Flipping Physics Lecture Notes:
Newton's Second Law - AP Physics 1: Dynamics Review Supplement
http://www.flippingphysics.com/ap1-dynamics-newtons-second-law.html

This lesson is a part of my AP Physics 1 Ultimate Review Packet. Please consider signing up for access to the whole Review Packet at www.UltimateReviewpPacket.com!

1) A rock is freely falling downward toward the Earth. The weight of the rock is W. Which of the following best describes the force from the rock on the Earth as the rock falls? The force the rock causes on the Earth as it falls is…

(A) Zero. (B) W upward (C) W downward
(D) Increasing in magnitude as the rock's speed increases.

This question is testing your understanding of Newton's Third Law: For every force object 1 applies on object 2, object 2 applies an equal but opposite force on object 1.

$$\vec{F}_{12} = -\vec{F}_{21}$$

In this case the two objects are the Earth and the rock, and the force the Earth applies on the rock is the weight of the rock. Therefore:

$$\vec{W} = \vec{F}_{\text{Earth rock}} = -\vec{F}_{\text{rock Earth}}$$

In other words, the force the rock causes on the Earth is equal to the downward weight of the rock only in the opposite direction or upwards. The correct answer is B.

2) A 300 N object is accelerating to the North at 1 m/s^2. A force, F_1, of 40 N acts due East on the object. If there is only one other force, F_2, acting on the object, what is the magnitude and direction of F_2?

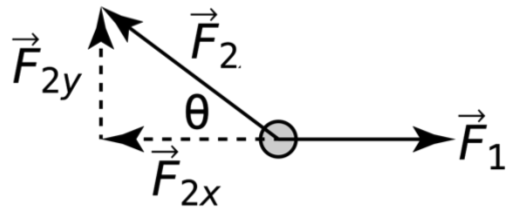
(A) 50 N @ 37° N of W (B) 50 N @ 53° N of W
(C) 35 N @ 37° N of W (D) 35 N @ 53° N of W

A "300 N" object has a weight of 300 newtons. So, let's use that to determine the mass of the object.

$$F_g = mg \Rightarrow m = \frac{F_g}{g} = \frac{300N}{10\frac{m}{s^2}} = 30kg$$

We know the acceleration of the object is completely North, let's call that the positive y-direction and identify East as the positive x-direction. Because F_1 is entirely in the positive x-direction, F_1 has no component in the y-direction. Therefore, the acceleration of the object is caused entirely by the y-component of F_2. That means we can find the y-component of F_2 by summing the forces in the y-direction.

$$\sum F_y = F_{2y} = ma_y = (30kg)\left(1\frac{m}{s^2}\right) = 30N$$



We also know the acceleration of the object in the x-direction is zero, therefore, the x-component of F_2 must be in the negative x-direction to counteract F_1. That means we can find the x-component of F_2 by summing the forces in the x-direction.

$$\sum F_x = -F_{2x} + F_1 = ma_x = m(0) = 0 \Rightarrow F_{2x} = F_1 = 40N$$

Now that we have the components of F_2 we can determine its magnitude and direction.

$$A^2 + B^2 = C^2 \Rightarrow {F_{2x}}^2 + {F_{2y}}^2 = {F_2}^2$$

$$\Rightarrow F_2 = \sqrt{{F_{2x}}^2 + {F_{2y}}^2} = \sqrt{40^2 + 30^2} = 50N$$

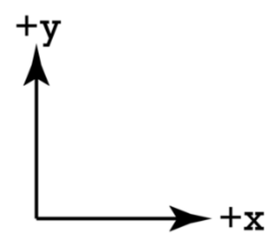
$$\tan\theta = \frac{O}{A} = \frac{F_{2y}}{F_{2x}} \Rightarrow \theta = \tan^{-1}\left(\frac{F_{2y}}{F_{2x}}\right) = \tan^{-1}\left(\frac{30}{40}\right) \approx 37^\circ$$

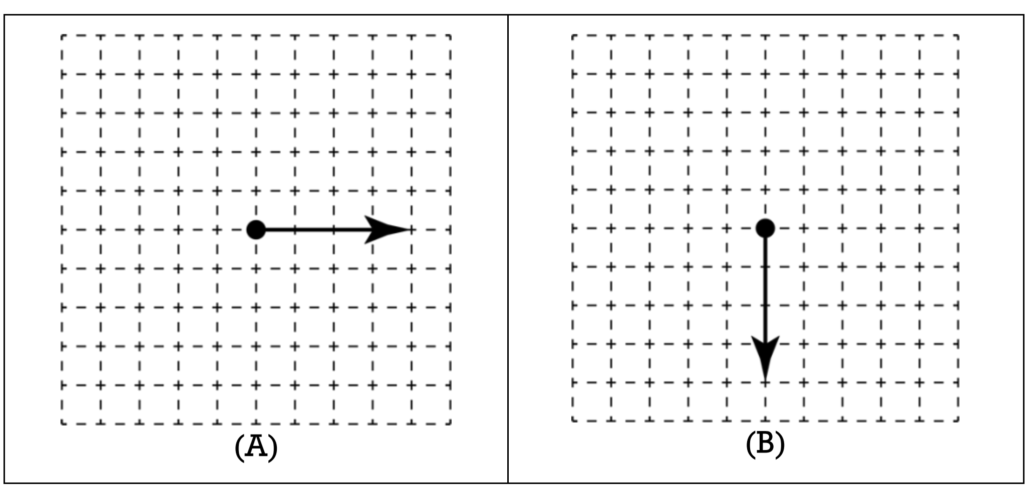
Correct answer is A.

