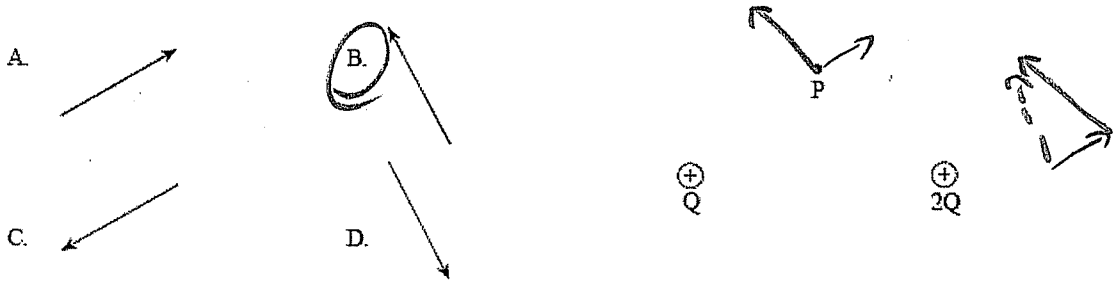
NAME: Key

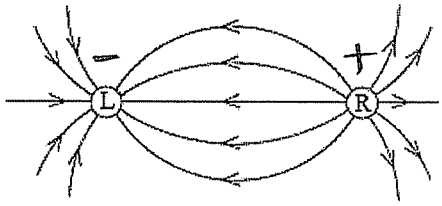
Electrostatics Review

1. 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?



2. 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

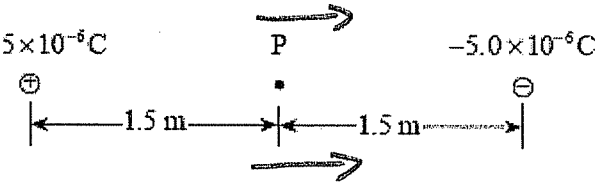


3. The electric field 2.0 m from a point charge has a magnitude of 8.0×10^4 N/C. What is the strength of the electric field at a distance of 4.0 m?

$E = \frac{kQ}{r^2} = 8\times10^4 N/C$ $\quad E = \frac{kQ}{(2r)^2} = \frac{kQ}{4r^2}$ So $\frac{1}{4}$ $\quad E = 2.0\times10^4 N/C$

4. 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?

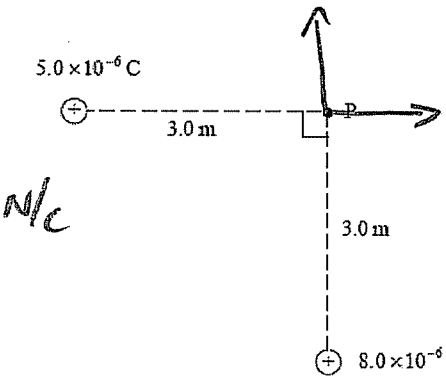
Both produce E to the right



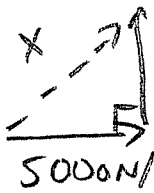
$E = \frac{kQ_1}{r_1^2} + \frac{kQ_2}{r_2^2} = 10\,000 + 20\,000$

$= 30,000$ N/C

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



$E = \frac{kQ}{r^2}$



$X = 9434$ N/C

6. 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?

– same sign

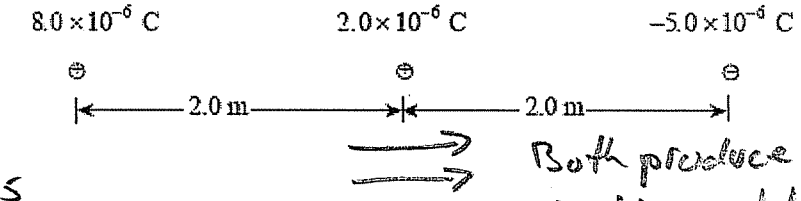
	MAGNITUDE	POLARITY
A	6.8×10^{-7} C	Negative
B.	6.8×10^{-7} C	Positive
C.	1.2×10^{-6} C	Negative
D.	1.2×10^{-6} C	Positive

$$F = \frac{kQ_1Q_2}{r^2}$$

$$0.35N = \frac{(9\times10^9)(-2.3\times10^{-6})(Q_2)}{.2^2}$$

7. 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



Both produce F to the right

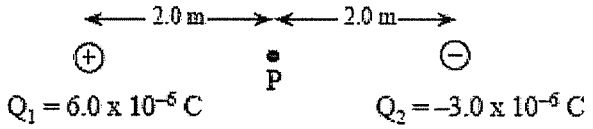
$F = F_1 + F_2 = .036 + .0225$

$= .0585\,N$

8. 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

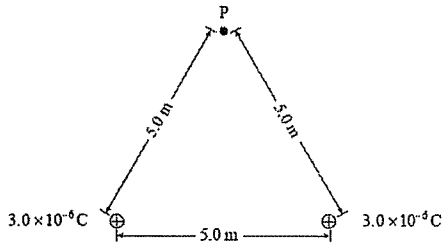
$$V = \frac{kQ_1}{r_1} + \frac{kQ_2}{r_2}$$



