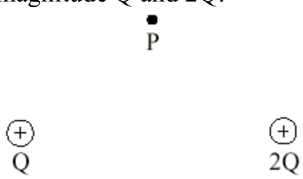
Unit 6: Electrostatics

Multiple Choice Portion

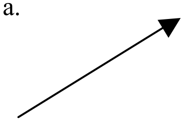
1. Which one of the following represents correct units for electric field strength?
   a. T
   b. N/C
   c. J / C
   d. N • m ^{2} • C^{-2}

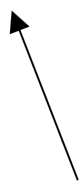
2. The flow of charge per unit time defines
   a. power.
   b. current.
   c. voltage.
   d. resistance.

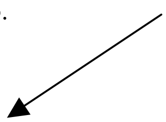
3. The diagram below shows two positive charges of magnitude Q and 2Q.

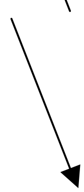


   Which vector best represents the direction of the electric field at point P, which is equidistant from both charges?

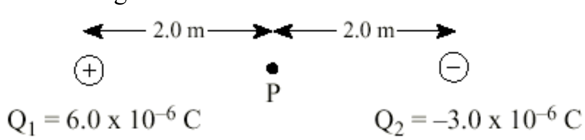
   a.


   c.


   b.


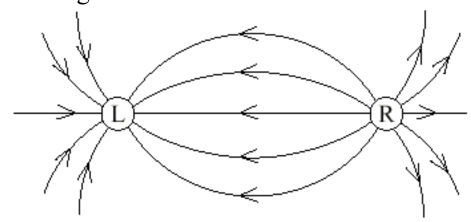
   d.


4. A 6.0 x 10 $^{-6}$ C charge is located 4.0 m from a –3.0 x 10 $^{-6}$ C charge.



   What is the electric potential at P, halfway between the charges?
   a. -4.1 x 10 $^{-2}$ V
   b. 6.8 x 10 ^{3} V
   c. 1.4 x 10 ^{4} V
   d. 4.1 x 10 ^{4} V

5. 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

6. The electric field 2.0 m from a point charge has a magnitude of 8. 0 x 10 ^{4} N/C. What is the strength of the electric field at a distance of 4.0 m?
   a. 2.0 x 10^4 N/C
   b. 4.0 x 10^4 N/C
   c. 1.6 x 10 ^{5} N/C
   d. 3.2 x 10 ^{5} N/C

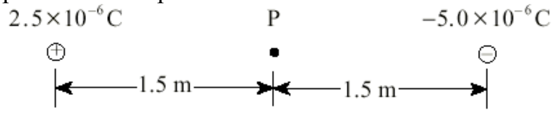
7. When a charge is accelerated through a potential difference of 500 V, its kinetic energy increases from 2.0 x 10 $^{-5}$ J to 6. 0 x 10 $^{-5}$ J. What is the magnitude of the charge?
   a. 4.0 x 10 $^{-8}$ C
   b. 8.0 x 10 $^{-8}$ C
   c. 1. 2 x 10 $^{-7}$ C
   d. 1. 6 x 10 $^{-7}$ C

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 x 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 x 10 $^{-7}$ C	Negative
b.	6.8 x 10 $^{-7}$ C	Positive
c.	1.2 x 10 $^{-6}$ C	Negative
d.	1.2 x 10 $^{-6}$ C	Positive

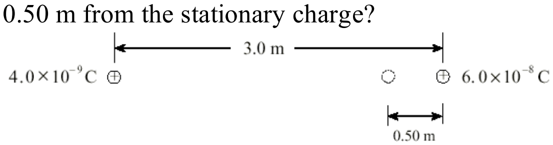
10. Two point charges, 2.5×10^{-6} C and -5.0×10^{-6} C , are placed 3.0 m apart as shown below.



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?

