2024 MCAS Sample Student Work and Scoring Guide

High School Introductory Physics
Question 43: Constructed-Response

Reporting Category: Energy
Practice Category: Evidence, Reasoning, and Modeling
Standard: HS.PHY.3.5 - Develop and use a model of magnetic or electric fields to illustrate the forces and changes in energy between two magnetically or electrically charged objects changing relative position in a magnetic or electric field, respectively.
Item Description: Analyze a diagram to compare the magnitude of the electrostatic forces acting on two objects, explain why the electrostatic forces have certain directions, and explain how releasing the objects changes the magnitude of the force acting on one of the objects and the kinetic energies of the objects.

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Scoring Guide

Select a score point in the table below to view the sample student response.

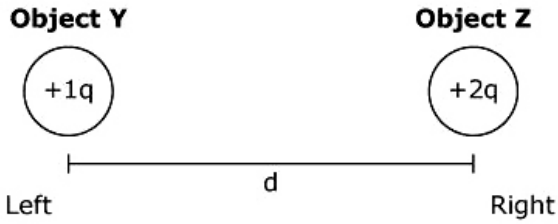
Score*	Description
4A	The response demonstrates a thorough understanding of the forces and changes in energy between two electrically charged objects. The response correctly compares the magnitude of the electrostatic force acting on object Y with the magnitude of the electrostatic force acting on object Z. The response correctly determines the directions of the electrostatic forces acting on object Y and object Z and clearly explains the reasoning. The response correctly identifies that the magnitude of the electrostatic force acting on object Z decreases after the objects are released and clearly explains the reasoning. The response also clearly explains how the kinetic energy of objects Y and Z change as a result of being released and clearly explains the reasoning.
4B	
3	The response demonstrates a general understanding of the forces and changes in energy between two electrically charged objects.
2	The response demonstrates a limited understanding of the forces and changes in energy between two electrically charged objects.
1	The response demonstrates a minimal understanding of the forces and changes in energy between two electrically charged objects.
0	The response is incorrect or contains some correct work that is irrelevant to the skill or concept being measured.

*Letters are used to distinguish between sample student responses that earned the same score (e.g., 4A and 4B).

Score Point 4A

This question has four parts.

Two charged objects, Y and Z, are held a distance, d, from each other. Both objects are positively charged, as shown.



Part A

Compare the magnitude of the electrostatic force acting on object Y with the magnitude of the electrostatic force acting on object Z.

The electrostatic force on the two objects is the same as each other. The equation for electric force uses the charges of both objects, so when calculating for one object's force, you are also calculating for the other object's force.

Part B

Determine the direction (left or right) of the electrostatic force acting on object Y **and** the direction (left or right) of the electrostatic force acting on object Z. Explain your reasoning.

The electrostatic force on object Y is acting toward the left. The electrostatic force on object Z is acting towards the right. The reason for these is because the two objects are both positively charged, and positive charges will always repel each other. Because of this, the forces will be in the direction opposite of where the other object is (which in this case, for Y is to the left, and for Z is to the right).

Part C

The objects are released and start to move.

Identify whether the magnitude of the electrostatic force acting on object Z increases, decreases, or remains the same after the objects are released. Explain your reasoning.

The electrostatic force on object Z will decrease after the objects are released. This is because when the objects are released, they will move away from each other. They are both positive charges, so they will have the tendency to repel each other. According to Coulomb's law, the greater the distance, the less electric force there will be. So, once released, the distance increases, and the force on object Z decreases.

Part D

Explain how the kinetic energies of object Y and object Z change as a result of the objects being released. Explain your reasoning.

The kinetic energy of both objects would increase as a result of the release of the objects.The potential energy that was stored as a result of the objects being held in place would be transformed into kinetic energy, which, because of the object not moving, would be zero. Because the objects are released, the potential energy would become kinetic in order for them to move (which would have to occur because of the electrostatic forces.

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Score Point 4B

This question has four parts.

Two charged objects, Y and Z, are held a distance, d, from each other. Both objects are positively charged, as shown.

Part A

Compare the magnitude of the electrostatic force acting on object Y with the magnitude of the electrostatic force acting on object Z.

They are equal

Part B

Determine the direction (left or right) of the electrostatic force acting on object Y **and** the direction (left or right) of the electrostatic force acting on object Z. Explain your reasoning.

The force acting on object Y is to the left, and the direction of force acting on object Z is to the right. This is becuase the objects are both positivly charged so they deflect eachother.

Part C

The objects are released and start to move.

Identify whether the magnitude of the electrostatic force acting on object Z increases, decreases, or remains the same after the objects are released. Explain your reasoning.

After the objects are released, the electorstatic force acting on object Z will start to decrease becusae as they move away from eachother the distance between them will increase, causing the force to decrease.

Part D

Explain how the kinetic energies of object Y and object Z change as a result of the objects being released. Explain your reasoning.

