Physics 11
Dynamics Unit Test 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? An object moving at high speed has more inertia than when it is at rest.

   a. True
   b. False

   Solution
   False. Inertia depends only on the mass of the object, not its speed.

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 weight 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 55 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. 540 N
   c. 6.1 N
   d. 590 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. The net force is zero.
   b. A force equal to its weight on Earth, mg.
   c. Cannot be determined without more information.
   d. A force equal to the gravity acting on it.

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

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

8. **Problem**
   What is the net force on a person who is standing in an elevator moving up with a constant velocity of 3.00 m/s?

   a. 0 N
   b. 3.00 N, up
   c. 3.00 N, down
   d. It depends on the mass of the person.

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

9. **Problem**
   An object weighs 59 N on Earth. What is its mass?

   a. 4.8 kg
   b. 580 kg
   c. 6 kg
   d. 3.8 kg

   Solution
   Weight is related to mass by

   $$m = W/g = (59\,\mathrm{N})/(9.8\,\mathrm{N/kg}) = 6\,\mathrm{kg}$$

10. **Problem**
    A net force of 968 N acts on an object, and it accelerates at 12 m/s/s in the direction of the net force. What is the mass of the object?

    a. 81 kg
    b. 0.01 kg
    c. 12000 kg
    d. 59 kg

    Solution
    According to Newton's Second Law of Motion

    $$m = F/a = (968\,\mathrm{N})/(12\,\mathrm{m/s^2}) = 81\,\mathrm{kg}$$

11. **Problem**
    A box slides on the floor in the $+x$ direction. It slows down and comes to a stop with a constant acceleration of $-3.29\,\mathrm{m/s^2}$. The only force acting on the box while it is slowing down is friction between the box and the floor. What is the coefficient of kinetic friction between the box and the floor?

    a. 0.387
    b. 0.336
    c. 0.178
    d. 0.263

    Solution
    The net force is the friction force, so

    $$F_f = F_{net} = ma$$

    The normal force, F_N, is the weight of the box, mg, so

    $$\mu_k = \frac{F_f}{F_N} = \frac{ma}{mg} = \frac{a}{g} = \frac{3.29}{9.80} = 0.336$$

12. **Problem**
    What force is needed to keep a 42-kg box moving at a constant velocity across a warehouse floor if the coefficient of kinetic friction between the box and the floor is 0.23?

    a. 9.7 N
    b. 39 N
    c. 95 N
    d. 120 N

    Solution
    The applied force needed for constant velocity (zero acceleration) is one that balances the friction force.
    $$F_f = \mu_k F_N = \mu m g = (0.23)(42\,\mathrm{kg})(9.8\,\mathrm{N/kg}) = 95\,\mathrm{N}$$

13. **Problem**
    Adam pulls on a box with 9.0 N of force. Bob pulls on the the same box with 7.0 N of force, at a right angle to Adam's force. What is the magnitude of the net force on the box?

    a. 16 N
    b. 11.4 N
    c. 5.2 N
    d. 14.7 N

    Solution
    Perpendicular forces are added using the Pythagorean theorem.
    $$F_{net} = \sqrt{F_1^2 + F_2^2} = \sqrt{(9N)^2 + (7N)^2} = 11.4\text{ N}$$

14. **Problem**
    Carly pulls on a box with 15.0 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 17.0 N?

    a. 14.2 N
    b. 8.0 N
    c. 2.0 N
    d. 32.0 N

    Solution
    Perpendicular forces are related by the Pythagorean theorem.
    $$F_{Debby} = \sqrt{F_{net}^2 - F_{Carly}^2} = \sqrt{(17N)^2 - (15N)^2} = 8\text{ N}$$

15. **Problem**
Robert pulls on a box with 84.0 N of force at $348°$. Steve pulls on the the same box with 62.0 N of force at $147°$. What is the magnitude of the net force on the box?

a. 47.1 N
b. 34.3 N
c. 45.3 N
d. 40.2 N

Solution
The sum of the horizontal components is

$$F_{net,x} = (84N)\cos(348°) + (62N)\cos(147°) = 30.1668232N$$

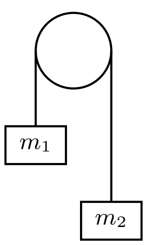
The sum of the vertical components is

$$F_{net,y} = (84N)\sin(348°) + (62N)\sin(147°) = 16.3030381N$$

The magnitude of the net force is

$$F_{net} = \sqrt{(30.1668232N)^2 + (16.3030381N)^2} = 34.3 \text{ N}$$

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 $m_1 = 24.0$ kg and $m_2 = 80.0$ kg. The hanging masses are free to move. What is the magnitude of the acceleration of the system?



a. 2.69 m/s/s
b. 7.23 m/s/s
c. 5.28 m/s/s
d. 6.52 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

$$a = 5.28 \text{ m/s/s}$$

17. **Problem**
Two forces act on an object. A 58.0-N force acts at $-83°$. A 47.0-N force acts at $9°$. What is the angle of their equilibrant?

    a. $148.4°$
    b. $152.0°$
    c. $136.8°$
    d. $65.1°$

    Solution
    The sum of the horizontal components is

$$F_{net,x} = (58N)\cos(-83°) + (47N)\cos(9°) = 53.4897739N$$

The sum of the vertical components is

$$F_{net,y} = (58N)\sin(-83°) + (47N)\sin(9°) = -50.2152569N$$

The angle of the net force is

$$\theta_{net} = \tan^{-1}(-50.2152569/53.4897739) = -43.2°$$

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

$$\theta_{eq} = 136.8°$$

Or

$$\theta_{eq} = -223.2°$$

18. **Problem**
A box of mass 68 kg slides down a frictionless inclined plane. The angle of incline is $62°$ from the horizontal. What is the acceleration of the box?

    a. 8.7 m/s^2
    b. 5.4 m/s^2
    c. 8.3 m/s^2
    d. 5.5 m/s^2

    Solution
    The acceleration is

$$a = g\sin\theta = (9.8\,\text{m/s}^2)\sin(62°) = 8.7\,\text{m/s}^2$$

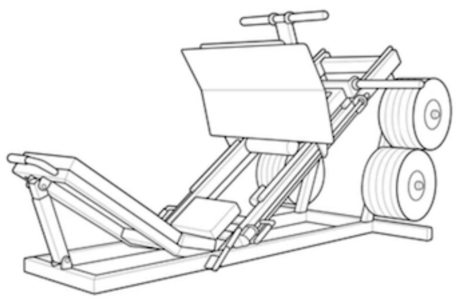
19. **Problem**
    A box of mass 71 kg slides down an inclined plane with friction. The angle of incline is $37°$ and $\mu_k = 0.61$. What is the acceleration of the box?

    a. 1.8 m/s^2
    b. 1.5 m/s^2
    c. 2.8 m/s^2
    d. 1.1 m/s^2

    Solution
    The acceleration is

    $$a = g(\sin\theta - \mu\cos\theta) = 1.1\,\mathrm{m/s^2}$$

20. **Problem**
    A leg press machine is inclined at $47.0°$ from the horizontal. The total mass to be pressed up is 119.0 kg. What force must the legs apply to move the mass at a constant velocity? Assume that friction is negligible.

    a. 1082 N
    b. 1151 N
    c. 1166 N
    d. 853 N

    Solution
    The forces must be balanced for the mass to be moving at constant velocity. The legs must apply a force equal to the parallel component of the force of gravity.

    $$F = mg\sin(47°) = 853\text{ N}$$