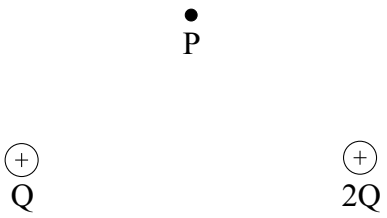
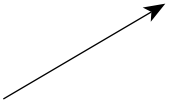
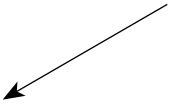
1. Which one of the following represents correct units for electric field strength?

   A. T
   B. N/C
   C. J / C
   D. $N \cdot m^2 / C^2$

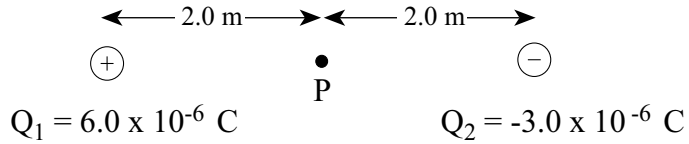
2. The diagram below shows two positive charges of magnitude Q and 2Q.



   Which vector **best** represents the direction of the electric field at point P, which is equidistant from both charges?

   A. 
   B. 
   C. 
   D. 

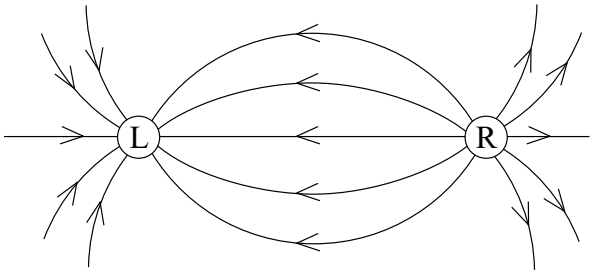
3. A 6.0×10^{-6} C charge is located 4.0 m from a -3.0×10^{-6} C charge.



   What is the electric potential at P, halfway between the charges?

   A. -4.1×10^{-2} V
   B. 6.8×10^{3} V
   C. 1.4×10^{4} V
   D. 4.1×10^{4} V

4. The diagram below shows the electric field near two point charges L and R.



What is the polarity of each charge?

	CHARGE L	CHARGE R
A.	positive	positive
B.	positive	negative
C.	negative	positive
D.	negative	negative

5. The electric field 2.0 m from a point charge has a magnitude of 8.0×10^4 N/C. What is the strength of the electric field at a distance of 4.0 m?

A. 2.0×10^4 N/C
B. 4.0×10^4 N/C
C. 1.6×10^5 N/C
D. 3.2×10^5 N/C

6. When a charge is accelerated through a potential difference of 500 V, its kinetic energy increases from 2.0×10^{-5} J to 6.0×10^{-5} J. What is the magnitude of the charge?

A. 4.0×10^{-8} C
B. 8.0×10^{-8} C
C. 1.2×10^{-7} C
D. 1.6×10^{-7} C

7. What is the electric potential energy of an electron located 5.3×10^{-11} m from the proton in a hydrogen atom?

A. -8.2×10^{-8} J
B. -4.3×10^{-18} J
C. -2.2×10^{-18} J
D. -1.6×10^{-19} J

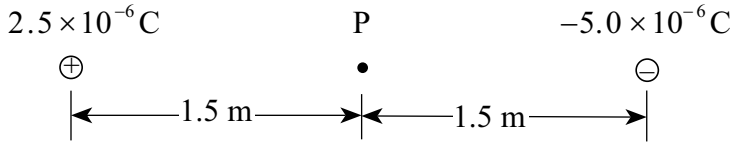
8. A negative charge in an electric field experiences a force accelerating it due south. What is the direction of the electric field?

A. east
B. west
C. north
D. south

9. A -2.3×10^{-6} C charge exerts a repulsive force of magnitude 0.35 N on an unknown charge 0.20 m away. What are the magnitude and polarity of the unknown charge?

	MAGNITUDE	POLARITY
A.	6.8×10^{-7} C	Negative
B.	6.8×10^{-7} C	Positive
C.	1.2×10^{-6} C	Negative
D.	1.2×10^{-6} C	Positive

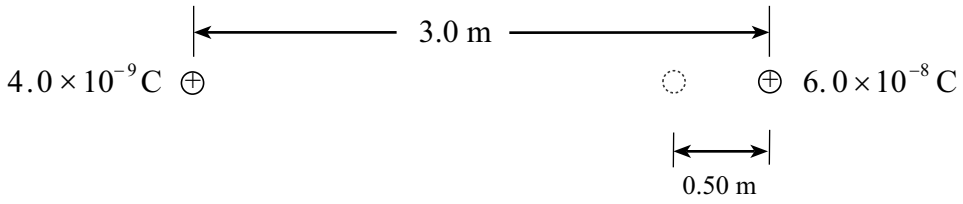
10. Two point charges, 2.5×10^{-6} C and -5.0×10^{-6} C, are placed 3.0 m apart as shown below.



What is the magnitude of the electric field at point P, midway between the two charges?

A. 0 N/C
B. 1.0×10^{4} N/C
C. 2.0×10^{4} N/C
D. 3.0×10^{4} N/C

11. A 4.0×10^{-9} C charge is initially located 3.0 m from a stationary 6.0×10^{-8} C charge. How much work is required to move the 4.0×10^{-9} C charge to a point 0.50 m from the stationary charge?

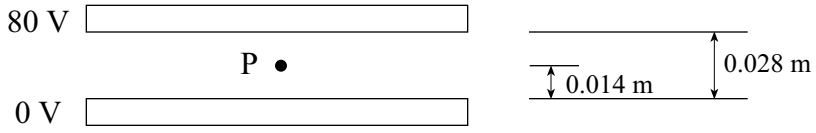


A. 6.0×10^{-7} J
B. 8.6×10^{-7} J
C. 3.6×10^{-6} J
D. 4.3×10^{-6} J

12. Two parallel plates 4.0×10^{-2} m apart have a potential difference of 1000 V. An electron is released from the negative plate at the same instant that a proton is released from the positive plate. Which of the following **best** compares their speed and kinetic energy as they strike the opposite plate?

	SPEED OF ELECTRON AND PROTON	KINETIC ENERGY OF ELECTRON AND PROTON
A.	same	same
B.	same	different
C.	different	same
D.	different	different

13. Two long, parallel plates are separated by 0.028 m and have a potential difference between them of 80 V, as shown below.



