

# 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.  X c.  d.
7. a.  X b.  c.  d.
8. a.  b.  c.  d.  X
9. a.  b.  c.  X d.
10. a.  X b.  c.  d.
11. a.  b.  X c.  d.
12. a.  b.  c.  d.  X
13. a.  X b.  c.  d.
14. a.  X b.  c.  d.
15. a.  b.  c.  X d.
16. a.  b.  c.  X d.
17. a.  b.  c.  X d.
18. a.  b.  X c.  d.
19. a.  b.  c.  d.  X
20. a.  X b.  c.  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? An object weighs less on the moon than it does on earth.

- a. True
- b. False

**Solution**

True. Weight is the force of gravity. The gravitational field strength on the moon is less than on earth, so objects weigh less on the moon.

**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 57 kg pushes on a wall with 63 N of force. What is the magnitude of the force that the wall exerts on the person?

- a. 63 N
- b. 560 N
- c. 620 N
- d. 6.4 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. The net force is zero.
- 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**

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. There is no reaction force because the apple is not touching anything.
- c. The force of impact when the object hits the ground.
- d. The air resistance pushing up on the apples.

**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, down
- c. 5.00 N, up
- 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 92 N on Earth. What is its mass?

- a. 490 kg
- b. 360 kg
- c. 9.4 kg
- d. 92 kg

**Solution**

Weight is related to mass by

$$m = W/g = (92 \text{ N})/(9.8 \text{ N/kg}) = 9.4 \text{ kg}$$

**10. Problem**

A net force of 40.0 N acts on an object of mass 9.00 kg. What is the acceleration of the object?

- a. 4.4 m/s<sup>2</sup>
- b. 2.3 m/s<sup>2</sup>
- c. 3.8 m/s<sup>2</sup>
- d. 3.1 m/s<sup>2</sup>

**Solution**

According to Newton's Second Law of Motion

$$a = F/m = (40 \text{ N})/(9 \text{ kg}) = 4.4 \text{ m/s}^2$$

**11. Problem**

A box is at rest on an inclined plane. The angle of incline is increased slowly. When the angle reaches 14.0°, the box begins to slide. What is the coefficient of static friction between the box and the inclined plane?

- a. 0.070
- b. 0.249
- c. 0.170
- d. 0.277

**Solution**

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

$$F_N = mg \cos \theta$$

The friction force when the object starts to slide, the maximum static friction force is reached and it must be equal to the parallel component of the force of gravity:

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

Therefore, the coefficient of static friction,  $\mu_s$ , is:

$$\mu_s = \frac{\sin \theta}{\cos \theta} = \tan \theta = \tan(14^\circ) = 0.249$$

**12. Problem**

A person (mass = 101 kg) stands on top of a box (mass = 3.0 kg) on the ground. What is the magnitude of the normal force that the ground applies to the box?

- a. 1400 N
- b. 227 N
- c. 990 N
- d. 1020 N

**Solution**

The normal force is

$$F_N = (101 \text{ kg} + 3 \text{ kg})(9.80 \text{ N/kg}) = 1020 \text{ N}$$

**13. Problem**

Adam pulls on a box with 13.0 N of force. Bob pulls on the same box with 12.0 N of force, at a right angle to Adam's force. What is the magnitude of the net force on the box?

- a. 17.7 N
- b. 10.8 N
- c. 1 N
- d. 25 N

**Solution**

Perpendicular forces are added using the Pythagorean theorem.

$$F_{net} = \sqrt{F_1^2 + F_2^2} = \sqrt{(13N)^2 + (12N)^2} = 17.7 \text{ N}$$

**14. Problem**

Xavier pulls on a box with 17.0 N of force at  $0^\circ$ . Yuri pulls on the same box with 25.0 N of force, at  $90^\circ$ . What is the angle of the net force?

- a.  $56.0^\circ$
- b.  $84.7^\circ$
- c.  $57.4^\circ$
- d.  $6.7^\circ$

**Solution**

The angle can be found using the arctangent.

$$\theta = \tan^{-1}(25/17) = 56^\circ$$

**15. Problem**

Charlie pulls on a box with 59.0 N of force at  $154^\circ$ . Dan pulls on the same box with 30.0 N of force at  $-66^\circ$ . What is the angle of the net force on the box?