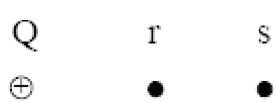


a. 6.0×10^{-7} J
b. 8.6×10^{-7} J
c. 3.6×10^{-6} J
d. 4.3×10^{-6} J

12. Two parallel plates 4.0×10^{-2} m apart have a potential difference of 1 000 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

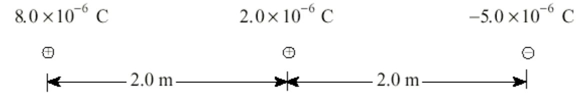
13. The diagram below shows a positive point charge Q.



Which of the following describes the magnitude and direction of the electric field at points r and s?

	Magnitude of field at r and s	Direction of field at r and s
a.	same	away from Q
b.	same	towards Q
c.	different	away from Q
d.	different	towards Q

14. A 2.0×10^{-6} C charge is located halfway between an 8.0×10^{-6} C charge and a -5.0×10^{-6} C charge as shown below.



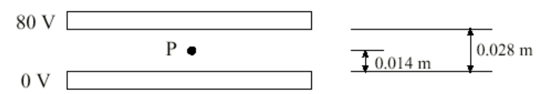
Find the net force on the 2.0×10^{-6} C charge.

a. 1.4×10^{-2} N towards the left
b. 1.4×10^{-2} N towards the right
c. 5.9×10^{-2} N towards the left
d. 5.9×10^{-2}N towards the right

15. 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

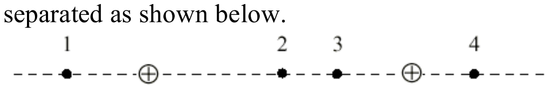
16. Two long, parallel plates are separated by 0.028 m and have a potential difference between them of 80 V, as shown below.



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

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



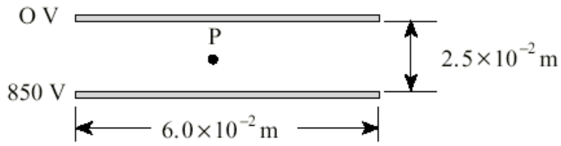
In which location would the electric field strength be zero?

a. 1
b. 2
c. 3
d. 4

18. 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

19. Two parallel plates 6. 0 x 10^{-2} m long are separated by 2.5 x10^{-2} m and have a potential difference of 850 V. Point P is located midway between the two plates as shown below.



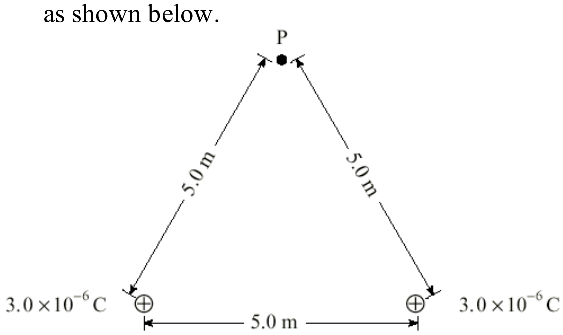
What is the magnitude of the electric field at point P?

a. 1. 4 x 10^{4} V/ m
b. 1. 7 x 10^{4} V/ m
c. 3.4 x 10^{4} V/ m
d. 6.8 x 10^{4} V/ m

20. A particle with a charge of 2. 4 x 10^{-5} C is accelerated from rest through a potential difference of 6.2 x 10^{4} V. If the final speed of this particle is 9.3 x 10^{3} m/s, what is the mass of the particle?

a. 7.7 x 10^{-10} kg
b. 5.2 x 10^{-9} kg
c. 3.4 x 10^{-8} kg
d. 1.5 x 10^{-1} kg

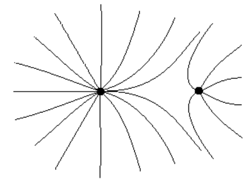
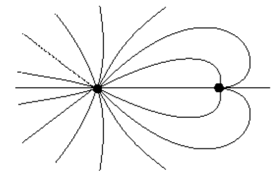
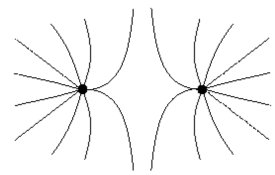
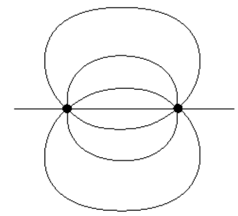
21. Two 3. 0 x 10^{-6} C point charges are placed 5.0 m apart as shown below.