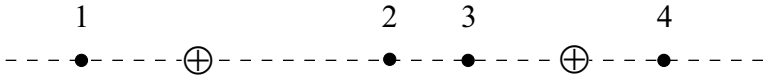
Point P is located midway between the plates. What is the potential difference between point P and one of the plates?

A. 0 V
B. 40 V
C. 80 V
D. 160 V

14. A particle with a charge of $2.4 \times 10^{-5}\,\text{C}$ is accelerated from rest through a potential difference of $6.2 \times 10^{4}\,\text{V}$. If the final speed of this particle is $9.3 \times 10^{3}\,\text{m/s}$, what is the mass of the particle?

A. 7.7×10^{-10} kg
B. 5.2×10^{-9} kg
C. 3.4×10^{-8} kg
D. 1.5×10^{-1} kg

15. Two positive charges, equal in magnitude, are separated as shown below.



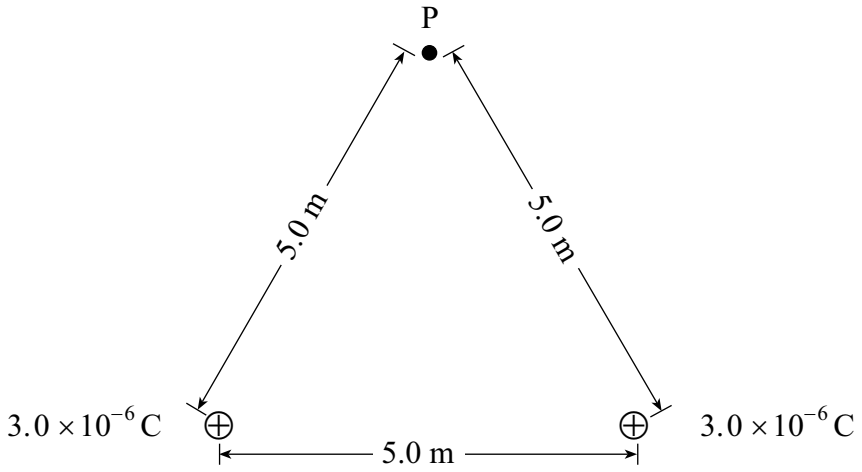
In which location would the electric field strength be zero?

A. 1
B. 2
C. 3
D. 4

16. An electron is positioned in an electric field. The force on the electron due to the electric field is equal to the force of gravity on the electron. What is the magnitude of this electric field?

A. 8.93×10^{-30} N/C
B. 5.69×10^{-12} N/C
C. 5.58×10^{-11} N/C
D. 1.44×10^{-9} N/C

17. Two $3.0 \times 10^{-6}\,\text{C}$ point charges are placed 5.0 m apart as shown below.

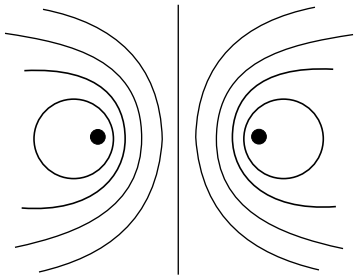


What is the potential at point P due to the two charges?

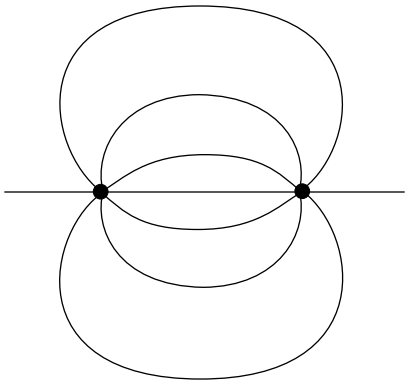
A. 0 V
B. 5.4×10^{3} V
C. 7.6×10^{3} V
D. 1.1×10^{4} V

18. Which of the following diagrams best shows the electric field between two equal negative charges?

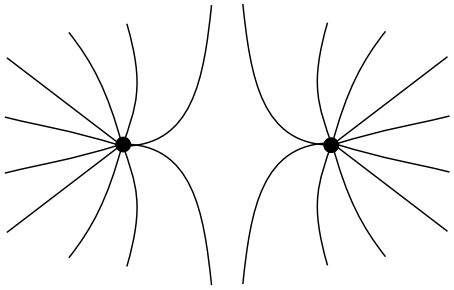
A.



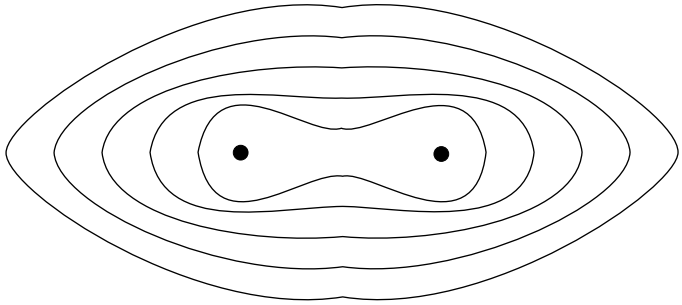
B.



C.



D.



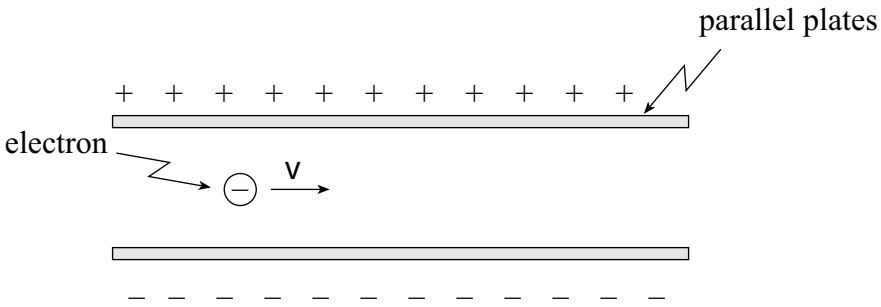
19. In a hydrogen atom, the electron and proton are separated by a distance of 5.3×10^{-11} m. What is the electric force exerted on the proton by the electron?

A. 0 N
B. 4.4×10^{-18} N
C. 8.2×10^{-8} N
D. 1.0×10^{12} N

20. A 2.5 C charge is moved from a point with a potential of 12 V to another point of potential 75 V. How much work was done on this charge?

