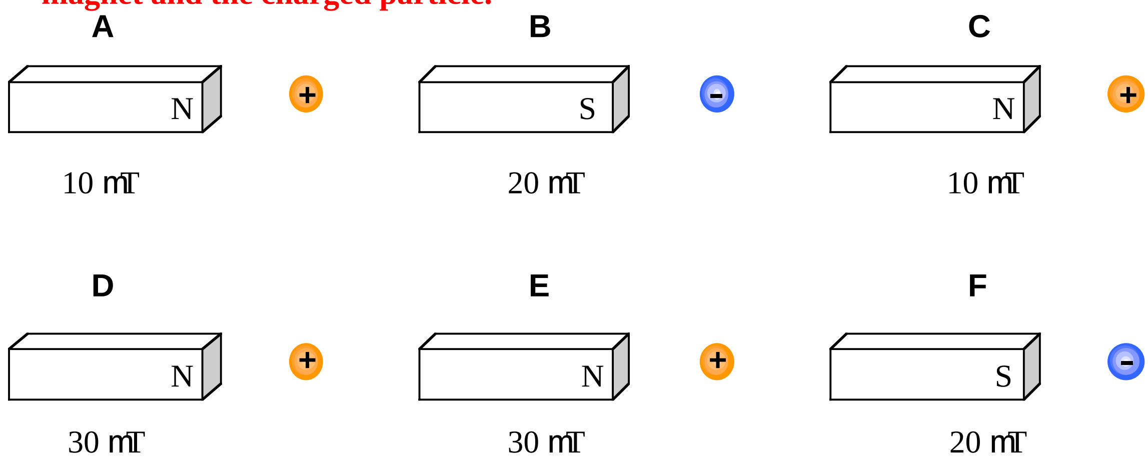
MFF 1A: ELECTRIC CHARGE AND A BAR MAGNET

MFF1a—RT1: Electric Charge and a Bar Magnet

Shown below are six situations where an electrically charged particle is placed near one pole of a permanent magnet. We are told the sign of the charge, the strength of the magnet and which pole, N or S, the particle is near. All of the charges have the same strength and are the same distance from the magnet.

Rank these situations, from greatest to least, on the basis of the repulsive force between the magnet and the charged particle.



Greatest 1 _______ 2 _______ 3 _______ 4 _______ 5 _______ 6 ________ Least

OR, ALL six charged particles will experience the same repulsion. _______

OR, There is no force on the charge in any of these six cases. _______

OR, ALL six charged particles will experience the same attraction. _______

Carefully explain your reasoning.

How sure were you of your ranking? (circle one)

Basically Guessed				Sure					Very Sure
1	2	3	4	5	6	7	8	9	10

MFF1a—WBT1: Electric Charge and a Bar Magnet

Construct a physical situation, involving a permanent magnet, to which the following equation for the magnetic force could apply.

$$\left|\vec{F}_B\right| = (88\times10^{-6}\,C)(0\text{ m / s})(45\times10^{-3}\text{ T})$$

Draw a diagram and carefully explain your reasoning.

MFF1a—CCT1: Electric Charge and a Bar Magnet

Consider the following students' statements about the magnetic force on a positively charged particle placed near a permanent magnet.

***Student A:** "A positively charged particle placed near the N pole of a permanent magnet will experience a MAGNETIC repulsion."*

***Student B:** "A positively charged particle placed near the N pole of a permanent magnet will experience a MAGNETIC attraction."*

***Student C:** "A positively charged particle placed near either the N or S pole of a permanent magnet will not experience any magnetic force"*

With which, if any, student do you agree?

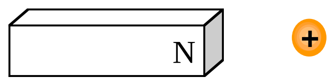
Student A _____ Student B _____ Student C _____ None of them _____

Carefully explain your reasoning.

MFF1a—WWT1: Electric Charge and a Bar Magnet

Determine what, if anything, is wrong with the situation presented below. If something is wrong, identify it and explain how to correct it. If nothing is wrong, explain why the situation is correct.

A positively charged particle placed at the position shown in the figure below will start moving to the right because it will be repelled by the N pole of the magnet.



MFF1a—TT1: Electric Charge and a Bar Magnet

Something is wrong with the situation described below**. Identify what is wrong and explain how to correct it.**

"A positively charged particle placed at rest near the S pole of a permanent magnet will be repelled by the magnet."

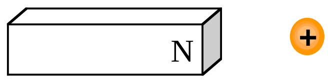
MFF1a—PET1: Electric Charge and a Bar Magnet

A positively charged Styrofoam packing “peanut” is suspended from a thread and hangs freely. The N pole of a permanent magnet is placed near the peanut. The peanut swings toward the magnet indicating that it is attracted to the magnet.

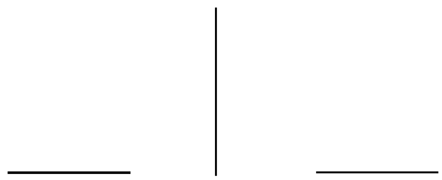
Suppose that the S pole of the magnet is placed near the peanut. What will the peanut do and why?

