Physics 11
Dynamics Unit Test Solutions

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

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

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

   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 air resistance pushing up on the apples.
   b. The force of impact when the object hits the ground.
   c. There is no reaction force because the apple is not touching anything.
   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**
What is the net force on a person who is standing in an elevator moving up with a constant velocity of 5.00 m/s?

   a. It depends on the mass of the person.
   b. 5.00 N, up
   c. 5.00 N, down
   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**
An object weighs 27 N on Earth. What is its mass?

   a. 2.8 kg
   b. 220 kg
   c. 27 kg
   d. 260 kg

   Solution
   Weight is related to mass by

$$m = W/g = (27\,\mathrm{N})/(9.8\,\mathrm{N/kg}) = 2.8\,\mathrm{kg}$$

10. **Problem**
A net force of 82.0 N acts on an object of mass 7.00 kg. What is the acceleration of the object?

    a. 12.0 m/s^2
    b. 15.0 m/s^2
    c. 13.0 m/s^2
    d. 6.8 m/s^2

    Solution
    According to Newton's Second Law of Motion

$$a = F/m = (82\,\text{N})/(7\,\text{kg}) = 12\,\text{m/s}^2$$

11. **Problem**
An box slides down an inclined plane with a constant velocity. The angle of incline is 38.0°. What is the coefficient of kinetic friction between the box and the inclined plane?

    a. 0.022
    b. 0.974
    c. 0.403
    d. 0.781

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

$$F_N = mg\cos\theta$$

    For constant velocity, zero acceleration motion, the friction force must be equal to the parallel component of the force of gravity:

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

    Therefore, the coefficient of kinetic friction, μ_k, is:

$$\mu_k = \frac{\sin\theta}{\cos\theta} = \tan\theta = \tan(38^\circ) = 0.781$$

12. **Problem**
A person (mass = 105 kg) stands on top of a box (mass = 9.0 kg) on the ground. What is the magnitude of the normal force that the ground applies to the box?

    a. 114 N
    b. 1160 N
    c. 1310 N
    d. 1120 N

    Solution
    The normal force is

$$F_N = (105\,\text{kg} + 9\,\text{kg})(9.80\,\text{N/kg}) = 1120\,\text{N}$$

13. **Problem**
Adam pulls on a box with 6.0 N of force. Bob pulls on the the same box with 3.0 N of force, at a right angle to Adam's force. What is the magnitude of the net force on the box?

    a. 7.6 N
    b. 6.7 N
    c. 9 N
    d. 4.8 N

    Solution
    Perpendicular forces are added using the Pythagorean theorem.

$$F_{net} = \sqrt{F_1^2 + F_2^2} = \sqrt{(6N)^2 + (3N)^2} = 6.71 \text{ N}$$

14. **Problem**
Carly pulls on a box with 16.0 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 24.0 N?

    a. 8.0 N
    b. 17.9 N
    c. 10.8 N
    d. 40.0 N

    Solution
    Perpendicular forces are related by the Pythagorean theorem.

$$F_{Debby} = \sqrt{F_{net}^2 - F_{Carly}^2} = \sqrt{(24N)^2 - (16N)^2} = 17.9 \text{ N}$$

15. **Problem**
Charlie pulls on a box with 52.0 N of force at 138°. Dan pulls on the the same box with 49.0 N of force at -73°. What is the angle of the net force on the box?

    a. 98.9°
    b. 12.3°
    c. -153.6°
    d. 134.8°

    Solution
    The sum of the horizontal components is

$$F_{net,x} = (52N)\cos(138^\circ) + (49N)\cos(-73^\circ) = -24.3173174N$$

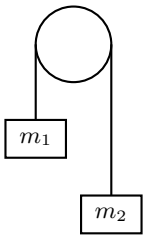
    The sum of the vertical components is

$$F_{net,y} = (52N)\sin(138^\circ) + (49N)\sin(-73^\circ) = -12.0641415N$$

    The angle of the net force is

$$\theta = \tan^{-1}(-12.0641415/-24.3173174) = -153.6^\circ$$

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 $m_1 = 60.0$ kg and $m_2 = 57.0$ kg. The hanging masses are free to move. What is the magnitude of the acceleration of the system?



a. 0.25 m/s/s
b. 0.19 m/s/s
c. 0.22 m/s/s
d. 0.15 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

$$a = 0.251 \text{ m/s/s}$$

17. **Problem**
Two forces act on an object. A 56.0-N force acts at -74°. A 90.0-N force acts at -178°. What is the angle of their equilibrant?

a. 74.6°
b. 37.4°
c. 169.3°
d. 39.3°

Solution
The sum of the horizontal components is

$$F_{net,x} = (56N)\cos(-74^\circ) + (90N)\cos(-178^\circ) = -74.5094825N$$

The sum of the vertical components is

$$F_{net,y} = (56N)\sin(-74^\circ) + (90N)\sin(-178^\circ) = -56.9716097N$$

The angle of the net force is

$$\theta_{net} = \tan^{-1}(-56.9716097/-74.5094825) = -142.6^\circ$$

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

$$\theta_{eq} = 37.4^\circ$$

Or

$$\theta_{eq} = -322.6^\circ$$

18. **Problem**
A box of mass 16 kg slides down a frictionless inclined plane. The angle of incline is 16° from the horizontal. What is the acceleration of the box?

a. 2.6 m/s^2
b. 1.9 m/s^2
c. 2.7 m/s^2
d. 1.8 m/s^2

Solution
The acceleration is

$$a = g\sin\theta = (9.8\,\mathrm{m/s^2})\sin(16^\circ) = 2.7\,\mathrm{m/s^2}$$

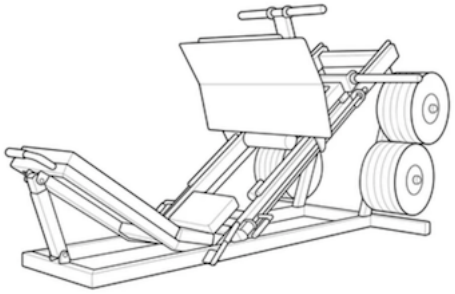
19. **Problem**
A box of mass 29 kg slides down an inclined plane with friction. The angle of incline is 54° and $\mu_k = 0.37$. What is the acceleration of the box?

a. 5.8 m/s^2
b. 0.1 m/s^2
c. 3.3 m/s^2
d. 8.4 m/s^2

Solution
The acceleration is

$$a = g(\sin\theta - \mu\cos\theta) = 5.8\,\mathrm{m/s^2}$$

20. **Problem**
A leg press machine is inclined at 47.0° from the horizontal. The total mass to be pressed up is 101.0 kg. What force must the legs apply to move the mass at a constant velocity? Assume that friction is negligible.



a. 973 N

b. 101 N

c. 724 N

d. 940 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.

$$F = mg\sin(47^\circ) = 724 \text{ N}$$