A. 30 J
B. 160 J
C. 180 J
D. 220 J

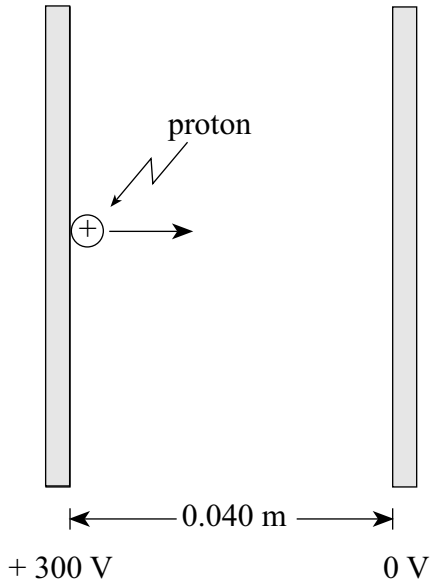
21. An electron is travelling in an electric field as shown.



Describe the electrostatic force acting on the electron while in the field.

	MAGNITUDE OF FORCE	DIRECTION OF FORCE
A.	Changing	Upward
B.	Changing	Downward
C.	Constant	Upward
D.	Constant	Downward

22. A proton initially at rest is accelerated between parallel plates through a potential difference of 300 V.



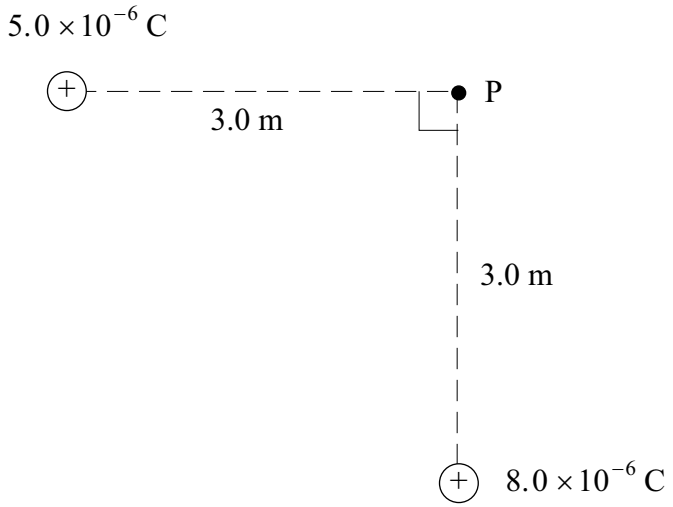
What is the maximum speed attained by the proton?

A. 7.5×10^3 m/s
B. 1.7×10^5 m/s
C. 2.4×10^5 m/s
D. 1.2×10^6 m/s

23. An electron experiences an electric force of $1.8 \times 10^{-11}\,\text{N}$ at a distance of $5.0 \times 10^{-9}\,\text{m}$ from the nucleus of an ion. The electron is moved farther away, to a distance of $2.0 \times 10^{-8}\,\text{m}$ from the ion. What is the new electric force on the electron?

A. $1.1 \times 10^{-12}\,\text{N}$
B. $4.5 \times 10^{-12}\,\text{N}$
C. $7.2 \times 10^{-11}\,\text{N}$
D. $2.9 \times 10^{-10}\,\text{N}$

24. What is the magnitude of the electric field at point P due to the two fixed charges as shown?



A. $3.0 \times 10^{3}\ \text{N/C}$
B. $9.4 \times 10^{3}\ \text{N/C}$
C. $1.3 \times 10^{4}\ \text{N/C}$
D. $3.9 \times 10^{4}\ \text{N/C}$

25. Which of the following is an equivalent unit for the volt?

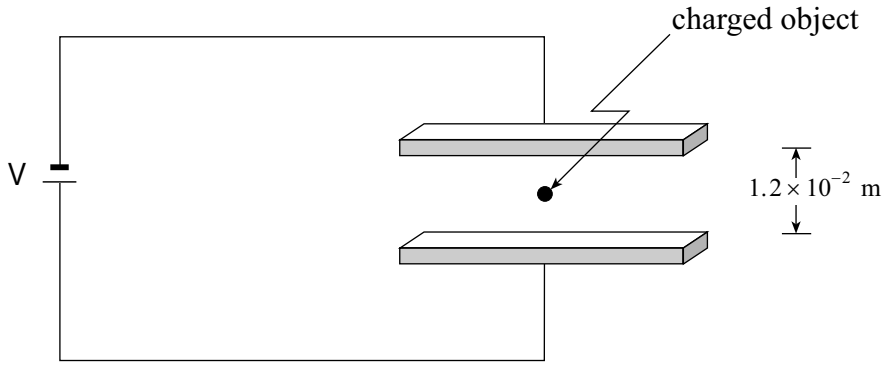
A. $\frac{\text{C}}{\text{s}}$

B. $\frac{\text{J}}{\text{C}}$

C. $\frac{\text{N}}{\text{C}}$

D. J

26. An object with a charge of $+4.0 \times 10^{-18}$ C and a mass of 1.1×10^{-15} kg is held stationary by balanced gravitational and electric forces midway between horizontal charged plates as shown. What is the applied voltage V?



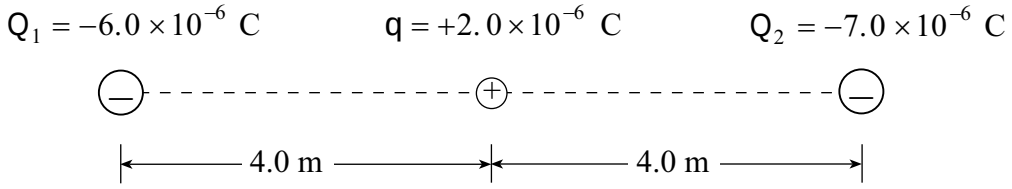
A. 16 V

B. 32 V

C. 65 V

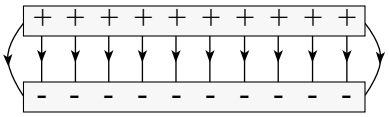
D. 2.7×10^{2} V

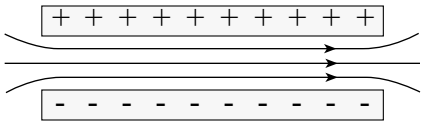
27. What are the magnitude and direction of the electric force on the $+2.0 \times 10^{-6}$ C charge shown below?