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

a. 0 V
b. 5.4 x 10^{3} V
c. 7.6 x 10^{3} V
d. 1.1 x 10^{4} V

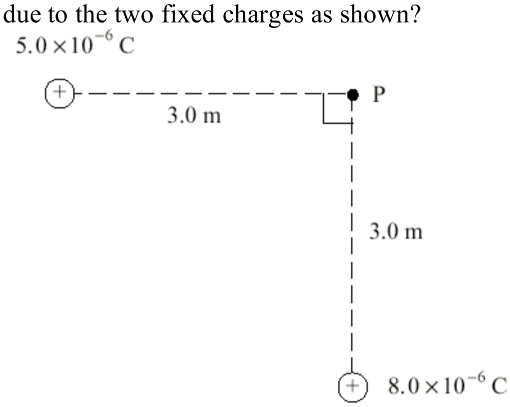
22. Which of the following diagrams shows the electric field in the region of two equal but opposite point charges?

a. 
c. 
b. 
d. 

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

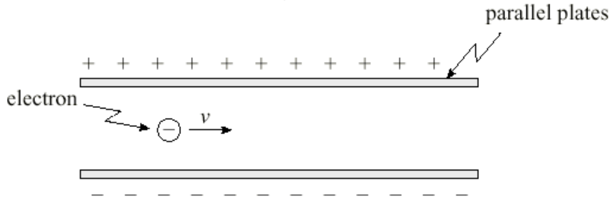
a. 1.1 x 10^{-12} N
b. 4.5 x 10^{-12} N
c. 7. 2 x 10^{-11} N
d. 2.9 x 10^{-10} N

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



a. 3.0 x 10^{3} N/C
b. 1.3 x 10^{4} N/C
c. 9.4 x 10^{3} N/C
d. 3.9 x 10^{4} N/C

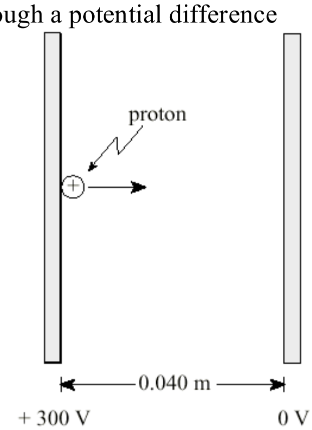
25. An electron is travelling in an electric field as shown.



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

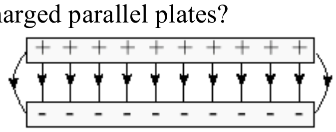
	MAGNITUDE OF FORCE	DIRECTION OF FORCE
a.	Changing	Upward
b.	Changing	Downward
c.	Constant	Upward
d.	Constant	Downward

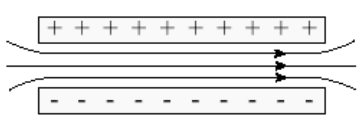
26. A proton initially at rest is accelerated between parallel plates through a potential difference

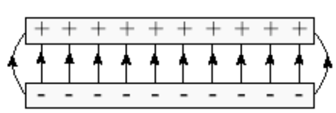


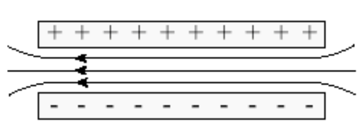
What is the maximum speed attained by the proton?
a. 7.5×10^{3} m/s
b. 1.7×10^{5} m/s
c. 2.4×10^{5} m/s
d. 1.2×10^{6} m/s

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

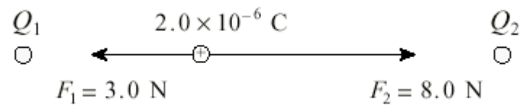

a.


b.


c.