- a.  $-89.6^\circ$
- b.  $-95.5^\circ$
- c.  $-177.8^\circ$
- d.  $-156.2^\circ$

**Solution**

The sum of the horizontal components is

$$F_{net,x} = (59N) \cos(154^\circ) + (30N) \cos(-66^\circ) = -40.8267494N$$

The sum of the vertical components is

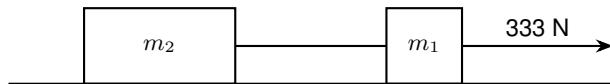
$$F_{net,y} = (59N) \sin(154^\circ) + (30N) \sin(-66^\circ) = -1.5424661N$$

The angle of the net force is

$$\theta = \tan^{-1}(-1.5424661 / -40.8267494) = -177.8^\circ$$

**16. Problem**

Two boxes connected by a light cord are on a frictionless table as shown in the diagram. The masses are  $m_1 = 58\text{ kg}$  and  $m_2 = 348\text{ kg}$ . A 333-N force is applied horizontally on the right box. What is the tension in the cord?



- a. 340 N
- b. 153 N
- c. 285 N
- d. 190 N

**Solution**

The acceleration of the system of two boxes is

$$a = \frac{333\text{ N}}{58\text{ kg} + 348\text{ kg}}$$

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

$$F_{tension} = (348\text{ kg}) \left( \frac{333\text{ N}}{58\text{ kg} + 348\text{ kg}} \right) = 285\text{ N}$$

**17. Problem**

Two forces act on an object. A 19.0-N force acts at  $-170^\circ$ . A 44.0-N force acts at  $66^\circ$ . What is the angle of their equilibrant?

- a.  $34.2^\circ$
- b.  $-13.2^\circ$
- c.  $-88.7^\circ$
- d.  $116.7^\circ$

**Solution**

The sum of the horizontal components is

$$F_{net,x} = (19N) \cos(-170^\circ) + (44N) \cos(66^\circ) = -0.814935N$$

The sum of the vertical components is

$$F_{net,y} = (19N) \sin(-170^\circ) + (44N) \sin(66^\circ) = 36.8966848N$$

The angle of the net force is

$$\theta_{net} = \tan^{-1}(36.8966848 / -0.814935) = 91.3^\circ$$

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

$$\theta_{eq} = 271.3^\circ$$

Or

$$\theta_{eq} = -88.7^\circ$$

**18. Problem**

A box of mass 32 kg slides down a frictionless inclined plane. The angle of incline is  $24^\circ$  from the horizontal. What is the acceleration of the box?

- a.  $5.8 \text{ m/s}^2$
- b.  $4.0 \text{ m/s}^2$
- c.  $3.5 \text{ m/s}^2$
- d.  $5.0 \text{ m/s}^2$

**Solution**

The acceleration is

$$a = g \sin \theta = (9.8 \text{ m/s}^2) \sin(24^\circ) = 4.0 \text{ m/s}^2$$

**19. Problem**

A box of mass 67 kg slides down an inclined plane with friction. The angle of incline is  $65^\circ$  and  $\mu_k = 0.018$ . What is the acceleration of the box?

- a.  $9.3 \text{ m/s}^2$
- b.  $0.2 \text{ m/s}^2$
- c.  $4.1 \text{ m/s}^2$
- d.  $8.8 \text{ m/s}^2$

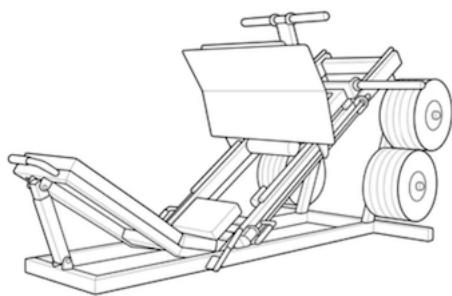
**Solution**

The acceleration is

$$a = g(\sin \theta - \mu \cos \theta) = 8.8 \text{ m/s}^2$$

**20. Problem**

A leg press machine is inclined at  $40.0^\circ$  from the horizontal. The total mass to be pressed up is 53.0 kg. What force must the legs apply to move the mass at a constant velocity? Assume that friction is negligible.



- a. 334 N
- b. 359 N
- c. 34 N
- d. 261 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.

$$F = mg \sin(40^\circ) = 334 \text{ N}$$