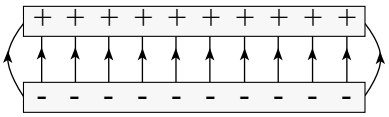


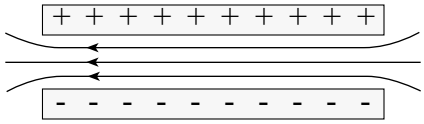
	MAGNITUDE OF FORCE	DIRECTION OF FORCE
A.	1.1×10^{-3} N	Left
B.	1.1×10^{-3} N	Right
C.	1.5×10^{-3} N	Left
D.	1.5×10^{-3} N	Right

28. Which diagram shows the electric field between a pair of charged parallel plates?

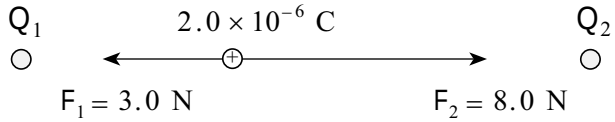
A. 

B. 

C. 

D. 

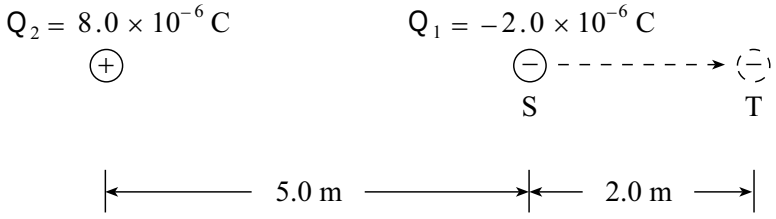
29. In the diagram below, a 2.0×10^{-6} C charge experiences forces of 3.0 N and 8.0 N at its location between charges Q_1 and Q_2.



Find the magnitude of the net electric field strength at the location of the 2.0×10^{-6} C charge.

A. 2.5×10^{6} N/C
B. 2.8×10^{6} N/C
C. 5.5×10^{6} N/C
D. 1.2×10^{7} N/C

30. How much work is done moving the -2.0×10^{-6} C charge, Q_1, from S to T in the diagram shown below?

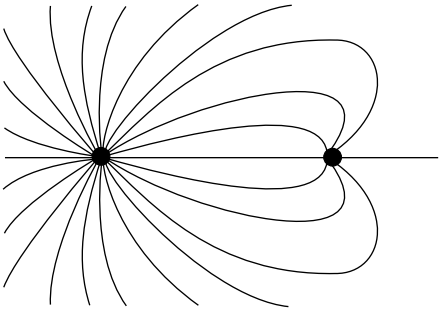


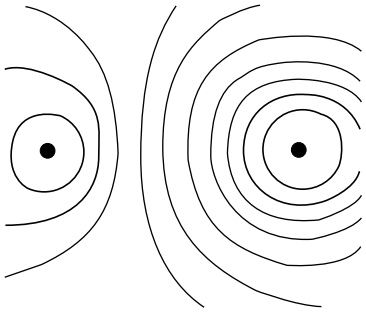
A. 5.6×10^{-3} J
B. 8.2×10^{-3} J
C. 1.2×10^{-2} J
D. 7.2×10^{-2} J

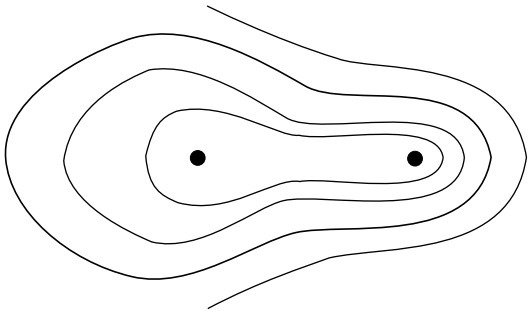
31. A 1.60×10^{-19} C ion is accelerated from rest through a potential difference of 750 V reaching a maximum speed of 8.50×10^{4} m/s. What is the mass of this ion?

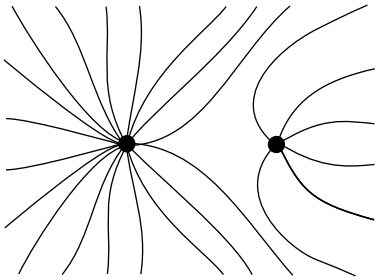
A. 9.11×10^{-31} kg
B. 1.67×10^{-27} kg
C. 3.32×10^{-26} kg
D. 4.84×10^{-20} kg

32. Which of the following shows the electric field between two opposite charges of unequal magnitude?

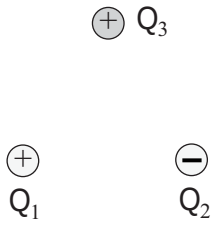
A.


B.


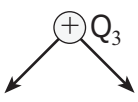
C.


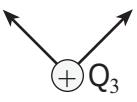
D.


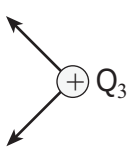
33. Three point charges of equal magnitude but opposite sign are arranged as shown in the diagram below.



Which of the diagrams below best represents the electric forces acting on Q_3 due to the other two charges?

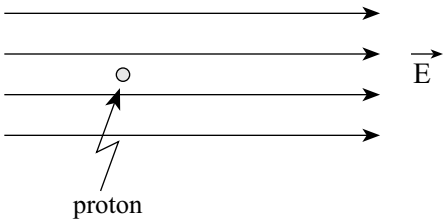
A.


B.


C.


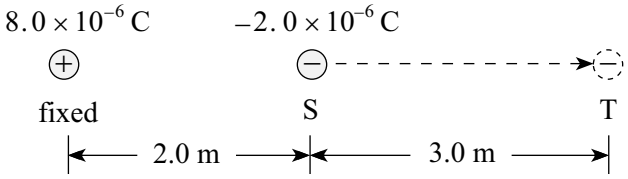
D.


