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.		b.	X	c.		d.	
6.	a.		b.		c.		d.	X
7.	a.		b.	X	c.		d.	
8.	a.		b.	X	c.		d.	
9.	a.		b.		c.		d.	X
10.	a.		b.	X	c.		d.	
11.	a.	X	b.		c.		d.	
12.	a.		b.	X	c.		d.	
13.	a.		b.		c.		d.	X
14.	a.		b.		c.	X	d.	
15.	a.	X	b.		c.		d.	
16.	a.		b.		c.	X	d.	
17.	a.	X	b.		c.		d.	
18.	a.		b.	X	c.		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 person of mass 45 kg pushes on a wall with 79 N of force. What is the magnitude of the force that the wall exerts on the person?

   a. 8.1 N
   b. 79 N
   c. 770 N
   d. 440 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. Cannot be determined without more information.
   b. A force equal to its weight on Earth, mg.
   c. A force equal to the gravity acting on it.
   d. The net force is zero.

   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 up on the book with force mg.
   b. The table pushing down on the floor with force mg.
   c. The book pushing down on the table with force mg.
   d. The book pulling upward on the Earth 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 mass
   b. weight
   c. inertial mass
   d. gravitational field strength

   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 91 kg. What is its weight on Earth?

   a. 1300 N
   b. 91 N
   c. 9.3 N
   d. 890 N

   Solution
   Weight is related to mass by

$$W = mg = (91\,\text{kg})(9.8\,\text{N/kg}) = 890\,\text{N}$$

10. **Problem**
A net force of 943 N acts on an object, and it accelerates at 26 m/s/s in the direction of the net force. What is the mass of the object?

   a. 25000 kg
   b. 36 kg
   c. 23 kg
   d. 0.03 kg

   Solution
   According to Newton's Second Law of Motion

$$m = F/a = (943\,\text{N})/(26\,\text{m/s}^2) = 36\,\text{kg}$$

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 $-1.49\,\text{m/s}^2$. 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. 0.152
   b. 0.125
   c. 0.171
   d. 0.222

   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

$$\mu_k = \frac{F_f}{F_N} = \frac{ma}{mg} = \frac{a}{g} = \frac{1.49}{9.80} = 0.152$$

12. **Problem**
A person (mass = 128 kg) stands on top of a box (mass = 4.0 kg) on the ground. What is the magnitude of the normal force that the ground applies to the box?

    a. 1580 N
    b. 1290 N
    c. 1650 N
    d. 132 N

    Solution
    The normal force is
    $$F_N = (128\,\text{kg} + 4\,\text{kg})(9.80\,\text{N/kg}) = 1290\,\text{N}$$

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

    a. 30 N
    b. 8 N
    c. 27.6 N
    d. 22 N

    Solution
    Perpendicular forces are added using the Pythagorean theorem.
    $$F_{net} = \sqrt{F_1^2 + F_2^2} = \sqrt{(19N)^2 + (11N)^2} = 22\text{ N}$$

14. **Problem**
Xavier pulls on a box with 27.0 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. 9.6°
    b. 0.2°
    c. 38.0°
    d. 13.1°

    Solution
    The angle can be found using the arctangent.
    $$\theta = \tan^{-1}(21/27) = 38^\circ$$

15. **Problem**
Charlie pulls on a box with 51.0 N of force at -153°. Dan pulls on the the same box with 76.0 N of force at -23°. What is the angle of the net force on the box?

a. -65.1°
b. -138.6°
c. -118.9°
d. -103.2°

Solution
The sum of the horizontal components is

$$F_{net,x} = (51N)\cos(-153^\circ) + (76N)\cos(-23^\circ) = 24.5170361N$$

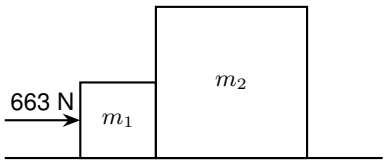
The sum of the vertical components is

$$F_{net,y} = (51N)\sin(-153^\circ) + (76N)\sin(-23^\circ) = -52.8490813N$$

The angle of the net force is

$$\theta = \tan^{-1}(-52.8490813/24.5170361) = -65.1^\circ$$

16. **Problem**
Two boxes are in contact with each other on a frictionless table as shown in the diagram. The masses are $m_1 = 19$ kg and $m_2 = 47.5$ kg. The first box (m_1)is pushed with a horizontal force of 663 N to the right. What is the net force on the second box (m_2)?



a. 240 N
b. 549 N
c. 474 N
d. 308 N

Solution
The acceleration of the system of two boxes is

$$a = \frac{663\,\text{N}}{19\,\text{kg} + 47.5\,\text{kg}}$$

The net force on m_2 is its mass times its acceleration

$$F_{net,2} = (47.5\,\text{kg})\left(\frac{663\,\text{N}}{19\,\text{kg} + 47.5\,\text{kg}}\right) = 474\,\text{N}$$

17. **Problem**
Two forces act on an object. A 22.0-N force acts at 80°. A 88.0-N force acts at 161°. What is the angle of their equilibrant?

a. -32.4°
b. -113.5°
c. -36.4°
d. -167.6°

Solution
The sum of the horizontal components is

$$F_{net,x} = (22N)\cos(80^\circ) + (88N)\cos(161^\circ) = -79.3853747N$$

The sum of the vertical components is

$$F_{net,y} = (22N)\sin(80^\circ) + (88N)\sin(161^\circ) = 50.3157682N$$

The angle of the net force is

$$\theta_{net} = \tan^{-1}(50.3157682/-79.3853747) = 147.6^\circ$$

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

$$\theta_{eq} = 327.6^\circ$$

Or

$$\theta_{eq} = -32.4^\circ$$

18. **Problem**
A box of mass 88 kg slides down a frictionless inclined plane. The angle of incline is 19° from the horizontal. What is the acceleration of the box?

a. $3.0\,\text{m/s}^2$
b. $3.2\,\text{m/s}^2$
c. $2.4\,\text{m/s}^2$
d. $1.9\,\text{m/s}^2$

Solution
The acceleration is

$$a = g\sin\theta = (9.8\,\text{m/s}^2)\sin(19^\circ) = 3.2\,\text{m/s}^2$$

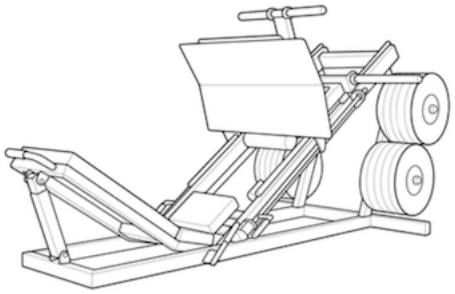
19. **Problem**
A box of mass 45 kg slides down an inclined plane with friction. The angle of incline is 49° and $\mu_k = 0.46$. What is the acceleration of the box?

a. $4.4\,\text{m/s}^2$
b. $1.6\,\text{m/s}^2$
c. $1.1\,\text{m/s}^2$
d. $5.3\,\text{m/s}^2$

Solution
The acceleration is

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

20. **Problem**
A leg press machine is inclined at 47.0° from the horizontal. The total mass to be pressed up is 23.0 kg. What force must the legs apply to move the mass at a constant velocity? Assume that friction is negligible.



a. 17 N
b. 136 N
c. 165 N
d. 23 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.

$$F = mg\sin(47^\circ) = 165 \text{ N}$$