

Physics 11

Dynamics Unit Retest 2 Solutions

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

1. Problem

True or false? If an object is in equilibrium (i.e. all the forces on it are balanced), then the object must be at rest.

- a. True
- b. False

Solution

False. An object in equilibrium must have zero acceleration, but its velocity is not necessarily zero.

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? A ball is thrown upwards and rightwards. While it is in the air, the net force on the ball is directed upwards and rightwards.

- a. True
- b. False

Solution

False. The only force on the ball while it is in the air is the force of gravity, which points downward (assuming no air resistance).

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 value greater 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 = 98 kg) tackles Joe (mass = 76 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. $\mu_s < \mu_k$
- b. The normal force is greater when the box is at rest.
- c. $\mu_k < \mu_s$
- 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 table pushing down on the floor 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 book pulling upward on the Earth with force mg .

Solution

Action-reaction force pairs are always between the same two objects. The reaction force to the Earth pulling down on the book is the book pulling upward on the Earth with force.

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

You place a 49.13-kg object on a spring scale. If the scale reads 401.4 N, what is the acceleration of gravity at that location?

- a. 8.17 m/s^2
- b. 10.57 m/s^2
- c. 8.19 m/s^2
- d. 8.41 m/s^2

Solution

The acceleration of gravity (g) is related to the mass (m) and weight (W) of objects by the equation $W = mg$. Solving for g , we get

$$g = \frac{W}{m} = \frac{401.4 \text{ N}}{49.13 \text{ kg}} = 8.17 \text{ m/s}^2$$

10. Problem

An object of mass 12.0 kg accelerates at 8.0 m/s^2 . What is the magnitude of the net force on the object?

- a. 58 N
- b. 130 N
- c. 96 N
- d. 110 N

Solution

According to Newton's Second Law of Motion

$$F = ma = (12 \text{ kg})(8 \text{ m/s}^2) = 96 \text{ N}$$

11. Problem

A box slides down an inclined plane with a constant velocity. The angle of incline is 40.0° . What is the coefficient of kinetic friction between the box and the inclined plane?

- a. 1.245
- b. 0.839
- c. 0.992
- d. 0.435

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:

$$\mu_k = \frac{\sin \theta}{\cos \theta} = \tan \theta = \tan(40^\circ) = 0.839$$

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 14.0 N of force. Bob pulls on 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. 17.8 N
- b. 13.1 N
- c. 11.1 N
- d. 15.2 N

Solution

Perpendicular forces are added using the Pythagorean theorem.

$$F_{net} = \sqrt{F_1^2 + F_2^2} = \sqrt{(14N)^2 + (11N)^2} = 17.8 \text{ N}$$

14. Problem

Xavier pulls on a box with 43.0 N of force at 0° . Yuri pulls on the same box with 47.0 N of force, at 90° . What is the angle of the net force?

- a. 51.8°
- b. 48.0°
- c. 69.8°
- d. 79.6°

Solution

The angle can be found using the arctangent.

$$\theta = \tan^{-1}(47/43) = 48^\circ$$

15. Problem

Charlie pulls on a box with 35.0 N of force at 160° . Dan pulls on the same box with 19.0 N of force at -161° . What is the angle of the net force on the box?

- a. 179.2°
- b. -177.6°
- c. 173.5°
- d. -131.9°

Solution

The sum of the horizontal components is

$$F_{net,x} = (35N) \cos(160^\circ) + (19N) \cos(-161^\circ) = -50.8540947N$$

The sum of the vertical components is

$$F_{net,y} = (35N) \sin(160^\circ) + (19N) \sin(-161^\circ) = 5.7849101N$$

The angle of the net force is

$$\theta = \tan^{-1}(5.7849101 / -50.8540947) = 173.5^\circ$$

16. Problem

Two boxes connected by a light cord are on a frictionless table as shown in the diagram. The masses are $m_1 = 89\text{ kg}$ and $m_2 = 534\text{ kg}$. A 770-N force is applied horizontally on the right box. What is the tension in the cord?



- a. 781 N
- b. 594 N
- c. 660 N
- d. 646 N

Solution

The acceleration of the system of two boxes is

$$a = \frac{770\text{ N}}{89\text{ kg} + 534\text{ kg}}$$

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

$$F_{tension} = (534\text{ kg}) \left(\frac{770\text{ N}}{89\text{ kg} + 534\text{ kg}} \right) = 660\text{ N}$$

17. Problem

Two forces act on an object. A 14.0-N force acts at -102° . A 39.0-N force acts at -104° . What is the angle of their equilibrant?

- a. 153.7°
- b. -50.7°
- c. 76.5°
- d. -156.2°

Solution

The sum of the horizontal components is

$$F_{net,x} = (14N) \cos(-102^\circ) + (39N) \cos(-104^\circ) = -12.3457176N$$

The sum of the vertical components is

$$F_{net,y} = (14N) \sin(-102^\circ) + (39N) \sin(-104^\circ) = -51.5355997N$$

The angle of the net force is

$$\theta_{net} = \tan^{-1}(-51.5355997 / -12.3457176) = -103.5^\circ$$

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

$$\theta_{eq} = 76.5^\circ$$

Or

$$\theta_{eq} = -283.5^\circ$$

18. Problem

A box of mass 49 kg slides down a frictionless inclined plane. The angle of incline is 51° from the horizontal. What is the acceleration of the box?

- a. 9.2 m/s^2
- b. 8.4 m/s^2
- c. 7.6 m/s^2
- d. 5.5 m/s^2

Solution

The acceleration is

$$a = g \sin \theta = (9.8 \text{ m/s}^2) \sin(51^\circ) = 7.6 \text{ m/s}^2$$

19. Problem

A box of mass 18 kg slides down an inclined plane with friction. The angle of incline is 33° and $\mu_k = 0.19$. What is the acceleration of the box?

- a. 3.8 m/s^2
- b. 1.3 m/s^2
- c. 0.1 m/s^2
- d. 2.3 m/s^2

Solution

The acceleration is

$$a = g(\sin \theta - \mu \cos \theta) = 3.8 \text{ m/s}^2$$

20. Problem

An 7-kg box slides down a 14° inclined plane with constant acceleration. The box starts from rest at the top. At the bottom, its velocity reaches 1.76 m/s. The length of the incline is 4.52 m. What is the coefficient of kinetic friction between the box and the plane?

- a. 0.154
- b. 0.098
- c. 0.213
- d. 0.015

Solution

The acceleration of the box can be calculated using the constant acceleration formula $v_f^2 = v_i^2 + 2ad$. Since $v_i = 0$, the acceleration is

$$a = \frac{v_f^2}{2d} = \frac{(1.76 \text{ m/s})^2}{2(4.52 \text{ m})} = 0.3426549 \text{ m/s}^2$$

The acceleration down an inclined plane with friction is

$$a = g \sin \theta - \mu g \cos \theta$$

Solving for μ

$$\mu = \tan \theta - \frac{a}{g \cos \theta} = \tan(14^\circ) - \frac{(0.3426549 \text{ m/s}^2)}{(9.80 \text{ m/s}^2) \cos(14^\circ)}$$

$$\mu = 0.213$$