34. What is the acceleration of a proton in a uniform 2.5×10^5 N/C electric field as shown below?



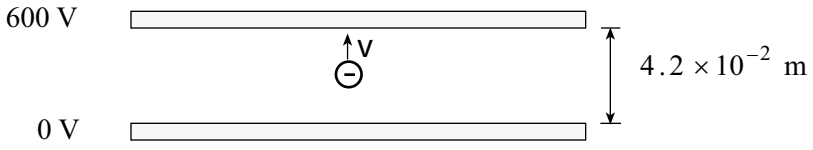
	MAGNITUDE OF ACCELERATION	DIRECTION OF ACCELERATION
A.	2.4×10^{13} m/s^2	Right
B.	2.4×10^{13} m/s^2	Left
C.	1.5×10^{32} m/s^2	Right
D.	1.5×10^{32} m/s^2	Left

35. How much work is needed to move a -2.0×10^{-6} C charge from position S to position T as shown below?



A. 4.3×10^{-2} J
B. 4.8×10^{-2} J
C. 9.1×10^{-2} J
D. 1.1×10^{-1} J

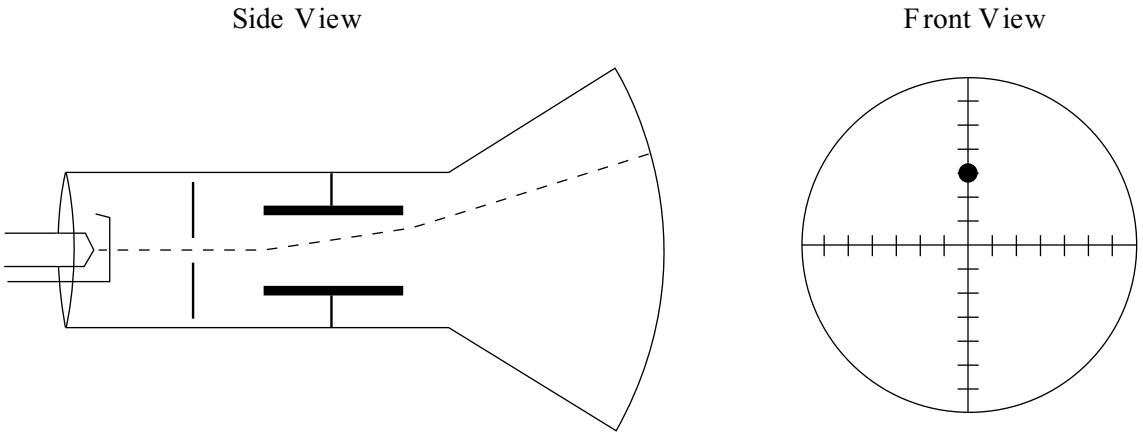
36. An electron, initially at rest, is accelerated through a potential difference of 600 V as shown.



What is the maximum kinetic energy of the electron?

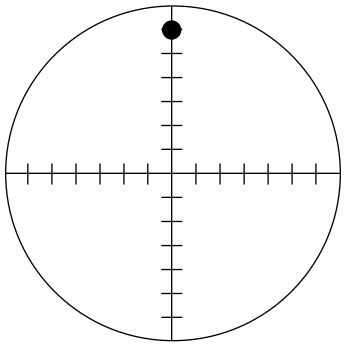
A. 3.7×10^{-31} J
B. 9.6×10^{-17} J
C. 6.0×10^{2} J
D. 1.4×10^{4} J

37. A cathode ray tube is adjusted so as to deflect the beam as shown.

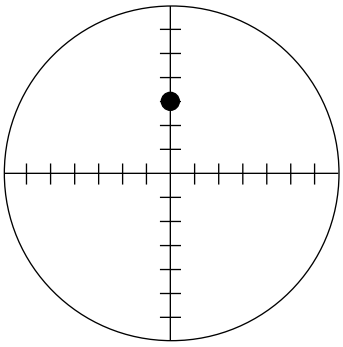


If the deflecting voltage is held constant and the accelerating voltage is then decreased , which diagram displays the new deflection?

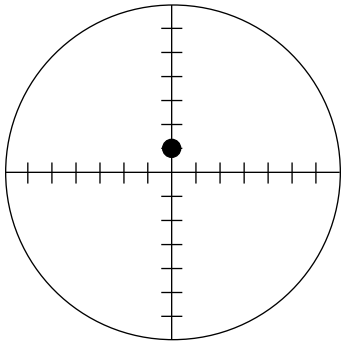
A.



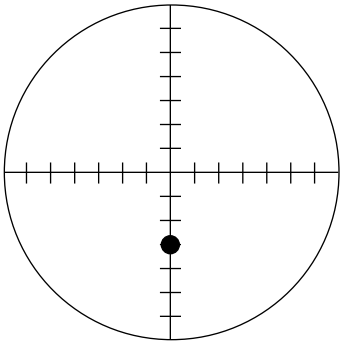
B.



C.



D.



38. A cathode ray tube beam deflects to the location as shown in Diagram I when a certain voltage is applied to the deflecting plates.

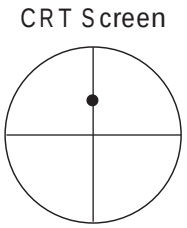


Diagram I

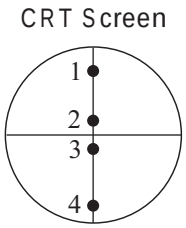
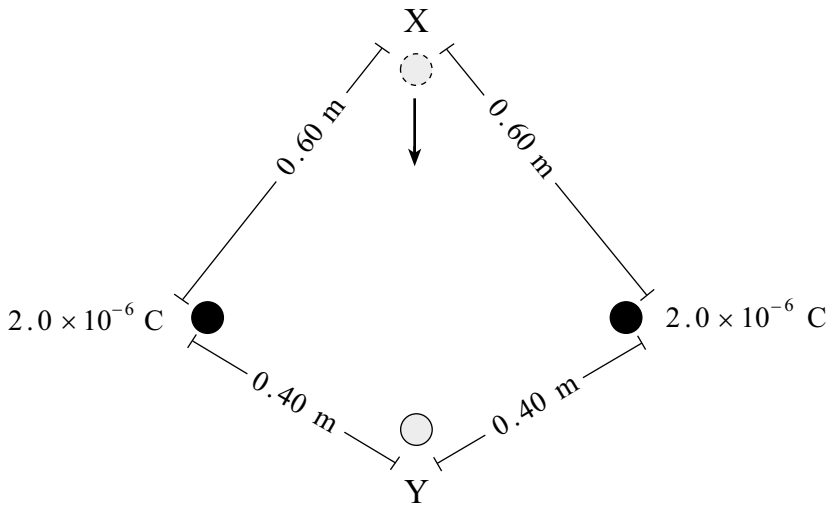


Diagram II

The connections to the deflecting plates are then **reversed** and the deflecting voltage is **reduced**. Which location in Diagram II best represents the new beam position?

