Physics 11

Vectors Quiz Solutions

1.	a.	X	b.				
2.	a.		b.	X			
3.	a.		b.	X			
4.	a.		b.		c.		d.	X
5.	a.		b.		c.	X	d.	
6.	a.	X	b.		c.		d.	
7.	a.		b.	X	c.		d.	
8.	a.		b.		c.	X	d.	
9.	a.		b.		c.	X	d.	
10.	a.	X	b.		c.		d.	
11.	a.		b.	X	c.		d.	
12.	a.		b.	X	c.		d.	

1. **Problem**
   True or false? The normal force on an object of mass M at rest on an inclined plane is less than Mg. Assume that the plane is inclined at a positive acute angle and that only gravity and the normal force act on the object.

   a. True

   b. False

   Solution
   True. The normal force on an inclined plane is $Mg\cos\theta$ and $\cos\theta$ is always less than one for positive acute angles.

2. **Problem**
   A student puts two objects on a physics book and carefully tilts the cover. At a small angle, object A starts to slide. At a larger angle, object B starts to slide. Which has the greater coefficient of static friction with the book cover?

   a. Object A

   b. Object B

   Solution
   As shown in the example on p. 126, the coefficient of static friction is equal to $\tan\theta$, where θ is the angle at which the object starts to slide. The tangent function increases with the angle so it is greater for greater angles. Therefore, object B, which starts sliding at a greater angle, has the greater coefficient of static friction.

3. **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.

4. **Problem**
   Xavier pulls on a box with 47.0 N of force at 0°. Yuri pulls on the the same box with 23.0 N of force, at 90°. What is the angle of the net force?

   a. 27.2°

   b. 56.7°

   c. 68.3°

   d. 26.0°

   Solution
   The angle can be found using the arctangent.

$$\theta = \tan^{-1}(23/47) = 26^\circ$$

5. **Problem**
Adam pulls on a box with 8.0 N of force. Bob pulls on the the same box with 14.0 N of force, at a right angle to Adam's force. What is the magnitude of the net force on the box?

   a. 6 N
   b. 22 N
   c. 16.1 N
   d. 19.4 N

   Solution
   Perpendicular forces are added using the Pythagorean theorem.

$$F_{net} = \sqrt{F_1^2 + F_2^2} = \sqrt{(8N)^2 + (14N)^2} = 16.1 \text{ N}$$

6. **Problem**
Carly pulls on a box with 15.0 N of force. Debby pulls on the the same box at a right angle to Carly. How hard must Debby pull to make the resultant force on the box 18.0 N?

   a. 9.9 N
   b. 33.0 N
   c. 5.1 N
   d. 6.4 N

   Solution
   Perpendicular forces are related by the Pythagorean theorem.

$$F_{Debby} = \sqrt{F_{net}^2 - F_{Carly}^2} = \sqrt{(18N)^2 - (15N)^2} = 9.95 \text{ N}$$

7. **Problem**
Charlie pulls on a box with 15.0 N of force at -10°. Dan pulls on the the same box with 11.0 N of force at 39°. What is the angle of the net force on the box?

   a. -111.6°
   b. 10.5°
   c. -110.5°
   d. 159.6°

   Solution
   The sum of the horizontal components is

$$F_{net,x} = (15N)\cos(-10^\circ) + (11N)\cos(39^\circ) = 23.3207219N$$

   The sum of the vertical components is

$$F_{net,y} = (15N)\sin(-10^\circ) + (11N)\sin(39^\circ) = 4.3178016N$$

   The angle of the net force is

$$\theta = \tan^{-1}(4.3178016/23.3207219) = 10.5^\circ$$

8. **Problem**
Two forces act on an object. A 45-N force acts at 0° and a 43-N force acts at 90°. What is the magnitude of the equilibrant?

   a. 82.2 N
   b. 70.1 N
   c. 62.2 N
   d. 90.7 N

   Solution
   Perpendicular forces are added using the Pythagorean theorem. The equilibrant has the same magnitude as the sum of the two forces.

$$F_{eq} = \sqrt{45N + 43N} = 62.2 \text{ N}$$

9. **Problem**
Two forces act on an object. A 75.0-N force acts at 148°. A 65.0-N force acts at 149°. What is the angle of their equilibrant?

   a. 5.1°
   b. -139.2°
   c. -31.5°
   d. -122.5°

   Solution
   The sum of the horizontal components is

$$F_{net,x} = (75N)\cos(148^\circ) + (65N)\cos(149^\circ) = -119.3194818N$$

   The sum of the vertical components is

$$F_{net,y} = (75N)\sin(148^\circ) + (65N)\sin(149^\circ) = 73.2214197N$$

   The angle of the net force is

$$\theta_{net} = \tan^{-1}(73.2214197/-119.3194818) = 148.5^\circ$$

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

$$\theta_{eq} = 328.5^\circ$$

   Or

$$\theta_{eq} = -31.5^\circ$$

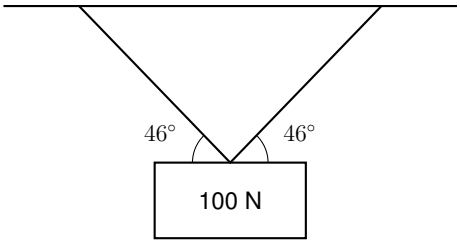
10. **Problem**
Two forces have magnitudes of 5 N and 7 N, respectively. When these two forces are added, the magnitude of the sum

   a. could be any value between 2 N and 12 N (inclusive)
   b. could be any value
   c. must be either 2 N or 12 N
   d. must be 12 N

   Solution
   If the two vectors point in the same direction, then the magnitude of their sum is 12 N. If the two

vectors point in opposite directions, then the magnitude of their sum is 2 N. Otherwise, the magnitude of their sum is somewhere between 2 N and 12 N. The correct answer is “could be any value between 2 N and 12 N”.

11. **Problem**
A sign that weighs 100 N is supported by two ropes that each make 46° angles with the horizontal. The sign is not moving. What is the magnitude of the force exerted by each rope?



a. 46.6 N
b. 69.5 N
c. 60.8 N
d. 53.9 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.)

$$F = \frac{(100N)}{2\sin(46^\circ)} = 69.5 \text{ N}$$

12. **Problem**
Robert pulls on a box with 25.0 N of force at 121°. Steve pulls on the the same box with 83.0 N of force at 98°. What is the magnitude of the net force on the box?

a. 126.2 N
b. 106 N
c. 142.1 N
d. 136.3 N

Solution
The sum of the horizontal components is

$$F_{net,x} = (25N)\cos(121^\circ) + (83N)\cos(98^\circ) = -24.4273193N$$

The sum of the vertical components is

$$F_{net,y} = (25N)\sin(121^\circ) + (83N)\sin(98^\circ) = 103.6214322N$$

The magnitude of the net force is

$$F_{net} = \sqrt{(-24.4273193N)^2 + (103.6214322N)^2} = 106 \text{ N}$$