The kinetic energies of the objects will increase. This is because when they are at rest their velocities are at 0. which means that their kinetic energie is 0 (KE=1/2m(0)^2). However when they are released they will start to move away from eachother, and be at rest no longer, meaning that they have velocity. Now the v in the KE equation will not be 0, and the KE equation will not equal 0, the KE will now be greater than 0.

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Score Point 3

This question has four parts.

Two charged objects, Y and Z, are held a distance, d, from each other. Both objects are positively charged, as shown.

Part A

Compare the magnitude of the electrostatic force acting on object Y with the magnitude of the electrostatic force acting on object Z.

The magnitude of the electrostatic force is weaker in object Y than in object Z since Z has a greater charge.

Part B

Determine the direction (left or right) of the electrostatic force acting on object Y **and** the direction (left or right) of the electrostatic force acting on object Z. Explain your reasoning.

The direction of the electrostatic force acting on object Y is to the left while the direction of the forces acting on object Z are to the right. the forces are repelling in opposite directions because they are like charges.

Part C

The objects are released and start to move.

Identify whether the magnitude of the electrostatic force acting on object Z increases, decreases, or remains the same after the objects are released. Explain your reasoning.

After the objects are released the magnitude of the electrostatic force acting on object Z will decrease as its distance from object Y increases.

Part D

Explain how the kinetic energies of object Y and object Z change as a result of the objects being released. Explain your reasoning.

At rest both objects experience zero kinetic energy, but as they are released they accelerate in opposite directions gaining kinetic energy.

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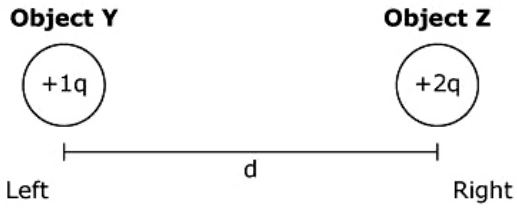
Score Point 2

This question has four parts.

Two charged objects, Y and Z, are held a distance, d, from each other. Both objects are positively charged, as shown.



Part A

Compare the magnitude of the electrostatic force acting on object Y with the magnitude of the electrostatic force acting on object Z.

The force acting on object Z is larger than the one acting on object Y.

Part B

Determine the direction (left or right) of the electrostatic force acting on object Y **and** the direction (left or right) of the electrostatic force acting on object Z. Explain your reasoning.

The direction of the electro static force on object Y is going to the left and object Z is going to the right. Since both of the objects are positivly charged they are going to repell eachtoher.

Part C

The objects are released and start to move.

Identify whether the magnitude of the electrostatic force acting on object Z increases, decreases, or remains the same after the objects are released. Explain your reasoning.

It will stay the same after the objects are released because it wont lose the charge moving away from the other object.

Part D

Explain how the kinetic energies of object Y and object Z change as a result of the objects being released. Explain your reasoning.

THe kinetic energy will increase when they are released because the objects will begin to move away from eachother instead of being stuck in place.

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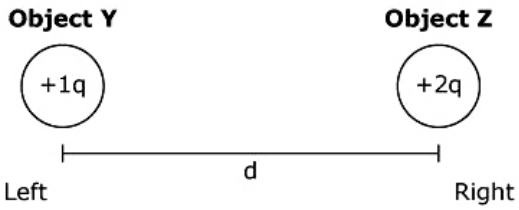
Score Point 1

This question has four parts.

Two charged objects, Y and Z, are held a distance, d, from each other. Both objects are positively charged, as shown.



Part A

Compare the magnitude of the electrostatic force acting on object Y with the magnitude of the electrostatic force acting on object Z.

The magnituded and tge eletrostatic for them is different because they cant be the same.

Part B

Determine the direction (left or right) of the electrostatic force acting on object Y **and** the direction (left or right) of the electrostatic force acting on object Z. Explain your reasoning.

The direction of the electrostatic is going to the right for both because there is more electrostatic on the right.

Part C

The objects are released and start to move.

Identify whether the magnitude of the electrostatic force acting on object Z increases, decreases, or remains the same after the objects are released. Explain your reasoning.

It decreases becasue it is moving father away.

Part D

Explain how the kinetic energies of object Y and object Z change as a result of the objects being released. Explain your reasoning.

They change because once they are realised the about of kinetc energy in the changes.

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Score Point 0

This question has four parts.

Two charged objects, Y and Z, are held a distance, d, from each other. Both objects are positively charged, as shown.

Part A

Compare the magnitude of the electrostatic force acting on object Y with the magnitude of the electrostatic force acting on object Z.

there is a largere eclectrostatic force acting on object z

Part B

Determine the direction (left or right) of the electrostatic force acting on object Y **and** the direction (left or right) of the electrostatic force acting on object Z. Explain your reasoning.

right for y and left for z since they attracted to each other.

Part C

The objects are released and start to move.

Identify whether the magnitude of the electrostatic force acting on object Z increases, decreases, or remains the same after the objects are released. Explain your reasoning.

it increases since it gains the force from object y

Part D

Explain how the kinetic energies of object Y and object Z change as a result of the objects being released. Explain your reasoning.

the kinetic energy tranferred from y to z

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