A. Location 1
B. Location 2
C. Location 3
D. Location 4

39. Two 2.0×10^{-6} C charges are positioned as shown in the diagram below.



What work must be done to move a 1.2×10^{-7} C charge from location X to location Y?

A. 3.6×10^{-3} J
B. 1.5×10^{-2} J
C. 1.8×10^{-2} J
D. 3.9×10^{-2} J

40. An electron orbits the nucleus of an atom with velocity v. If this electron were to orbit the same nucleus with twice the previous orbital radius, its orbital velocity would now be

A. $\frac{v}{2}$

B. $\frac{v}{\sqrt{2}}$

C. v

D. 2v

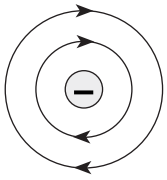
41. In a cathode ray tube,

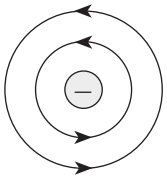
A. protons are accelerated from anode (positive) to cathode (negative).
B. protons are accelerated from cathode (negative) to anode (positive).
C. electrons are accelerated from anode (positive) to cathode (negative).
D. electrons are accelerated from cathode (negative) to anode (positive).

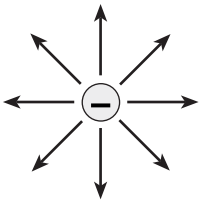
42. Which pair of values will cause the greatest deflection of an electron beam in a cathode ray tube?

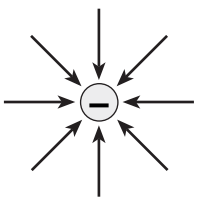
	ACCELERATING VOLTAGE	DEFLECTION (PLATE) VOLTAGE
A.	400 V	20 V
B.	400 V	40 V
C.	800 V	20 V
D.	800 V	40 V

43. Which diagram shows the electric field near a negative point charge?

A. 

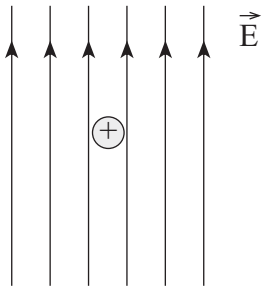
B. 

C. 

D. 

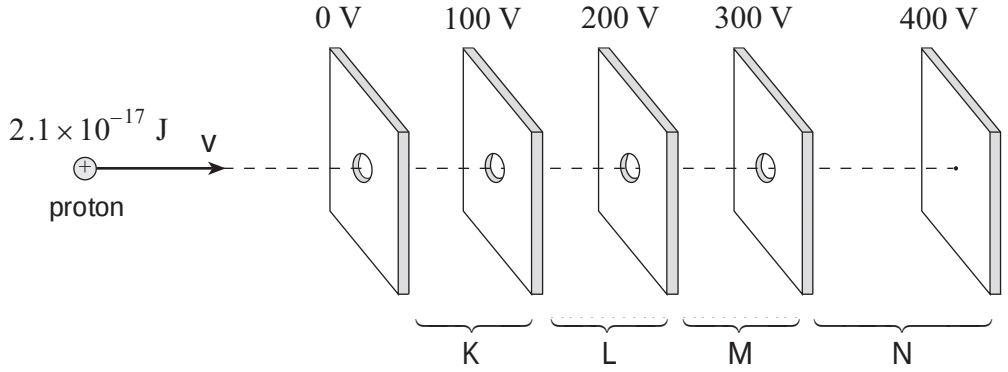
44. In an experiment, a positively charged oil droplet weighing 6.5×10^{-15} N is held stationary by a vertical electric field as shown in the diagram.

If the electric field strength is 5.3×10^{3} N/C, what is the charge on the oil droplet?



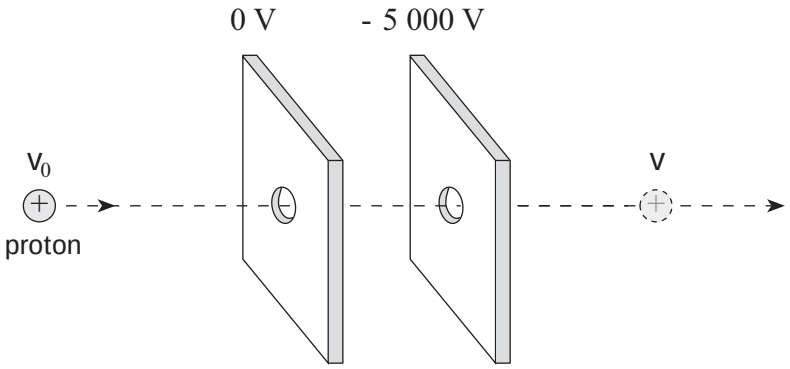
A. 1.2×10^{-18} C
B. 3.4×10^{-11} C
C. 4.1×10^{4} C
D. 8.2×10^{17} C

45. A proton with kinetic energy of 2.1×10^{-17} J is moving into a region of charged parallel plates. The proton will be stopped momentarily in what region?



A. Region K
B. Region L
C. Region M
D. Region N

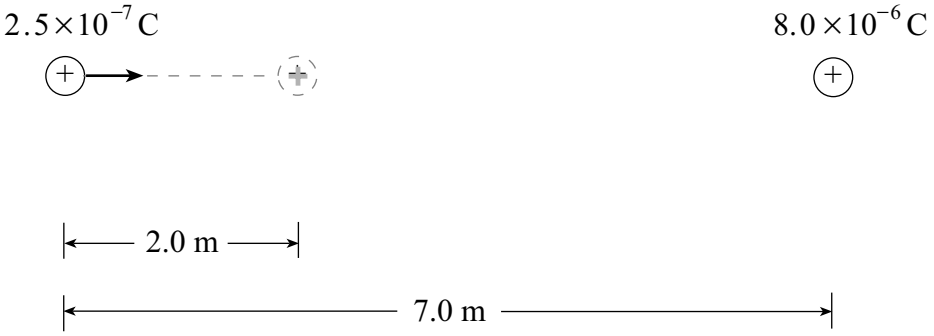
46. A moving proton has 6.4×10^{-16} J of kinetic energy. The proton is accelerated by a potential difference of 5 000 V between parallel plates.