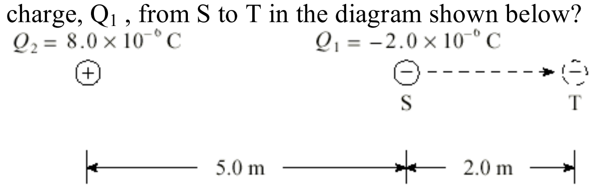

d.

28. 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

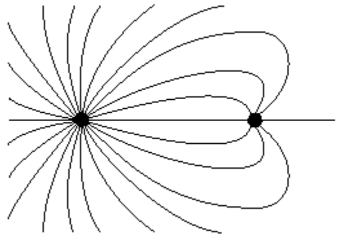
29. How much work is done moving the -2.0×10^{-6} C charge, Q_1 , from S to T in the diagram shown below?



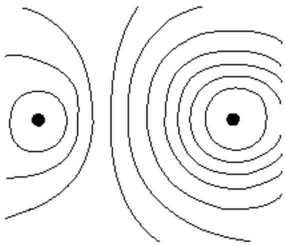
a. 5.6×10^{-3} J
b. 8.2×10^{-3} J
c. 1.2×10^{-2} J
d. 7.2×10^{-2} J

30. 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

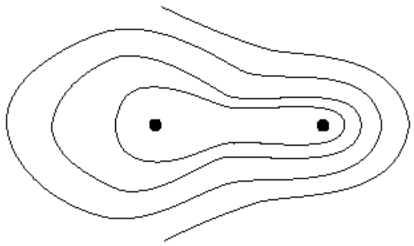
31. Which of the following shows the electric field between two opposite charges of unequal magnitude?



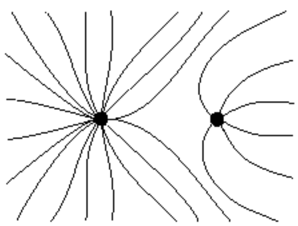
a.



b.

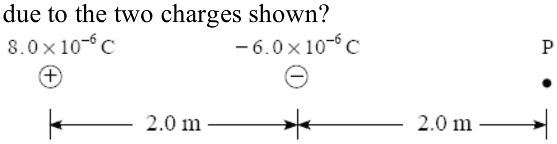


c.



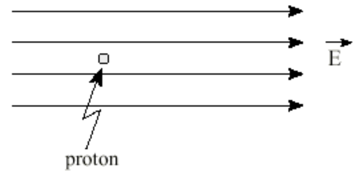
d.

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



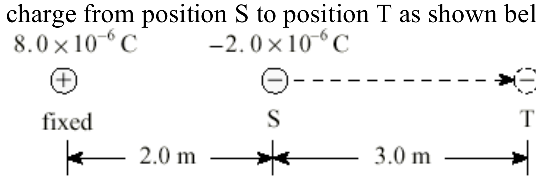
a. 4.5×10^{3} N/C
b. 9.0×10^{3} N/C
c. 1.4×10^{4} N/C
d. 1.8×10^{4} N/C

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



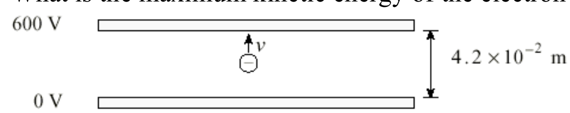
	MAGNITUDE OF ACCELERATION	DIRECTION OF ACCELERATION
a.	2.4×10^{13} m/s^2	Right
b.	2.4×10^{13} m/s^2	Left
c.	1.5×10^{32} m/s^2	Right
d.	1.5×10^{32}m/s^2	Left

