Physics 11
Dynamics Unit Retest 2 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? The mass of an object on the moon is the same as its mass on earth.

   a. True
   b. False

   Solution
   True. Mass is an inherent property of the object that does not depend on its location.

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. not enough information to determine
   b. less than 2400 N
   c. 2400 N
   d. more 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. $\mu_k < \mu_s$
   b. The inertia of the box is greater when it is at rest.
   c. The normal force is greater when the box is at rest.
   d. $\mu_s < \mu_k$

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

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

8. **Problem**
   The gravitational force exerted by a large body, such as the Earth, is called

   a. gravitational field strength
   b. gravitational mass
   c. weight
   d. inertial mass

   Solution
   The gravitational force exerted by a large body, such as the Earth, is called **weight**. (p. 94)

9. **Problem**
   You place a 18.53-kg object on a spring scale. If the scale reads 122.5 N, what is the acceleration of gravity at that location?

   a. $5.32\,\mathrm{m/s^2}$
   b. $3.32\,\mathrm{m/s^2}$
   c. $6.61\,\mathrm{m/s^2}$
   d. $3.96\,\mathrm{m/s^2}$

   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

   $$g = \frac{W}{m} = \frac{122.5\,\mathrm{N}}{18.53\,\mathrm{kg}} = 6.61\,\mathrm{m/s^2}$$

10. **Problem**
    An object of mass 20.0 kg accelerates at 2.0 m/s^2. What is the magnitude of the net force on the object?

    a. 59 N
    b. 40 N
    c. 35 N
    d. 46 N

    Solution
    According to Newton's Second Law of Motion

    $$F = ma = (20\,\mathrm{kg})(2\,\mathrm{m/s^2}) = 40\,\mathrm{N}$$

11. **Problem**
    An box is at rest on an inclined plane. The angle of incline is increased slowly. When the angle reaches $35.0°$, the box begins to slide. What is the coefficient of static friction between the box and the inclined plane?

    a. 0.966
    b. 1.038
    c. 0.811
    d. 0.700

    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:

$$\mu_s = \frac{\sin\theta}{\cos\theta} = \tan\theta = \tan(35^\circ) = 0.700$$

12. **Problem**
What force is needed to keep a 46-kg box moving at a constant velocity across a warehouse floor if the coefficient of kinetic friction between the box and the floor is 0.29?

a. 180 N
b. 170 N
c. 130 N
d. 54 N

Solution
The applied force needed for constant velocity (zero acceleration) is one that balances the friction force.

$$F_f = \mu_k F_N = \mu m g = (0.29)(46\,\mathrm{kg})(9.8\,\mathrm{N/kg}) = 130\,\mathrm{N}$$

13. **Problem**
Two forces act on an object. A 46-N force acts at 0° and a 12-N force acts at 90°. What is the magnitude of the equilibrant?

a. 40.6 N
b. 47.5 N
c. 35.5 N
d. 45.1 N

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

$$F_{eq} = \sqrt{46N + 12N} = 47.5 \text{ N}$$

14. **Problem**
Xavier pulls on a box with 44.0 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. 45.0°
b. 49.9°
c. 80.0°
d. 52.9°

Solution
The angle can be found using the arctangent.

$$\theta = \tan^{-1}(44/44) = 45^\circ$$

15. **Problem**
Charlie pulls on a box with 45.0 N of force at $-30°$. Dan pulls on the the same box with 18.0 N of force at $-57°$. What is the angle of the net force on the box?

   a. $-43.6°$
   b. $20.2°$
   c. $-37.6°$
   d. $-159.4°$

Solution
The sum of the horizontal components is

$$F_{net,x} = (45N)\cos(-30°) + (18N)\cos(-57°) = 48.7746458N$$

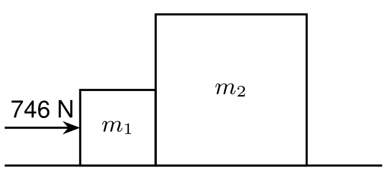
The sum of the vertical components is

$$F_{net,y} = (45N)\sin(-30°) + (18N)\sin(-57°) = -37.5960702N$$

The angle of the net force is

$$\theta = \tan^{-1}(-37.5960702/48.7746458) = -37.6°$$

16. **Problem**
Two boxes are in contact with each other on a frictionless table as shown in the diagram. The masses are $m_1 = 80$ kg and $m_2 = 400$ kg. The first box (m_1)is pushed with a horizontal force of 746 N to the right. What is the net force on the second box (m_2)?



   a. 395 N
   b. 622 N
   c. 741 N
   d. 529 N

Solution
The acceleration of the system of two boxes is

$$a = \frac{746\,\text{N}}{80\,\text{kg} + 400\,\text{kg}}$$

The net force on m_2 is its mass times its acceleration

$$F_{net,2} = (400\,\text{kg})\left(\frac{746\,\text{N}}{80\,\text{kg} + 400\,\text{kg}}\right) = 622\,\text{N}$$

17. **Problem**
Two forces act on an object. A 96.0-N force acts at $-167°$. A 36.0-N force acts at $55°$. What is the angle of their equilibrant?

   a. $88.1°$
   b. $-161.2°$
   c. $-6.2°$
   d. $166.3°$

Solution
The sum of the horizontal components is

$$F_{net,x} = (96N)\cos(-167°) + (36N)\cos(55°) = -72.8907745N$$

The sum of the vertical components is

$$F_{net,y} = (96N)\sin(-167°) + (36N)\sin(55°) = 7.8941724N$$

The angle of the net force is

$$\theta_{net} = \tan^{-1}(7.8941724/-72.8907745) = 173.8°$$

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

$$\theta_{eq} = 353.8°$$

Or

$$\theta_{eq} = -6.2°$$

18. **Problem**
A box of mass 86 kg slides down a frictionless inclined plane. The angle of incline is $53°$ from the horizontal. What is the acceleration of the box?

   a. $7.9\,\text{m/s}^2$
   b. $10.6\,\text{m/s}^2$
   c. $8.0\,\text{m/s}^2$
   d. $7.8\,\text{m/s}^2$

Solution
The acceleration is

$$a = g\sin\theta = (9.8\,\text{m/s}^2)\sin(53°) = 7.8\,\text{m/s}^2$$

19. **Problem**
A box of mass 20 kg slides down an inclined plane with friction. The angle of incline is $58°$ and $\mu_k = 0.78$. What is the acceleration of the box?

   a. $4.9\,\text{m/s}^2$
   b. $4.3\,\text{m/s}^2$
   c. $1.3\,\text{m/s}^2$
   d. $9.0\,\text{m/s}^2$

Solution
The acceleration is

$$a = g(\sin\theta - \mu\cos\theta) = 4.3\,\text{m/s}^2$$

20. **Problem**
An 3.7-kg box slides down a 51° inclined plane with constant acceleration. The box starts from rest at the top. At the bottom, its velocity reaches 4.02 m/s. The length of the incline is 1.46 m. What is the coefficient of kinetic friction between the box and the plane?

   a. 0.157
   b. 0.426
   c. 0.385
   d. 0.338

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

$$a = \frac{v_f^2}{2d} = \frac{(4.02\,\mathrm{m/s})^2}{2(1.46\,\mathrm{m})} = 5.5343836\,\mathrm{m/s^2}$$

The acceleration down an inclined plane with friction is

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

Solving for μ

$$\mu = \tan\theta - \frac{a}{g\cos\theta} = \tan(51^\circ) - \frac{(5.5343836\,\mathrm{m/s^2})}{(9.80\,\mathrm{m/s^2})\cos(51^\circ)}$$

$$\mu = 0.338$$