly. How hard must Debby pull to make the resultant force on the box 27.0 N?

    a. 18.0 N
    b. 10.4 N
    c. 20.1 N
    d. 13.1 N

    Solution
    Perpendicular forces are related by the Pythagorean theorem.

$$F_{Debby} = \sqrt{F_{net}^2 - F_{Carly}^2} = \sqrt{(27N)^2 - (18N)^2} = 20.1 \text{ N}$$

15. **Problem**
Robert pulls on a box with 30.0 N of force at $176°$. Steve pulls on the the same box with 21.0 N of force at $19°$. What is the magnitude of the net force on the box?

   a. 13.5 N
   b. 18.5 N
   c. 10.5 N
   d. 14.8 N

Solution
The sum of the horizontal components is

$$F_{net,x} = (30N)\cos(176°) + (21N)\cos(19°) = -10.0710314N$$

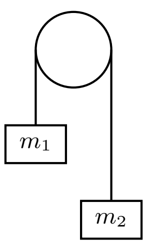
The sum of the vertical components is

$$F_{net,y} = (30N)\sin(176°) + (21N)\sin(19°) = 8.9296255N$$

The magnitude of the net force is

$$F_{net} = \sqrt{(-10.0710314N)^2 + (8.9296255N)^2} = 13.5 \text{ N}$$

16. **Problem**
Two masses are attached to a lightweight cord that passes over a frictionless pulley as shown in the diagram. The values of the masses are $m_1 = 73.0$ kg and $m_2 = 27.0$ kg. The hanging masses are free to move. What is the magnitude of the acceleration of the system?



   a. 3.03 m/s/s
   b. 4.51 m/s/s
   c. 5.62 m/s/s
   d. 2.56 m/s/s

Solution
Since the weight of the two masses oppose each other, the net force is the difference of the masses times the gravitational field strength. The direction is of course down toward the heavier side. We can use the absolute value of the difference to find the magnitude of the acceleration.

$$F_{net} = |m_1 - m_2|g$$

The magnitude of the acceleration is then

$$a = \left|\frac{m_1 - m_2}{m_1 + m_2}\right| g$$

The answer is

$$a = 4.51 \text{ m/s/s}$$

17. **Problem**
Two forces act on an object. A 24.0-N force acts at $-112°$. A 68.0-N force acts at $39°$. What is the angle of their equilibrant?

a. $-154.9°$
b. $-180.0°$
c. $-165.2°$
d. $-169.7°$

Solution
The sum of the horizontal components is

$$F_{net,x} = (24N)\cos(-112°) + (68N)\cos(39°) = 43.8553671N$$

The sum of the vertical components is

$$F_{net,y} = (24N)\sin(-112°) + (68N)\sin(39°) = 20.5413741N$$

The angle of the net force is

$$\theta_{net} = \tan^{-1}(20.5413741/43.8553671) = 25.1°$$

The direction of the equilibrant is opposite that of the net force so we add or subtract $180°$.

$$\theta_{eq} = 205.1°$$

Or

$$\theta_{eq} = -154.9°$$

18. **Problem**
A box of mass 12 kg slides down a frictionless inclined plane. The angle of incline is $71°$ from the horizontal. What is the acceleration of the box?

a. 13.0 m/s^2
b. 9.3 m/s^2
c. 10.9 m/s^2
d. 11.1 m/s^2

Solution
The acceleration is

$$a = g\sin\theta = (9.8\,\mathrm{m/s^2})\sin(71°) = 9.3\,\mathrm{m/s^2}$$

19. **Problem**
A box of mass 14 kg slides down an inclined plane with friction. The angle of incline is $41°$ and $\mu_k = 0.15$. What is the acceleration of the box?

a. 5.3 m/s^2
b. 1.2 m/s^2
c. 0.6 m/s^2
d. 1.1 m/s^2

Solution
The acceleration is

$$a = g(\sin\theta - \mu\cos\theta) = 5.3\,\mathrm{m/s^2}$$

20. **Problem**
An 2.6-kg box slides down a $34°$ inclined plane with constant acceleration. The box starts from rest at the top. At the bottom, its velocity reaches 4.03 m/s. The length of the incline is 3.44 m. What is the coefficient of kinetic friction between the box and the plane?

   a. 0.384
   b. 0.344
   c. 0.264
   d. 0.014

Solution
The acceleration of the box can be calculated using the constant acceleration formula $v_f^2 = v_i^2 + 2ad$. Since $v_i = 0$, we the acceleration is

$$a = \frac{v_f^2}{2d} = \frac{(4.03\,\mathrm{m/s})^2}{2(3.44\,\mathrm{m})} = 2.3605959\,\mathrm{m/s^2}$$

The acceleration down an inclined plane with friction is

$$a = g\sin\theta - \mu g\cos\theta$$

Solving for μ

$$\mu = \tan\theta - \frac{a}{g\cos\theta} = \tan(34°) - \frac{(2.3605959\,\mathrm{m/s^2})}{(9.80\,\mathrm{m/s^2})\cos(34°)}$$

$$\mu = 0.384$$