Physics 11
Dynamics Unit Test Solutions

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

1. **Problem**
   True or false? If an object is at rest, then the net force on the object must be zero.

   a. True
   b. False

   Solution
   True. If an object is at rest, then its acceleration and the net force on the object must both be zero.

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**
   In a rugby game, Bob (mass = 73 kg) tackles Joe (mass = 94 kg) and knocks Joe to the ground. During the collision, who applied the greater force on whom?

   a. Bob applied a greater force on Joe (than Joe did on him).
   b. Joe applied a greater force on Bob (than Bob did on him).
   c. Bob and Joe applied the same magnitude force on each other.
   d. It depends on the relative speeds of Bob and Joe.

   Solution

According to Newton's Third Law of Motion, the force of Bob on Joe is equal (but opposite) the force of Joe on Bob.

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. $\mu_k < \mu_s$
   c. $\mu_s < \mu_k$
   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**
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 book pulling upward on the Earth with force mg.
   b. The book pushing down on the table with force mg.
   c. The table pushing up on the book with force mg.
   d. The table pushing down on the floor 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**
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**
The mass of an object is 12 kg. What is its weight on Earth?

   a. 170 N
   b. 120 N
   c. 12 N
   d. 140 N

   Solution
   Weight is related to mass by

$$W = mg = (12\,\text{kg})(9.8\,\text{N/kg}) = 120\,\text{N}$$

10. **Problem**
A net force of 41.0 N acts on an object of mass 2.00 kg. What is the acceleration of the object?

    a. 23.0 m/s^2
    b. 26.0 m/s^2
    c. 20.0 m/s^2
    d. 29.0 m/s^2

    Solution
    According to Newton's Second Law of Motion

$$a = F/m = (41\,\mathrm{N})/(2\,\mathrm{kg}) = 20\,\mathrm{m/s^2}$$

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 $-4.01\,\mathrm{m/s^2}$. 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. 0.409
    b. 0.594
    c. 0.253
    d. 0.535

    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

$$\mu_k = \frac{F_f}{F_N} = \frac{ma}{mg} = \frac{a}{g} = \frac{4.01}{9.80} = 0.409$$

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 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. 11.4 N
    b. 16 N
    c. 13.6 N
    d. 2 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**
Xavier pulls on a box with 17.0 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. 51.0°
    b. 15.4°
    c. 82.1°
    d. 70.7°

    Solution
    The angle can be found using the arctangent.

$$\theta = \tan^{-1}(21/17) = 51^\circ$$

15. **Problem**
Charlie pulls on a box with 27.0 N of force at -171°. Dan pulls on the the same box with 62.0 N of force at 149°. What is the angle of the net force on the box?

    a. 160.9°
    b. 101.1°
    c. 175.7°
    d. 100.1°

    Solution
    The sum of the horizontal components is

$$F_{net,x} = (27N)\cos(-171^\circ) + (62N)\cos(149^\circ) = -79.8119578N$$

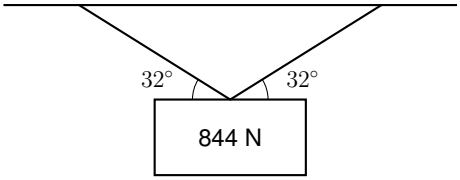
    The sum of the vertical components is

$$F_{net,y} = (27N)\sin(-171^\circ) + (62N)\sin(149^\circ) = 27.7086301N$$

    The angle of the net force is

$$\theta = \tan^{-1}(27.7086301/-79.8119578) = 160.9^\circ$$

16. **Problem**
A sign that weighs 844 N is supported by two ropes that each makes a 32° angle with the horizontal. The sign is not moving. What is the magnitude of the force exerted by each rope?



a. 983 N
b. 784 N
c. 747 N
d. 796 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.)

$$F = \frac{(844N)}{2\sin(32^\circ)} = 796 \text{ N}$$

17. **Problem**
Two forces act on an object. A 31.0-N force acts at 20°. A 79.0-N force acts at 42°. What is the angle of their equilibrant?

a. -161.0°
b. -149.9°
c. -176.3°
d. -144.2°

Solution
The sum of the horizontal components is

$$F_{net,x} = (31N)\cos(20^\circ) + (79N)\cos(42^\circ) = 87.8389125N$$

The sum of the vertical components is

$$F_{net,y} = (31N)\sin(20^\circ) + (79N)\sin(42^\circ) = 63.4639423N$$

The angle of the net force is

$$\theta_{net} = \tan^{-1}(63.4639423/87.8389125) = 35.8^\circ$$

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

$$\theta_{eq} = 215.8^\circ$$

Or

$$\theta_{eq} = -144.2^\circ$$

18. **Problem**
A box of mass 42 kg slides down a frictionless inclined plane. The angle of incline is 20° from the horizontal. What is the acceleration of the box?

a. 2.1 m/s^2
b. 2.5 m/s^2
c. 3.9 m/s^2
d. 3.4 m/s^2

Solution
The acceleration is

$$a = g\sin\theta = (9.8\,\mathrm{m/s^2})\sin(20^\circ) = 3.4\,\mathrm{m/s^2}$$

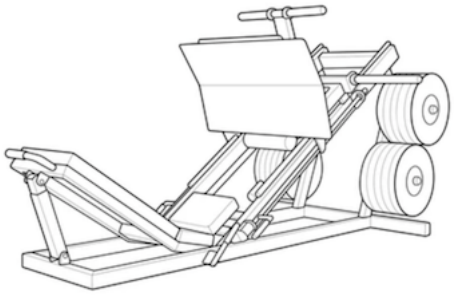
19. **Problem**
A box of mass 50 kg slides down an inclined plane with friction. The angle of incline is 70° and $\mu_k = 1.2$. What is the acceleration of the box?

a. 3.1 m/s^2
b. 1.0 m/s^2
c. 5.2 m/s^2
d. 5.8 m/s^2

Solution
The acceleration is

$$a = g(\sin\theta - \mu\cos\theta) = 5.2\,\mathrm{m/s^2}$$

20. **Problem**
A leg press machine is inclined at 49.0° from the horizontal. The total mass to be pressed up is 77.0 kg. What force must the legs apply to move the mass at a constant velocity? Assume that friction is negligible.



a. 622 N
b. 791 N
c. 58 N
d. 570 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.

$$F = mg\sin(49^\circ) = 570\text{ N}$$