$= 27000 - 13500$

$= 13500\,V$

9. Two 3.0×10^{-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?



$V = V_1 + V_2$

$V = \frac{kQ}{r}$

$= 5400 + 5400$

$= 10800\,V$

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

$$E_p = \frac{kQ_1Q_2}{r^2} = \frac{(9\times10^9)(1.6\times10^{-19})(-1.6\times10^{-19})}{(5.3\times10^{-11}m)^2} = -4.3\times10^{-18}\,J$$

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

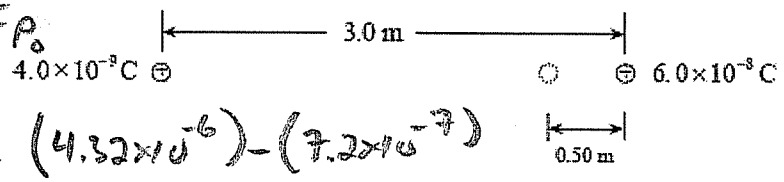
$\Delta E_p = V \cdot Q = \Delta E_K = \frac{1}{2} m v^2$

$= (6.2 \times 10^4 V)(2.4 \times 10^{-5} C) = \frac{1}{2} m (9.3 \times 10^3)^2, \quad m = 3.4 \times 10^{-8} kg$

12. 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

$W = \Delta E_p = E_{p_f} - E_{p_i}$



$\frac{KQ_1Q_2}{0.5m} - \frac{KQ_1Q_2}{3.0m} = (4.32 \times 10^{-6}) - (7.2 \times 10^{-7})$

$= 3.6 \times 10^{-6}$ J

13. 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?

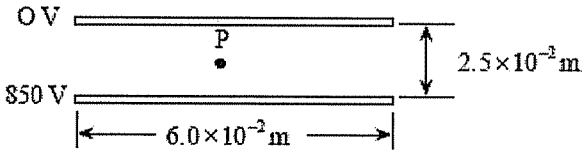
$\Delta E_p = Q \Delta V$

$Q = \frac{\Delta E_p}{\Delta V} = \frac{4.0 \times 10^{-5} J}{500 V} = 8 \times 10^{-8} C$

14. Two parallel plates 6.0×10^{-2}m long are separated by 2.5×10^{-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**?

$E = \frac{V}{d} = \frac{850 V}{2.5 \times 10^{-2} m}$

$= 3.4 \times 10^4$ V/m



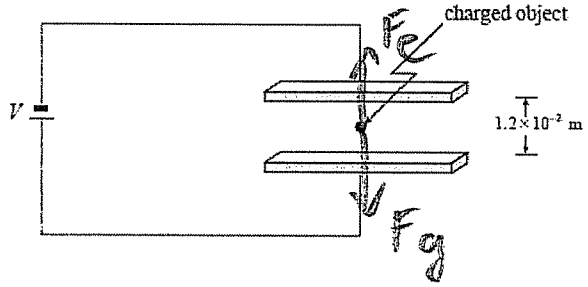
15. An object with a charge of $+ 4.0 \times 10^{-18}$ C and a mass of 1.1×10^{-15} kg is held stationary by balanced gravitational and electric forces midway between horizontal charged plates as shown. What is the applied voltage *V*?

$F_g = F_e$

$mg = E \cdot Q$

$mg = \left(\frac{V}{d}\right) Q$

$V = 32.3 V$



16. 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

proton – more mass, less velocity

Same charge – same $\Delta E = V \cdot Q$

17. 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?

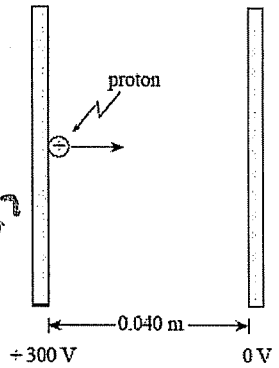
A. 7.5×10^3 m/s
B. 1.7×10^5 m/s
(C.) 2.4×10^5 m/s
D. 1.2×10^6 m/s

m, Q

$\Delta E_p = Q \cdot \Delta V = \Delta E_K = \frac{1}{2} m v^2$

$= (1.6 \times 10^{-19} C)(300) = \frac{1}{2}(1.67 \times 10^{-27}) v^2$

$V = 2.4 \times 10^5$ m/s



Enrichment

18. 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?