34. 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

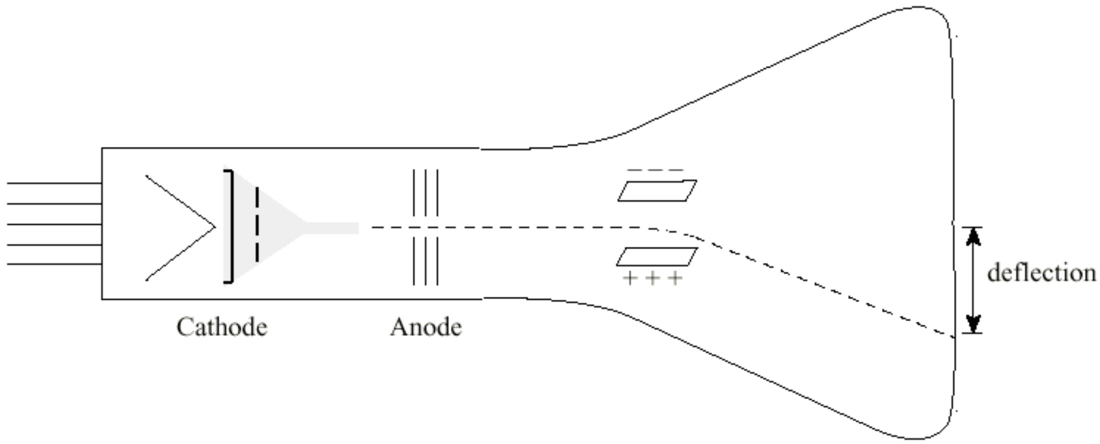
35. An electron, initially at rest, is accelerated through a potential difference of 600 V as shown.
What is the maximum kinetic energy of the electron?



a. 3.7×10^{-31} J
b. 9.6×10^{-17} J
c. 6.0×10^{2} J
d. 1.4×10^{4} J

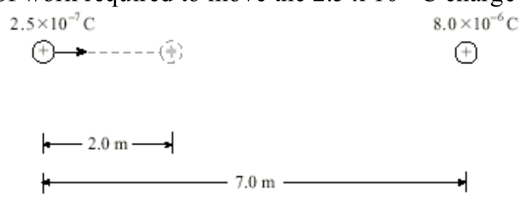
Written Response

1. 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.



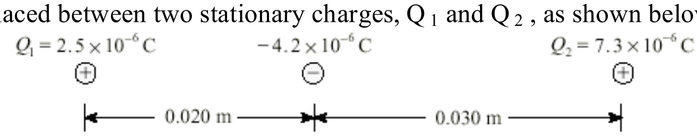
If the accelerating voltage V_a is increased, will the deflection increase, decrease, or remain the same? Using principles of physics, explain your answer.

2. A 2.5×10^{-7} C charge is initially located 7.0 m from a fixed 8.0×10^{-6} C charge.
   a. What is the minimum amount of work required to move the 2.5×10^{-7} C charge 2.0 m closer as shown?



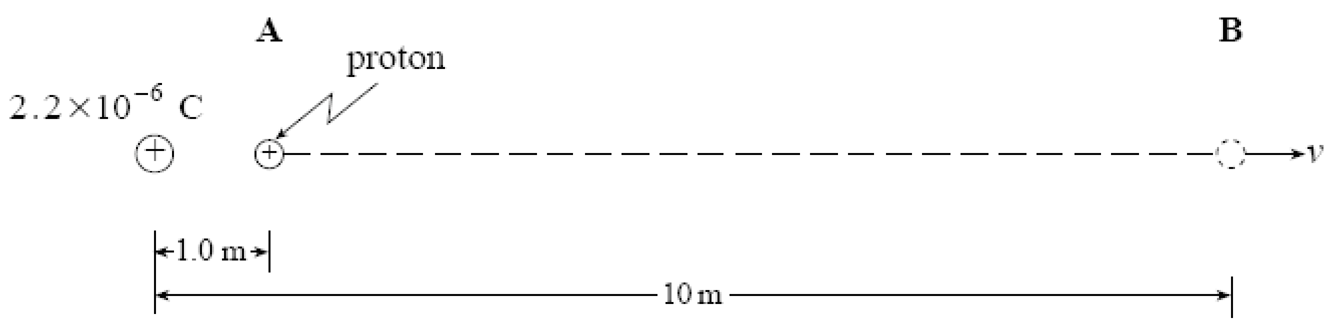
   b. If the 2.5×10^{-7} C charge is moved a further 2.0 m closer to the 8.0×10^{-6} C charge, will the additional work required be less than, the same as or greater than the work required in (a)? Using principles of physics, explain your answer.

