Physics 11
Dynamics Unit Retest 2 Solutions

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

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? 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 = 51 kg) tackles Joe (mass = 114 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**
   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. The net force is zero.
   b. Cannot be determined without more information.
   c. A force equal to its weight on Earth, mg.
   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 air resistance pushing up on the apple.
   b. The apple's gravity pulling upward on the Earth.
   c. The force of impact when the object hits the ground.
   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**
   You place a 76.19-kg object on a spring scale. If the scale reads 185.3 N, what is the acceleration of gravity at that location?

   a. $2.43\,\mathrm{m/s^2}$
   b. $3.33\,\mathrm{m/s^2}$
   c. $1.72\,\mathrm{m/s^2}$
   d. $2.38\,\mathrm{m/s^2}$

   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

   $$g = \frac{W}{m} = \frac{185.3\,\mathrm{N}}{76.19\,\mathrm{kg}} = 2.43\,\mathrm{m/s^2}$$

10. **Problem**
    A net force of 93.0 N acts on an object of mass 3.00 kg. What is the acceleration of the object?

    a. 45.0 m/s^2
    b. 38.0 m/s^2
    c. 31.0 m/s^2
    d. 41.0 m/s^2

    Solution
    According to Newton's Second Law of Motion

    $$a = F/m = (93\,\mathrm{N})/(3\,\mathrm{kg}) = 31\,\mathrm{m/s^2}$$

11. **Problem**
    An 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. 0.522
    b. 0.223
    c. 0.839
    d. 0.012

    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:

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

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 the same box with 2.0 N of force, at a right angle to Adam's force. What is the magnitude of the net force on the box?

    a. 17.3 N
    b. 7.1 N
    c. 20.9 N
    d. 14.1 N

    Solution
    Perpendicular forces are added using the Pythagorean theorem.

$$F_{net} = \sqrt{F_1^2 + F_2^2} = \sqrt{(14N)^2 + (2N)^2} = 14.1 \text{ N}$$

14. **Problem**
    Xavier pulls on a box with 46.0 N of force at $0°$. Yuri pulls on the the same box with 16.0 N of force, at $90°$. What is the angle of the net force?

    a. $19.0°$
    b. $69.6°$
    c. $82.9°$
    d. $55.9°$

    Solution
    The angle can be found using the arctangent.

$$\theta = \tan^{-1}(16/46) = 19°$$

15. **Problem**
    Robert pulls on a box with 10.0 N of force at $113°$. Steve pulls on the the same box with 21.0 N of force at $208°$. What is the magnitude of the net force on the box?

    a. 22.5 N
    b. 26.1 N
    c. 30.4 N
    d. 31.5 N

    Solution

The sum of the horizontal components is

$$F_{net,x} = (10N)\cos(113^\circ) + (21N)\cos(208^\circ) = -22.4492107N$$

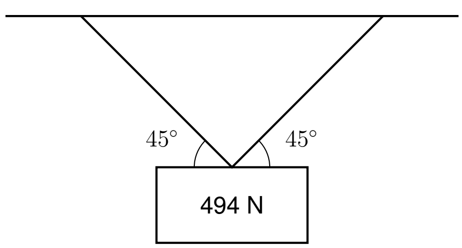
The sum of the vertical components is

$$F_{net,y} = (10N)\sin(113^\circ) + (21N)\sin(208^\circ) = -0.6538543N$$

The magnitude of the net force is

$$F_{net} = \sqrt{(-22.4492107N)^2 + (-0.6538543N)^2} = 22.5 \text{ N}$$

16. **Problem**
A sign that weighs 494 N is supported by two ropes that each makes a 45° angle with the horizontal. The sign is not moving. What is the magnitude of the force exerted by each rope?



a. 349 N
b. 389 N
c. 251 N
d. 264 N

Solution
The horizontal components cancel out so the two vertical components must balance the weight of the sign. (See the example problem on p. 122.)

$$F = \frac{(494N)}{2\sin(45^\circ)} = 349 \text{ N}$$

17. **Problem**
Two forces act on an object. A 43.0-N force acts at -148°. A 86.0-N force acts at -83°. What is the angle of their equilibrant?

a. -125.5°
b. 76.5°
c. -64.3°
d. 147.6°

Solution
The sum of the horizontal components is

$$F_{net,x} = (43N)\cos(-148^\circ) + (86N)\cos(-83^\circ) = -25.9853046N$$

The sum of the vertical components is

$$F_{net,y} = (43N)\sin(-148^\circ) + (86N)\sin(-83^\circ) = -108.1454974N$$

The angle of the net force is

$$\theta_{net} = \tan^{-1}(-108.1454974/-25.9853046) = -103.5^\circ$$

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 61 kg slides down a frictionless inclined plane. The angle of incline is 52° from the horizontal. What is the acceleration of the box?
   a. 8.4 m/s^2
   b. 7.7 m/s^2
   c. 6.4 m/s^2
   d. 5.5 m/s^2

Solution
The acceleration is
$$a = g\sin\theta = (9.8\,\mathrm{m/s^2})\sin(52^\circ) = 7.7\,\mathrm{m/s^2}$$

19. **Problem**
A box of mass 23 kg slides down an inclined plane with friction. The angle of incline is 25° and $\mu_k = 0.25$. What is the acceleration of the box?
   a. 5.3 m/s^2
   b. 0.0 m/s^2
   c. 1.9 m/s^2
   d. 0.6 m/s^2

Solution
The acceleration is
$$a = g(\sin\theta - \mu\cos\theta) = 1.9\,\mathrm{m/s^2}$$

20. **Problem**
An 6-kg box slides down a 29° inclined plane with constant acceleration. The box starts from rest at the top. At the bottom, its velocity reaches 4.39 m/s. The length of the incline is 3.83 m. What is the coefficient of kinetic friction between the box and the plane?

    a. 0.261
    b. 0.024
    c. 0.344
    d. 0.375

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

$$a = \frac{v_f^2}{2d} = \frac{(4.39\,\mathrm{m/s})^2}{2(3.83\,\mathrm{m})} = 2.5159399\,\mathrm{m/s^2}$$

The acceleration down an inclined plane with friction is

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

Solving for μ

$$\mu = \tan\theta - \frac{a}{g\cos\theta} = \tan(29^\circ) - \frac{(2.5159399\,\mathrm{m/s^2})}{(9.80\,\mathrm{m/s^2})\cos(29^\circ)}$$

$$\mu = 0.261$$