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? 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? If an object is moving to the left, then the net force on it must point to the left.

   a. True
   b. False

   Solution
   False. The net force is the direction of acceleration, not the direction of motion (velocity).

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 93 kg pushes on a wall with 40 N of force. What is the magnitude of the force that the wall exerts on the person?

   a. 4.1 N
   b. 40 N
   c. 390 N
   d. 910 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**
   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 inertia of the box is greater when it is at rest.
   b. $\mu_s < \mu_k$
   c. The normal force is greater when the box is at rest.
   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 air resistance pushing up on the apple.
   c. The force of impact when the object hits the ground.
   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. inertial mass
   b. gravitational mass
   c. weight
   d. gravitational field strength

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

9. **Problem**
   You place a 71.77-kg object on a spring scale. If the scale reads 486.5 N, what is the acceleration of gravity at that location?

   a. $5.18\,\mathrm{m/s^2}$
   b. $8.26\,\mathrm{m/s^2}$
   c. $5.78\,\mathrm{m/s^2}$
   d. $6.78\,\mathrm{m/s^2}$

   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

   $$g = \frac{W}{m} = \frac{486.5\,\mathrm{N}}{71.77\,\mathrm{kg}} = 6.78\,\mathrm{m/s^2}$$

10. **Problem**
    A net force of 890 N acts on an object, and it accelerates at 95 m/s/s in the direction of the net force. What is the mass of the object?

    a. 9.4 kg
    b. 85000 kg
    c. 17000 kg
    d. 0.11 kg

    Solution
    According to Newton's Second Law of Motion

    $$m = F/a = (890\,\mathrm{N})/(95\,\mathrm{m/s^2}) = 9.4\,\mathrm{kg}$$

11. **Problem**
    An box is at rest on an inclined plane. The angle of incline is increased slowly. When the angle reaches $21.0°$, the box begins to slide. What is the coefficient of static friction between the box and the inclined plane?

    a. 0.481
    b. 0.384
    c. 0.433
    d. 0.575

    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:

$$\mu_s = \frac{\sin\theta}{\cos\theta} = \tan\theta = \tan(21^\circ) = 0.384$$

12. **Problem**
What force is needed to keep a 15-kg box moving at a constant velocity across a warehouse floor if the coefficient of kinetic friction between the box and the floor is 0.24?

    a. 49 N
    b. 39 N
    c. 35 N
    d. 3.6 N

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

$$F_f = \mu_k F_N = \mu mg = (0.24)(15\,\mathrm{kg})(9.8\,\mathrm{N/kg}) = 35\,\mathrm{N}$$

13. **Problem**
Adam pulls on a box with 11.0 N of force. Bob pulls on the the same box with 19.0 N of force, at a right angle to Adam's force. What is the magnitude of the net force on the box?

    a. 19.7 N
    b. 11.3 N
    c. 22 N
    d. 15.7 N

    Solution
Perpendicular forces are added using the Pythagorean theorem.

$$F_{net} = \sqrt{F_1^2 + F_2^2} = \sqrt{(11N)^2 + (19N)^2} = 22 \text{ N}$$

14. **Problem**
Xavier pulls on a box with 24.0 N of force at 0°. Yuri pulls on the the same box with 21.0 N of force, at 90°. What is the angle of the net force?

    a. 41.0°
    b. 87.0°
    c. 73.2°
    d. 1.1°

    Solution
The angle can be found using the arctangent.

$$\theta = \tan^{-1}(21/24) = 41^\circ$$

15. **Problem**
Charlie pulls on a box with 91.0 N of force at $67°$. Dan pulls on the the same box with 65.0 N of force at $-150°$. What is the angle of the net force on the box?

a. $121.8°$
b. $173.6°$
c. $112.0°$
d. $-2.0°$

Solution
The sum of the horizontal components is

$$F_{net,x} = (91N)\cos(67°) + (65N)\cos(-150°) = -20.7351186N$$

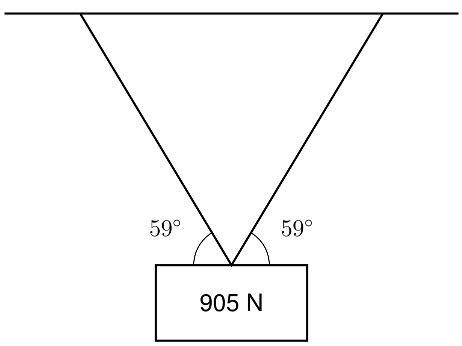
The sum of the vertical components is

$$F_{net,y} = (91N)\sin(67°) + (65N)\sin(-150°) = 51.2659417N$$

The angle of the net force is

$$\theta = \tan^{-1}(51.2659417/-20.7351186) = 112.0°$$

16. **Problem**
A sign that weighs 905 N is supported by two ropes that each makes a $59°$ angle with the horizontal. The sign is not moving. What is the magnitude of the force exerted by each rope?



a. 726 N
b. 541 N
c. 585 N
d. 528 N

Solution
The horizontal components cancel out so the two vertical components must balance the weight of the sign. (See the example problem on p. 122.)

$$F = \frac{(905N)}{2\sin(59°)} = 528 \text{ N}$$

17. **Problem**
    Two forces act on an object. A 37.0-N force acts at $79°$. A 15.0-N force acts at $78°$. What is the angle of their equilibrant?

    a. $-101.3°$
    b. $-45.7°$
    c. $56.4°$
    d. $-30.6°$

    Solution
    The sum of the horizontal components is

    $$F_{net,x} = (37N)\cos(79°) + (15N)\cos(78°) = 10.1786082N$$

    The sum of the vertical components is

    $$F_{net,y} = (37N)\sin(79°) + (15N)\sin(78°) = 50.9924198N$$

    The angle of the net force is

    $$\theta_{net} = \tan^{-1}(50.9924198/10.1786082) = 78.7°$$

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

    $$\theta_{eq} = 258.7°$$

    Or

    $$\theta_{eq} = -101.3°$$

18. **Problem**
    A box of mass 59 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. 11.1 m/s^2
    c. 7.7 m/s^2
    d. 8.2 m/s^2

    Solution
    The acceleration is

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

19. **Problem**
    A box of mass 32 kg slides down an inclined plane with friction. The angle of incline is $40°$ and $\mu_k = 0.25$. What is the acceleration of the box?

    a. 2.8 m/s^2
    b. 7.7 m/s^2
    c. 5.7 m/s^2
    d. 4.4 m/s^2

    Solution
    The acceleration is

    $$a = g(\sin\theta - \mu\cos\theta) = 4.4\,\mathrm{m/s^2}$$

20. **Problem**
An 4.3-kg box slides down a $53°$ inclined plane with constant acceleration. The box starts from rest at the top. At the bottom, its velocity reaches 3.03 m/s. The length of the incline is 1.51 m. What is the coefficient of kinetic friction between the box and the plane?

a. 0.812
b. 0.452
c. 1.141
d. 1.053

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

$$a = \frac{v_f^2}{2d} = \frac{(3.03\,\mathrm{m/s})^2}{2(1.51\,\mathrm{m})} = 3.0400331\,\mathrm{m/s^2}$$

The acceleration down an inclined plane with friction is

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

Solving for μ

$$\mu = \tan\theta - \frac{a}{g\cos\theta} = \tan(53°) - \frac{(3.0400331\,\mathrm{m/s^2})}{(9.80\,\mathrm{m/s^2})\cos(53°)}$$

$$\mu = 0.812$$