The proton emerges from the parallel plates with what speed?

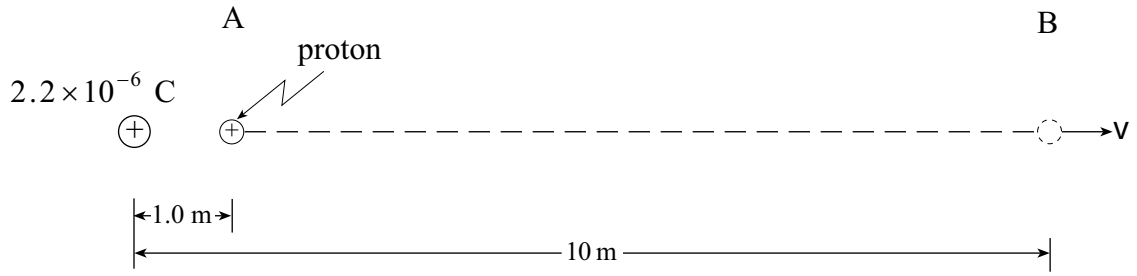
A. 8.8×10^{5} m/s
B. 9.8×10^{5} m/s
C. 1.3×10^{6} m/s
D. 1.8×10^{6} m/s

1. a) A $2.5\times10^{-7}\,\text{C}$ charge is initially located 7.0 m from a fixed $8.0\times10^{-6}\,\text{C}$ charge. What is the minimum amount of work required to move the $2.5\times10^{-7}\,\text{C}$ charge 2.0 m closer as shown? **(5 marks)**



b) If the 2.5×10^{-7} C charge is moved a further 2.0 m closer to the 8.0×10^{-6} C charge, will the additional work required be less than, the same as or greater than the work required in (a)? Using principles of physics, explain your answer. **(4 marks)**

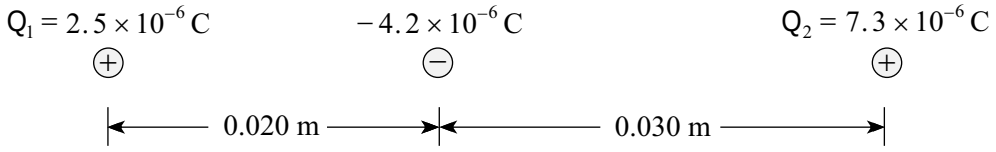
2. A proton is located at A, 1.0 m from a fixed $+2.2 \times 10^{-6}$C charge.



a) What is the change in potential energy of the proton as it moves to B, 10 m from the fixed charge? **(5 marks)**

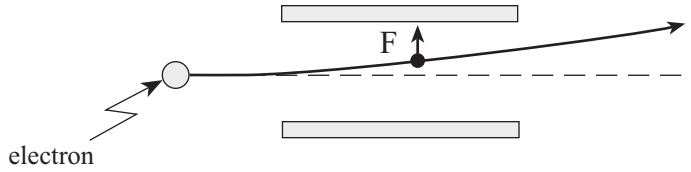
b) If the proton started from rest at A, what would be its speed at B? **(2 marks)**

3. A -4.2×10^{-6} C charge is placed between two stationary charges, Q_1 and Q_2, as shown below.



What is the magnitude and direction of the net force on the -4.2×10^{-6} C charge due to the **two** stationary charges? **(7 marks)**

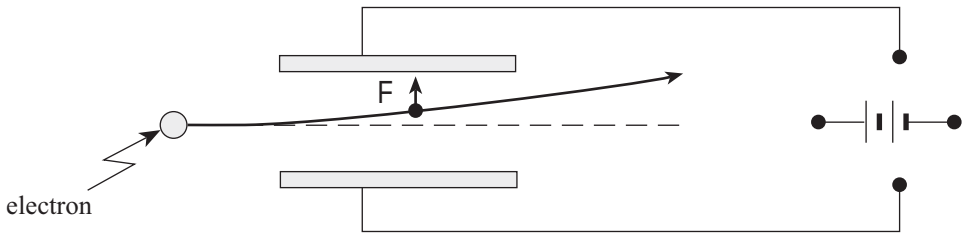
4. An electron passing between parallel plates 0.025 m apart experiences an upward electrostatic force of 5.1×10^{-16} N.



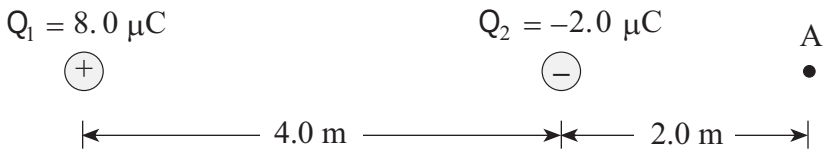
a) What is the magnitude of the electric field between the plates? **(3 marks)**

b) What is the potential difference between the plates? **(2 marks)**

c) On the diagram below draw in the connections to the power supply necessary for the electron to experience this upward force. **(2 marks)**



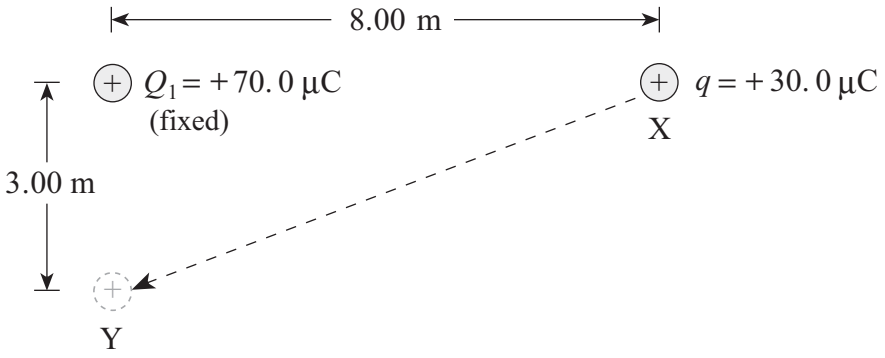
5. Two charges are positioned as shown in the diagram below.



a) Find the magnitude and direction of the electric field at A. (Note: $1.0\ \mu C = 1.0 \times 10^{-6}$ C)
(4 marks)

