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 in equilibrium (i.e. all the forces on it are balanced), then the object must be at rest.

   a. True
   b. False

   Solution
   False. An object in equilibrium must have zero acceleration, but its velocity is not necessarily zero.

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 golf club hits a golf ball with a force of 2400 N. The golf ball hits the club with a force

   a. more than 2400 N
   b. not enough information to determine
   c. 2400 N
   d. less than 2400 N

   Solution
   According to Newton's Third Law of Motion, the golf ball exerts the same force back on the club. The answer is exactly 2400 N.

6. **Problem**
   Why is a greater force needed to start moving a heavy box from rest than to keep pushing it with constant velocity? In the choices below, μ_k is the coefficient of kinetic friction and μ_s is the coefficient of static friction.

   a. The normal force is greater when the box is at rest.
   b. The inertia of the box is greater when it is at rest.
   c. $\mu_s < \mu_k$
   d. $\mu_k < \mu_s$

   Solution
   $\mu_k < \mu_s$. The coefficient of kinetic friction is less than the coefficient of static friction.

7. **Problem**
   An apple is falling straight down toward the ground. Take the weight of the apple to be the action force. What is the reaction force?

   a. There is no reaction force because the apple is not touching anything.
   b. The force of impact when the object hits the ground.
   c. The apple's gravity pulling upward on the Earth.
   d. The air resistance pushing up on the apple.

   Solution
   The apple applies an equal and opposite gravitational pull on the Earth.

8. **Problem**
   What is the net force on a person who is standing in an elevator moving up with a constant velocity of 4.00 m/s?

   a. It depends on the mass of the person.
   b. 4.00 N, down
   c. 4.00 N, up
   d. 0 N

   Solution
   The elevator is moving with constant velocity so the acceleration is zero and the net force must also be zero.

9. **Problem**
   You place a 84.65-kg object on a spring scale. If the scale reads 392.4 N, what is the acceleration of gravity at that location?

   a. $6.7\,\mathrm{m/s^2}$
   b. $2.9\,\mathrm{m/s^2}$
   c. $5.96\,\mathrm{m/s^2}$
   d. $4.64\,\mathrm{m/s^2}$

   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

$$g = \frac{W}{m} = \frac{392.4\,\mathrm{N}}{84.65\,\mathrm{kg}} = 4.64\,\mathrm{m/s^2}$$

10. **Problem**
    An object of mass 3.0 kg accelerates at 18.0 m/s^2. What is the magnitude of the net force on the object?

    a. 74 N
    b. 27 N
    c. 54 N
    d. 67 N

    Solution
    According to Newton's Second Law of Motion

$$F = ma = (3\,\mathrm{kg})(18\,\mathrm{m/s^2}) = 54\,\mathrm{N}$$

11. **Problem**
    An box is at rest on an inclined plane. The angle of incline is increased slowly. When the angle reaches $46.0°$, the box begins to slide. What is the coefficient of static friction between the box and the inclined plane?

    a. 1.510
    b. 1.036
    c. 1.181
    d. 1.287

    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:

$$\mu_s = \frac{\sin\theta}{\cos\theta} = \tan\theta = \tan(46^\circ) = 1.036$$

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**
Adam pulls on a box with 20.0 N of force. Bob pulls on the the same box with 2.0 N of force, at a right angle to Adam's force. What is the magnitude of the net force on the box?

    a. 12.7 N
    b. 17.1 N
    c. 20.1 N
    d. 14.8 N

    Solution
    Perpendicular forces are added using the Pythagorean theorem.

$$F_{net} = \sqrt{F_1^2 + F_2^2} = \sqrt{(20N)^2 + (2N)^2} = 20.1 \text{ N}$$

14. **Problem**
Xavier pulls on a box with 20.0 N of force at 0°. Yuri pulls on the the same box with 44.0 N of force, at 90°. What is the angle of the net force?

    a. 86.4°
    b. 87.7°
    c. 77.1°
    d. 66.0°

    Solution
    The angle can be found using the arctangent.