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



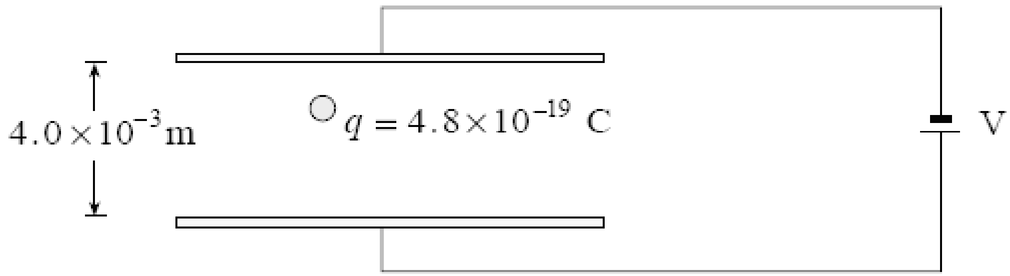
What is the magnitude and direction of the net force on the -4.2×10^{-6} C charge due to the two stationary charges?

4. 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?
   b. If the proton started from rest at **A**, what would be its speed at **B**?

5. The diagram shows a small sphere of mass 1.5×10^{-14} kg held in equilibrium between two parallel plates by electrostatic and gravitational forces.



If the plates are 4.0×10^{-3} m apart and the sphere carries a charge of magnitude 4.8×10^{-19} C, what is the potential difference V between the plates?

Answer to Electrostatics Study Pack:

Part 1: Multiple Choice

1. b	8. c	15. b	22. d	29. b
2. b	9. a	16. b	23. a	30. c
3. c	10. d	17. b	24. c	31. a
4. c	11. c	18. c	25. c	32. b
5. c	12. c	19. c	26. c	33. a
6. a	13. c	20. c	27. a	34. a
7. b	14. d	21. d	28. a	35. b

Part 2: Written Response

1. The deflection y will decrease. If V_a is increased, the electrons are given a greater kinetic energy: e.g., $V_a = E_k \div q$. Hence, the electrons are moving faster, so they spend less time between the plates. A force accelerates the electrons transversely between the plates; however, as the acceleration occurs for a shorter time, their deflection is reduced; e.g., $y = \frac{1}{2}at^2$.

2a.

$$W = \frac{kQ_1Q_2}{5} - \frac{kQ_1Q_2}{7}$$
$$W = 0.0036 - 0.0026$$
$$W = 1.0 \times 10^{-3}\ \text{J}$$

or

$$W = q\Delta V$$
$$W = q\left(\frac{kQ}{5} - \frac{kQ}{7}\right)$$
$$W = 2.5 \times 10^{-7}\left(\frac{kQ}{5} - \frac{kQ}{7}\right)$$
$$W = 1.0 \times 10^{-3}\ \text{J}$$

b. The work required will be greater than in (a). The force acting on the 2.5×10^{-7} C charge is greater, therefore the work required to move the same distance will also be greater.

3. $F_{net} = F_1 + F_2$

$$F_1 = \frac{kQ_1Q_2}{R^2} = \frac{(9.00 \times 10^9) \times (2.5 \times 10^{-6}) \times (-4.2 \times 10^{-6})\ C}{(0.02)^2} = -236.25\ \text{N (left)}$$

$$F_2 = \frac{kQ_1Q_2}{R^2} = \frac{(9.00 \times 10^9) \times (7.3 \times 10^{-6}) \times (-4.2 \times 10^{-6})\ C}{(0.030)^2} = -306.6\ \text{N (right)}$$

Therefore, $F_{net} = 306.6 - 236.25 = 70$ N (right)

4a. $\Delta Ep = -2.9 \times 10^{-15}$ J
b. $v = 1.9 \times 10^6$ m/s

5. $V = 1.2 \times 10^3$ V

