

Physics 11

Dynamics Unit Test Solutions

1. a. ☐ b. ☒
2. a. ☒ b. ☐
3. a. ☐ b. ☒
4. a. ☐ b. ☒ c. ☒ d. ☐
5. a. ☒ b. ☐ c. ☐ d. ☐
6. a. ☐ b. ☒ c. ☐ d. ☐
7. a. ☒ b. ☐ c. ☐ d. ☐
8. a. ☐ b. ☐ c. ☐ d. ☒
9. a. ☐ b. ☐ c. ☒ d. ☐
10. a. ☒ b. ☐ c. ☐ d. ☐
11. a. ☐ b. ☒ c. ☐ d. ☐
12. a. ☐ b. ☐ c. ☐ d. ☒
13. a. ☒ b. ☐ c. ☐ d. ☐
14. a. ☒ b. ☐ c. ☐ d. ☐
15. a. ☐ b. ☐ c. ☒ d. ☐
16. a. ☐ b. ☐ c. ☒ d. ☐
17. a. ☐ b. ☐ c. ☒ d. ☐
18. a. ☐ b. ☒ c. ☐ d. ☐
19. a. ☐ b. ☐ c. ☐ d. ☒
20. a. ☒ 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/s²
- b. 2.3 m/s²
- c. 3.8 m/s²
- d. 3.1 m/s²

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

An 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, μ_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 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.

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

14. Problem

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

- a. 56.0°
- b. 84.7°
- c. 57.4°
- d. 6.7°

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° . Dan pulls on the the same box with 30.0 N of force at -66° . What is the angle of the net force on the box?

- a. -89.6°
- b. -95.5°
- c. -177.8°
- d. -156.2°

Solution

The sum of the horizontal components is

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

The sum of the vertical components is

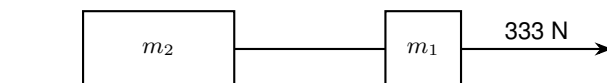
$$F_{net,y} = (59\text{N}) \sin(154^\circ) + (30\text{N}) \sin(-66^\circ) = -1.5424661\text{N}$$

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° . A 44.0-N force acts at 66° . What is the angle of their equilibrant?

- a. 34.2°
- b. -13.2°
- c. -88.7°
- d. 116.7°

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° .

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

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° from the horizontal. What is the acceleration of the box?

- a. 5.8 m/s^2
- b. 4.0 m/s^2
- c. 3.5 m/s^2
- d. 5.0 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° and $\mu_k = 0.018$. What is the acceleration of the box?

- a. 9.3 m/s^2
- b. 0.2 m/s^2
- c. 4.1 m/s^2
- d. 8.8 m/s^2

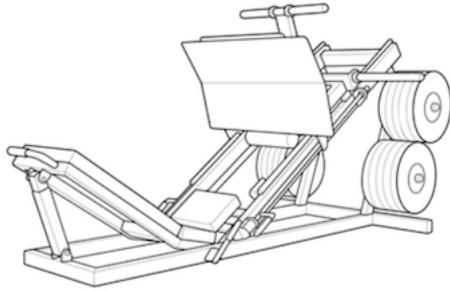
Solution

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° 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.

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