Physics 11
Dynamics Unit Test Solutions

1.	a.	X	b.				
2.	a.	X	b.				
3.	a.		b.	X			
4.	a.	X	b.		c.		d.	X
5.	a.	X	b.		c.		d.	
6.	a.		b.		c.	X	d.	
7.	a.	X	b.		c.		d.	
8.	a.		b.	X	c.		d.	
9.	a.		b.		c.		d.	X
10.	a.		b.	X	c.		d.	
11.	a.		b.		c.	X	d.	
12.	a.	X	b.		c.		d.	
13.	a.	X	b.		c.		d.	
14.	a.		b.		c.	X	d.	
15.	a.		b.		c.		d.	X
16.	a.		b.		c.	X	d.	
17.	a.		b.		c.		d.	X
18.	a.		b.	X	c.		d.	
19.	a.		b.	X	c.		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 more 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 39 kg pushes on a wall with 74 N of force. What is the magnitude of the force that the wall exerts on the person?

   a. 74 N
   b. 380 N
   c. 7.6 N
   d. 730 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. A force equal to its weight on Earth, mg.
   b. Cannot be determined without more information.
   c. The net force is zero.
   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**
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 apple's gravity pulling upward on the Earth.
   b. The force of impact when the object hits the ground.
   c. The air resistance pushing up on the apples.
   d. There is no reaction force because the apple is not touching anything.

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

8. **Problem**
A box, of mass M, is suspended by a string from the ceiling inside an elevator. The elevator is traveling downward with a constant speed. The tension in the string is

   a. less than Mg.
   b. equal to Mg.
   c. greater than Mg.
   d. impossible to determine without knowing the speed.

   Solution
   The elevator is moving with constant velocity so the acceleration is zero and the net force must also be zero. Therefore, the tension force must balance (equal) the gravitational force, Mg.

9. **Problem**
The mass of an object is 94 kg. What is its weight on Earth?

   a. 94 N
   b. 820 N
   c. 9.6 N
   d. 920 N

   Solution
   Weight is related to mass by

$$W = mg = (94\,\text{kg})(9.8\,\text{N/kg}) = 920\,\text{N}$$

10. **Problem**
A net force of 822 N acts on an object, and it accelerates at 62 m/s/s in the direction of the net force. What is the mass of the object?

    a. 5.7 kg
    b. 13 kg
    c. 15000 kg
    d. 0.08 kg

    Solution
    According to Newton's Second Law of Motion

$$m = F/a = (822\,\mathrm{N})/(62\,\mathrm{m/s^2}) = 13\,\mathrm{kg}$$

11. **Problem**
An box slides down an inclined plane with a constant velocity. The angle of incline is 55.0°. What is the coefficient of kinetic friction between the box and the inclined plane?

    a. 0.986
    b. 0.772
    c. 1.428
    d. 1.265

    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:

$$\mu_k = \frac{\sin\theta}{\cos\theta} = \tan\theta = \tan(55^\circ) = 1.428$$

12. **Problem**
What force is needed to keep a 59-kg box moving at a constant velocity across a warehouse floor if the coefficient of kinetic friction between the box and the floor is 0.60?

    a. 350 N
    b. 35 N
    c. 480 N
    d. 310 N

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

$$F_f = \mu_k F_N = \mu mg = (0.6)(59\,\mathrm{kg})(9.8\,\mathrm{N/kg}) = 350\,\mathrm{N}$$

13. **Problem**
Two forces act on an object. A 54-N force acts at 0° and a 64-N force acts at 90°. What is the magnitude of the equilibrant?

a. 83.7 N
b. 94.2 N
c. 113 N
d. 79.8 N

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

$$F_{eq} = \sqrt{54N + 64N} = 83.7 \text{ N}$$

14. **Problem**
Xavier pulls on a box with 28.0 N of force at 0°. Yuri pulls on the the same box with 17.0 N of force, at 90°. What is the angle of the net force?

a. 72.6°
b. 59.4°
c. 31.0°
d. 61.2°

Solution
The angle can be found using the arctangent.