$$\theta = \tan^{-1}(44/20) = 66^\circ$$

15. **Problem**
Robert pulls on a box with 46.0 N of force at $344°$. Steve pulls on the the same box with 97.0 N of force at $75°$. What is the magnitude of the net force on the box?

    a. 97.5 N
    b. 102.9 N
    c. 107 N
    d. 117.6 N

    Solution
    The sum of the horizontal components is

$$F_{net,x} = (46N)\cos(344°) + (97N)\cos(75°) = 69.3234854N$$

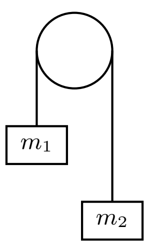
The sum of the vertical components is

$$F_{net,y} = (46N)\sin(344°) + (97N)\sin(75°) = 81.0154868N$$

The magnitude of the net force is

$$F_{net} = \sqrt{(69.3234854N)^2 + (81.0154868N)^2} = 107 \text{ N}$$

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 $m_1 = 76.0$ kg and $m_2 = 64.0$ kg. The hanging masses are free to move. What is the tension in the cord?



    a. 1020 N
    b. 681 N
    c. 793 N
    d. 851 N

    Solution
    The acceleration (where m_1 moving downward is positive) is

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

Newton's Second Law for m_2 is $T - m_2 g = m_2 a$. Rearranging for T gives

$$T = m_2(g + a) = m_2 g \left(1 + \frac{m_1 - m_2}{m_1 + m_2}\right) = \left(\frac{2m_1 m_2}{m_1 + m_2}\right) g$$

The answer is

$$T = 681 \text{ N}$$

17. **Problem**
Two forces act on an object. A 20.0-N force acts at 113°. A 99.0-N force acts at 71°. What is the angle of their equilibrant?

a. -175.3°
b. -71.9°
c. 146.7°
d. -102.3°

Solution
The sum of the horizontal components is

$$F_{net,x} = (20N)\cos(113^\circ) + (99N)\cos(71^\circ) = 24.4166247N$$

The sum of the vertical components is

$$F_{net,y} = (20N)\sin(113^\circ) + (99N)\sin(71^\circ) = 112.0164361N$$

The angle of the net force is

$$\theta_{net} = \tan^{-1}(112.0164361/24.4166247) = 77.7^\circ$$

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

$$\theta_{eq} = 257.7^\circ$$

Or

$$\theta_{eq} = -102.3^\circ$$

18. **Problem**
A box of mass 34 kg slides down a frictionless inclined plane. The angle of incline is 49° from the horizontal. What is the acceleration of the box?

a. 7.4 m/s^2
b. 10.7 m/s^2
c. 8.0 m/s^2
d. 8.1 m/s^2

Solution
The acceleration is

$$a = g\sin\theta = (9.8\,\mathrm{m/s^2})\sin(49^\circ) = 7.4\,\mathrm{m/s^2}$$

19. **Problem**
A box of mass 48 kg slides down an inclined plane with friction. The angle of incline is 60° and $\mu_k = 1.3$. What is the acceleration of the box?

a. 2.1 m/s^2
b. 0.9 m/s^2
c. 0.8 m/s^2
d. 1.3 m/s^2

Solution
The acceleration is

$$a = g(\sin\theta - \mu\cos\theta) = 2.1\,\mathrm{m/s^2}$$

20. **Problem**
An 4.9-kg box slides down a 20° inclined plane with constant acceleration. The box starts from rest at the top. At the bottom, its velocity reaches 1.7 m/s. The length of the incline is 1.19 m. What is the coefficient of kinetic friction between the box and the plane?

    a. 0.286
    b. 0.232
    c. 0.347
    d. 0.319

    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

$$a = \frac{v_f^2}{2d} = \frac{(1.7\,\mathrm{m/s})^2}{2(1.19\,\mathrm{m})} = 1.2142857\,\mathrm{m/s^2}$$

The acceleration down an inclined plane with friction is

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

Solving for μ

$$\mu = \tan\theta - \frac{a}{g\cos\theta} = \tan(20^\circ) - \frac{(1.2142857\,\mathrm{m/s^2})}{(9.80\,\mathrm{m/s^2})\cos(20^\circ)}$$

$$\mu = 0.232$$