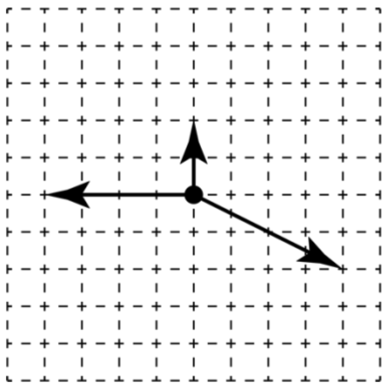
A few things to point out. One is that the College Board will often use common triangles like 3, 4, 5 triangles and 30, 60, 90 triangles, etc. It's just good to be aware of that.

Also, notice there must be a downward force of gravity in this problem, and therefore a counteracting upward force. That upward force is probably a normal force and the object is probably moving on a frictionless surface. All of that is ignored in the problem, which is too bad, however, you will likely see things like this on the AP Physics exam. Sorry!

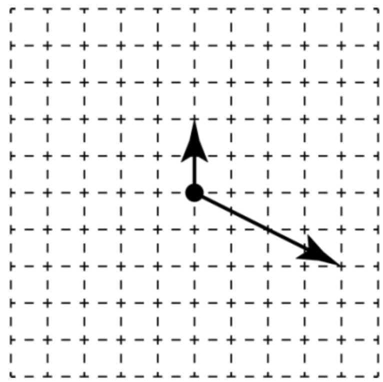
3) Which of the following **two** free body diagrams could be for an object which has a constant velocity in the y-direction and a constant acceleration in the x-direction?







(C)

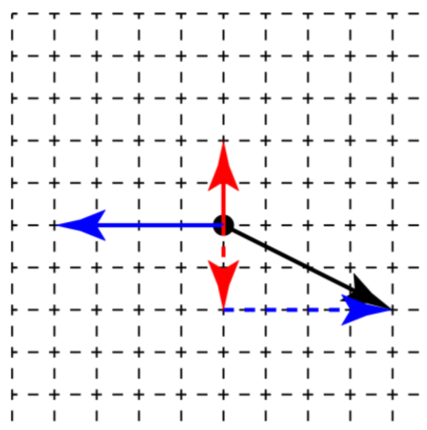


(D)

Because net force equals mass times acceleration, to have a constant velocity in the y-direction, the net force in the y-direction must be zero, and to have a constant acceleration in the x-direction, the net force in the x-direction must be nonzero.

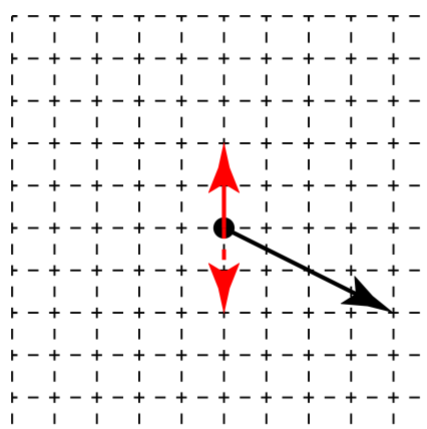
Choice A has a net force in the y-direction equal to zero and a net force in the x-direction which is nonzero. So, choice A is a correct answer.

Choice B has a net force in the y-direction which is nonzero and a net force in the x-direction equal to zero. So, choice B is an incorrect answer.



Choice C has a net force in the y-direction equal to zero and a net force in the x-direction equal to zero. So, choice C is an incorrect answer.

To clarify, look at the grid. The y-component of the force at an angle (in red) is two grid spacings in length down which balances out the force vector which is two grid spacings in length up. And the x-component of the force at an angle (in blue) is four grid spacings to the right which balances out the force vector which is four grid spacings to the left. This is why the net force in all directions is equal to zero.



Choice D has a net force in the y-direction equal to zero and a net force in the x-direction which is nonzero. So, choice D is a correct answer.

To clarify, again, look at the grid. The y-component of the force at an angle (in red) is two grid spacings in length down which balances out the force vector which is two grid spacings in length up. This is why the net force in the y-direction is zero, and the net force in the x-direction is nonzero.