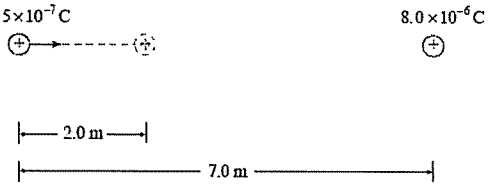
	Magnitude of field at r and s	Direction of field at r and s
A.	same	away from Q
B.	same	towards Q
(C.)	different	away from Q
D.	different	towards Q

19.

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

$W = \Delta E = E_{p_f} - E_{p_0}$

$\frac{kQ_1Q_2}{5m} - \frac{kQ_1Q_2}{7m} = 0.0015$



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.

as d gets smaller W increases.

20. 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?

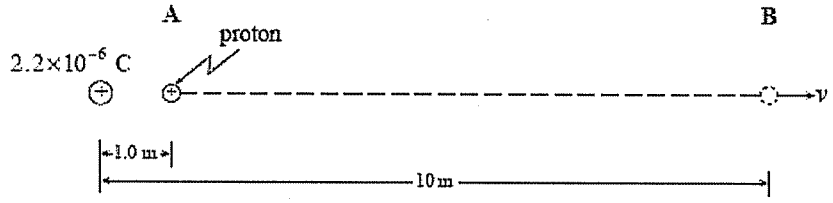
$F_e = F_g$ $\quad EQ = mg$ $\quad E = \frac{mg}{Q} = 5.58\times10^{-11}\ N/C$

21. 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?

$E_p = Q \cdot \Delta V$

$= (2.5C)(63V) = 158\ J$

22. A proton is located at **A,** 1.0 m from a fixed $+2.2\times10^{-6}$ C charge.



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

m, Q

$\Delta E_p = Q\Delta V = Q(V_f - V_0)$

$= Q\left(\frac{kQ_1}{10m} - \frac{kQ_1}{1m}\right) = -2.9\times10^{-5}\ J$

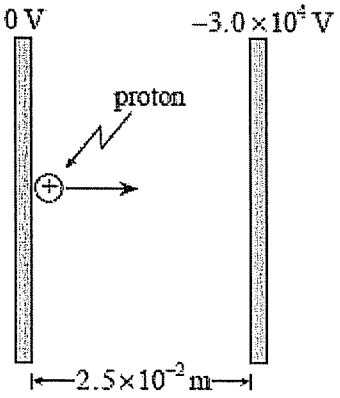
b) If the proton started from rest at **A,** what would be its speed at **B**?

$\Delta E_p = \Delta E_K = \frac{1}{2}mv^2$, $v = 1.9\times10^6\ m/s$

23. A proton is accelerated from rest between parallel plates with a potential difference of 3.0×10^4 V. What is the maximum speed of the proton?

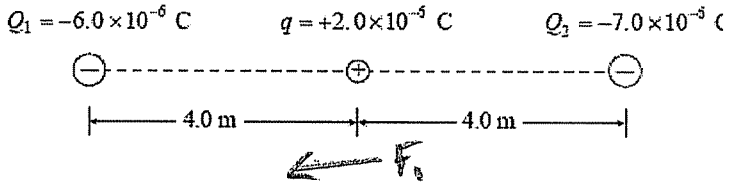
A. 1.3×10^1 m/s
B. 3.8×10^5 m/s
C. 2.4×10^6 m/s
D. 1.5×10^7 m/s

$\Delta E_p = Q\Delta V = \Delta E_K = \frac{1}{2}mv^2$



24. What are the magnitude and direction of the electric force on the $+2.0\times10^{-6}$ 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



$F_1 = 6.75\times10^{-3}\ N$ (left), $F_2 = 7.88\times10^{-3}\ N$ (right)

$F = 1.1\times10^{-3}\ N$ right

Answers:

1. B
2. C
3. 2.0×10^4 N/C
4. 3.0×10^4 N/C
5. 9.4×10^3 N/C
6. A
7. D
8. C
9. 1.1×10^4 V
10. -4.3×10^{-18} J
11. 3.4×10^{-8} kg
12. C
13. 8.0×10^{-8} C
14. 3.4×10^4 V/m
15. 32 V
16. C
17. C
18. C
19. $1.0X10^{-3}$ J, greater
20. 5.6×10^{-11} N/C
21. 160 J
22. $-2.9X10^{-15}$ J, $1.9X10^6$ m/s
23. C
24. B