$$\theta = \tan^{-1}(17/28) = 31^\circ$$

15. **Problem**
Charlie pulls on a box with 91.0 N of force at 179°. Dan pulls on the the same box with 71.0 N of force at 115°. What is the angle of the net force on the box?

a. 27.0°
b. -116.6°
c. 1.4°
d. 151.4°

Solution
The sum of the horizontal components is

$$F_{net,x} = (91N)\cos(179^\circ) + (71N)\cos(115^\circ) = -120.9920368N$$

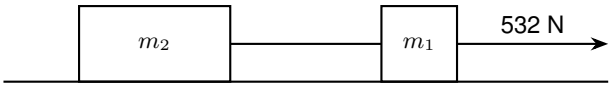
The sum of the vertical components is

$$F_{net,y} = (91N)\sin(179^\circ) + (71N)\sin(115^\circ) = 65.9360219N$$

The angle of the net force is

$$\theta = \tan^{-1}(65.9360219/-120.9920368) = 151.4^\circ$$

16. **Problem**
Two boxes connected by a light cord are on a frictionless table as shown in the diagram. The masses are $m_1 = 56$ kg and $m_2 = 140$ kg. A 532-N force is applied horizontally on the right box. What is the tension in the cord?



a. 424 N
b. 287 N
c. 380 N
d. 369 N

Solution
The acceleration of the system of two boxes is

$$a = \frac{532\,\text{N}}{56\,\text{kg} + 140\,\text{kg}}$$

The tension in the cord is the net force on m_2 and it is equal to m_2 times the acceleration

$$F_{tension} = (140\,\text{kg})\left(\frac{532\,\text{N}}{56\,\text{kg} + 140\,\text{kg}}\right) = 380\,\text{N}$$

17. **Problem**
Two forces act on an object. A 27.0-N force acts at -122°. A 37.0-N force acts at 10°. What is the angle of their equilibrant?

a. 178.3°
b. 145.2°
c. 172.1°
d. 143.3°

Solution
The sum of the horizontal components is

$$F_{net,x} = (27N)\cos(-122^\circ) + (37N)\cos(10^\circ) = 22.1300667N$$

The sum of the vertical components is

$$F_{net,y} = (27N)\sin(-122^\circ) + (37N)\sin(10^\circ) = -16.472316N$$

The angle of the net force is

$$\theta_{net} = \tan^{-1}(-16.472316/22.1300667) = -36.7^\circ$$

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

$$\theta_{eq} = 143.3^\circ$$

Or

$$\theta_{eq} = -216.7^\circ$$

18. **Problem**
A box of mass 45 kg slides down a frictionless inclined plane. The angle of incline is 75° from the horizontal. What is the acceleration of the box?

a. 11.0 m/s^2
b. 9.5 m/s^2
c. 13.0 m/s^2
d. 10.1 m/s^2

Solution
The acceleration is

$$a = g\sin\theta = (9.8\,\mathrm{m/s^2})\sin(75^\circ) = 9.5\,\mathrm{m/s^2}$$

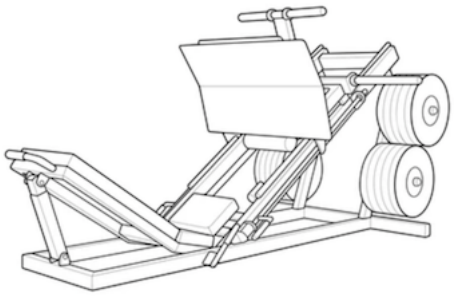
19. **Problem**
A box of mass 26 kg slides down an inclined plane with friction. The angle of incline is 69° and $\mu_k = 1.9$. What is the acceleration of the box?

a. 0.6 m/s^2
b. 2.5 m/s^2
c. 6.5 m/s^2
d. 4.6 m/s^2

Solution
The acceleration is

$$a = g(\sin\theta - \mu\cos\theta) = 2.5\,\mathrm{m/s^2}$$

20. **Problem**
A leg press machine is inclined at 42.0° from the horizontal. The total mass to be pressed up is 117.0 kg. What force must the legs apply to move the mass at a constant velocity? Assume that friction is negligible.



a. 812 N
b. 869 N
c. 117 N
d. 767 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.

$$F = mg\sin(42^\circ) = 767 \text{ N}$$