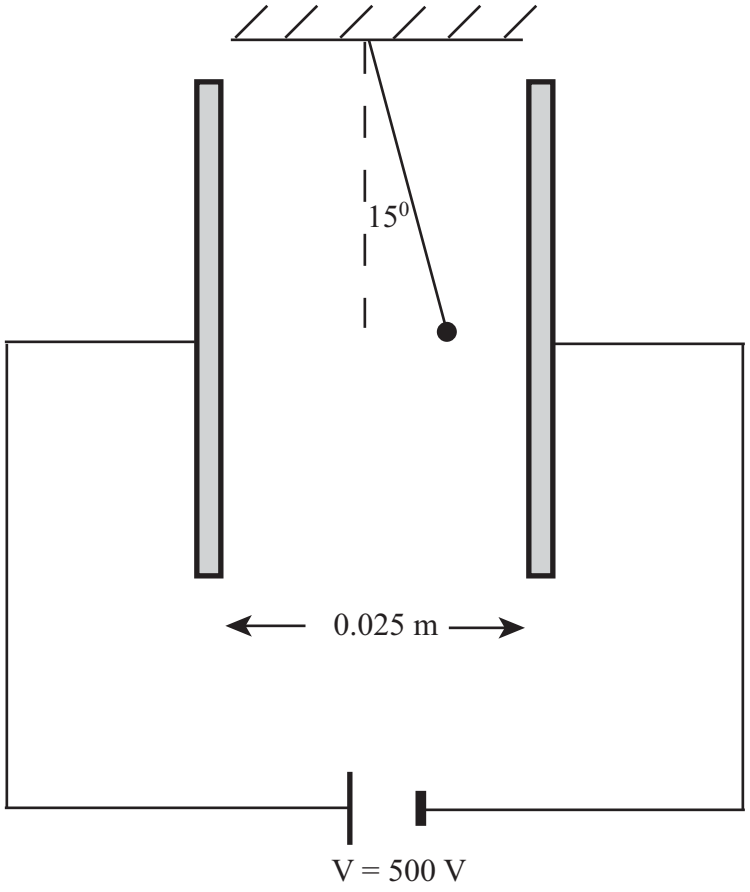
b) A charge placed at A experiences a force of 4.0×10^{-3} N towards the right. What are the magnitude and polarity of this charge? **(3 marks)**

6. A charge q of $30.0\ \mu C$ is moved from point X to point Y.



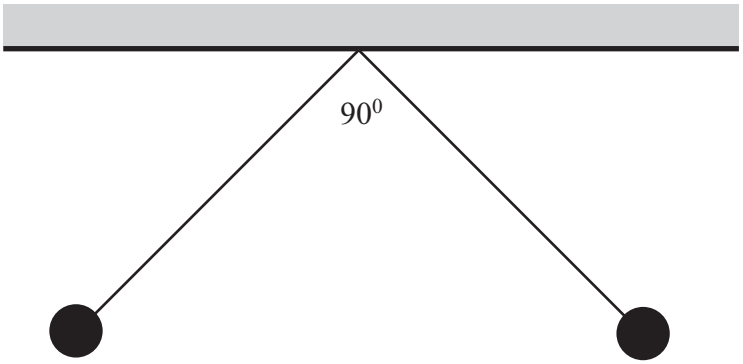
How much work is done on the $30.0\ \mu C$ charge? $\left(1\ \mu C = 1 \times 10^{-6}\ C\right)$ **(7 marks)**

7. A small 4.0×10^{-3} kg charged sphere is suspended by a light thread between parallel plates, as shown in the diagram below. When the plates are connected to a 500 V source, the thread makes a 15^0 angle with the vertical.

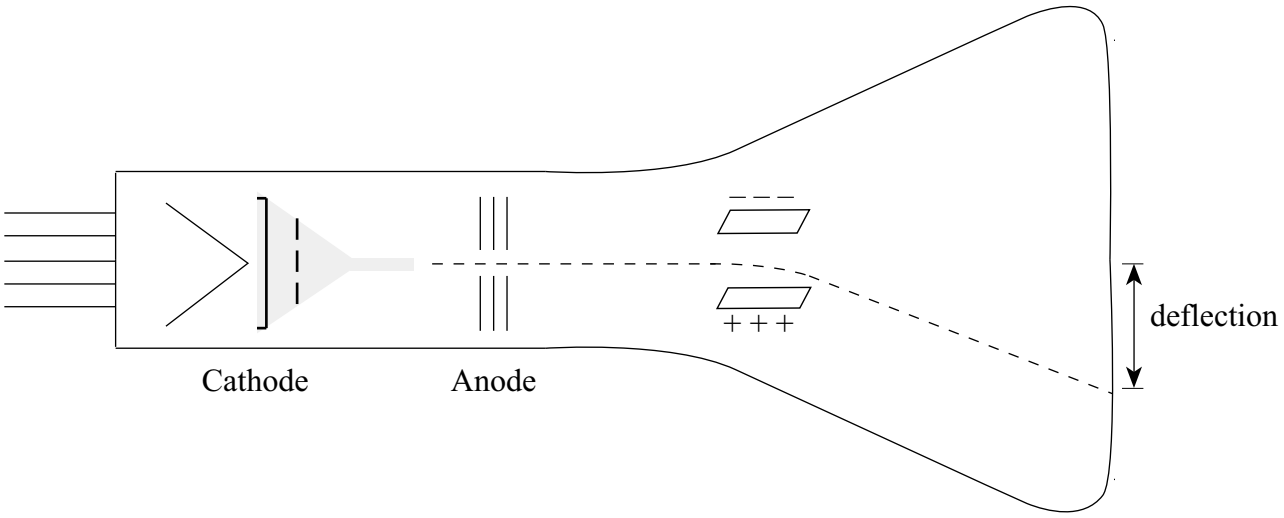


What is the charge on the sphere? **(9 marks)**

8. Two small, indentically-charged conducting spheres each of mass 2.5×10^{-4} kg hang from the same point on insulating threads of length 0.50 m as shown in the diagram below. If the enclosed angle between the threads is 90^0, what is the charge on each sphere? **(9 marks)**



9. In a cathode-ray tube, electrons are accelerated from the cathode towards the anode by an accelerating voltage V_a. After passing through the anode, the electrons are deflected by the two oppositely-charged parallel plates.



If the accelerating voltage V_a is increased, will the deflection increase, decrease, or remain the same? Using principles of physics, explain your answer. **(4 marks)**