MFF1a—BCT1: Electric Charge and a Bar Magnet

The figure below shows a positively charged particle that is placed at rest near the N pole of a permanent magnet and released. The particle is released at t = 0 s and allowed to move freely.



Complete the bar chart below showing the particle's speed 1 second after being released.

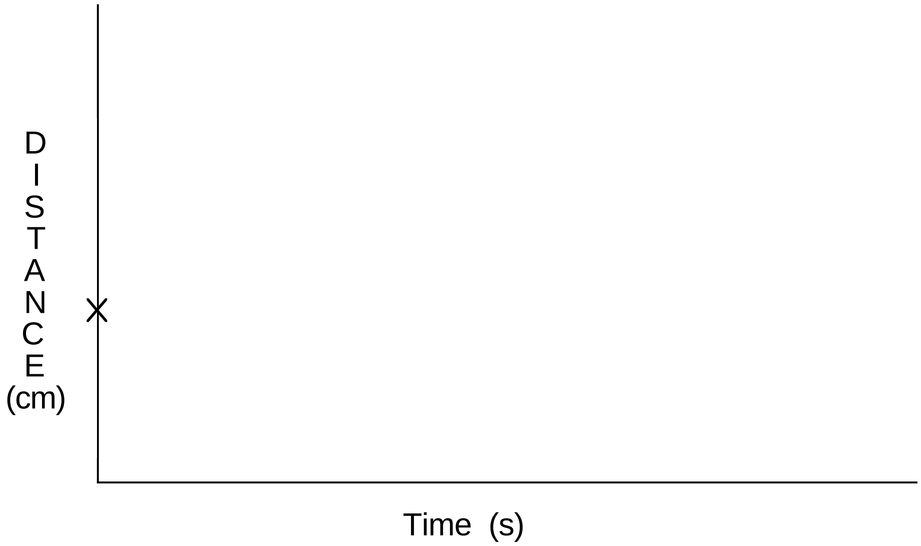


Speed at t=o s Speed at t=1 s

Explain your answer fully.

MFF1a—CRT1: Electric Charge and a Bar Magnet

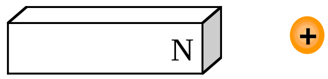
A positively charged particle is placed at rest near the N pole of a permanent magnet and released. **On the axes below, plot the distance of the particle from the magnet versus time starting from the initial position marked by an X.**



Explain fully why the graph looks as you have drawn it.

MFF1a—LMCT1: Electric Charge and a Bar Magnet

A positively charged particle is placed at rest 3 cm from the N pole of a permanent magnet. Several modifications to this initial situation are described below. For each modification **identify how the magnetic force exerted on the particle will change, if it does.**



The same possible answers are available for all changes, they are:

a) This change will increase the force.
b) This change will decrease the force.
c) This change will reverse the direction of the force.
d) This change will have no effect on the force.
e) There was no force and this change will not alter that.

All of the modifications are to the original situation.

1) The strength of the magnet is doubled. ______

2) The particle is placed 7 cm from the N pole. ______

3) The magnet is reversed so the particle is located 3 cm from the S pole. ______

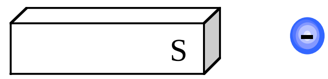
4) The charge on the particle is tripled. ______

5) The mass of the particle is doubled. ______

6) A second magnet is placed 3 cm on the other side of the charge with its S pole facing the charge. ______

MFF1a—M/MCT1: Electric Charge and a Bar Magnet

A 74 nC negatively charged particle is placed 3.5 cm from the N pole of a permanent magnet of strength 0.66 T.



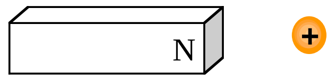
A student calculates the force on the particle 3 seconds after the particle is put in place in the following way:

$$\left|\vec{F}\right| = \frac{(74\times10^{-9}\text{C})(3.5\times10^{-2}\text{m})(0.66\text{T})}{3\text{s}}$$

Is this calculation meaningful, i.e., it actually tells us something about a physical quantity relevant to the situation, or is it meaningless, i.e., it is not a legitimate calculation?

MFF1a—QRT1: Electric Charge and a Bar Magnet

The figure below shows a positively charged particle at a certain position relative to the N pole of a permanent magnet. A number of modifications are going to be made to this situation, in each case **explain how the modification will affect, if it does, the force exerted on the particle.**



a) The charge on the particle is tripled.

b) The strength of the magnet is decreased.

c) The charge is placed closer to the magnet.

d) The magnet is reversed so the particle is sitting near the S pole.

e) The positive charge is replaced by a negative charge of the same magnitude.

f) The mass of the particle is increased.

MFF1a—CODT1: Electric Charge and a Bar Magnet

A permanent magnet is placed near a hanging negatively charged ball with the S pole of the magnet near the ball. The ball swings toward the magnet.

What will happen if we place the magnet near the ball but with the N pole near the ball?

Actually conduct the experiment and ask them to explain any discrepancies between their predictions and what actually occurred.