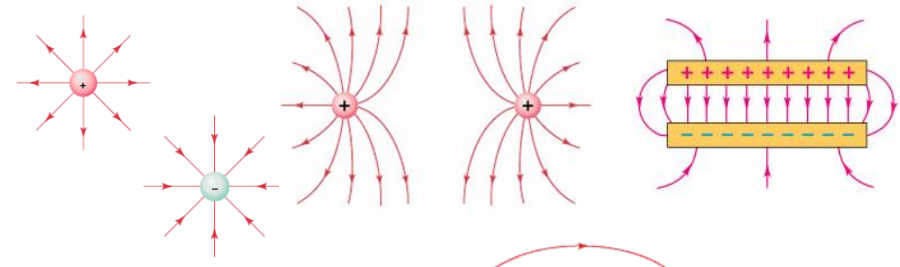
Name: _____Answer Key_____ Date: _____
Honors Physics Test #9 Review

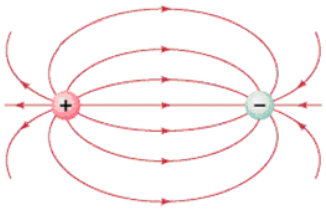
Electrostatics

1. Read Chapter 17

2. Terms to know: electrostatics, neutral, positively charged, negatively charged, insulators, conductors, electroscope, charging by conduction, charging by induction, Coulomb's Law, electrostatic force, coulomb, elementary charge, ion, conservation of charge, electric field, electric potential difference, voltage, volt, grounding, leakage, capacitance

3. When a rubber rod and fur are rubbed together, what is the charge that each acquires? Why?
   Rod is negative (gained electrons), Fur is positive (lost electrons)
4. When a plastic strip and silk are rubbed together, what is the charge that each acquires? Why?
   Plastic is positive (lost electrons), Silk is negative (gained electrons)
5. How is an object charged by conduction? What charge does it acquire?
   Conduction is charging through direct contact and transfer of electrons. Same charge as charging object.
6. How is an object charged by induction? What charge does it acquire?
   Induce charge separation and then ground it. Opposite charge of charging object
7. How does the electrostatic force between two charges change if
   a. the distance between them is doubled? $1/4^{th}$ the size
   b. one charge is doubled? Doubles
   c. both charges are doubled? Quadruples
   d. the distance between them is halved? Quadruples
8. What is a neutral atom? A Positive ion? A negative ion?
   Nuetrual = no charge Postive = loss of electrons Negative = extra electrons
9. What is the difference between an insulator and a conductor?
   Conductors allow charge flow Insulators prevent charge flow
10. Draw the electric field lines around:
    e. A single positive charge
    f. A single negative charge
    g. Two like charges
    h. Two unlike charges
    i. Two parallel plates

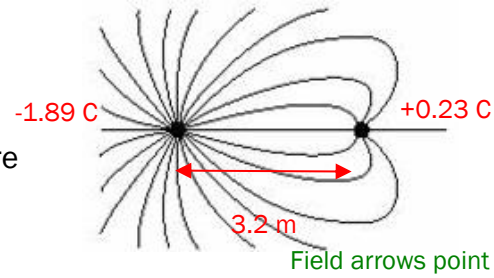




11. How is the direction of an electric field defined?
    From the positive to the negative
12. What is the charge on an electron? A proton?
    ---- 1.6×10^{-19} C + 1.6×10^{-19} C
13. How many electrons are there in a coulomb?
    6.25×10^{18}
14. How does the electric field strength change as you move further away from the charged object creating the field?
    It decreases as you move away
15. How does the electric field strength change as you move from one parallel plate to the other?
    It remains the same – it is constant between two parallel plates
16. What does the conservation of electric charge principal mean? Charge can never be lost or gained

Directions: Read each question carefully and record your answers in the space provided. Be sure to show all work! Answers should be in significant figures. You will be graded on proper use of the GUESS method. **These will be the same directions on the test. Practice the GUESS method now.**

17. Two identical metal spheres are charged as shown.



Field arrows point from positive to negative (right to left)

a. Sketch the electric field created by the spheres

b. What is the electrostatic force that the positive sphere exerts on the negative sphere?

$$F_e = \frac{kq_1q_2}{r^2} = \frac{8.99\times10^9 \frac{N\cdot m^2}{C^2}(1.89C)(0.23C)}{(3.2m)^2} = 3.8\times10^8 N \text{ right}$$

c. If the distance is doubled between the spheres, what will happen to the force?

$F_e = \frac{kq_1q_2}{r^2} = \frac{1\cdot1\cdot1}{(2)^2}$ It will be cut in fourth: 9.5 x 10^7 N

d. How many excess electrons does the negative sphere have?

$$-1.89C\left(\frac{1e}{-1.60\times10^{-19}C}\right) = 1.18\times10^{19} \text{ electrons}$$

e. If the two spheres are brought into contact with each other and then separated, what is the final charge on each sphere?

$$q_{each} = \frac{q_{total}}{\#}$$
$$\frac{-1.89C + 0.23C}{2}$$
$$= -0.83C$$

The total charge is split between them.

18. How much work is necessary to move an electron between two oppositely charged parallel plates that have a potential difference of 7.0 V?

$$W = Vq = (7.0V)(1.60\times10^{-19}C) = {}^{+}1.1\times10^{-18} J$$

Positive because force and movement are in the same direction

19. In an experiment, moving a charge through an electric field requires 10.5 eV of work. How much work is this in joules?

$$10.5eV\left(\frac{1.60\times10^{-19} J}{1eV}\right) = {}^{+}1.68\times10^{-18} J$$

Conversion factor is listed on reference tables

20. A balloon is rubbed with fur and receives a charge of -4.3 x 10^{-6} C. How many excess electrons are on the surface of the balloon?

$$-4.3\times10^{-6}C\left(\frac{1e}{-1.60\times10^{-19}C}\right) = 2.7\times10^{13} \text{ electrons}$$

Conversion factor is listed on reference tables

21. What is the strength of the electric field at a distance of 4.2 x 10^{-9} meter away from a proton? How much force would be exerted on an electron placed at this spot?

E field leaves a +, proton

Honors Equation

$$E = \frac{kq}{r^2} = \frac{(8.99\times10^{9}\ \frac{N\cdot m^2}{C^2})(1.60\times10^{-19}C)}{(4.2\times10^{-9}m)^2} = 8.2\times10^{7}\ \frac{N}{C}\ \text{out of +}$$

Proton and electron attract

$$F = Eq = (8.2\times10^{7}\ \tfrac{N}{C})(1.60\times10^{-19}C) = 1.3\times10^{-11}N\ \text{attractive}$$

22. Two large, charged parallel plates are 5.0 cm apart. The magnitude of the electric field between the plates is 485 N/C.

a. What is the electric potential difference between the plates?

Honors Equation

$$V = Ed = (485\ \tfrac{N}{C})(0.050\ m) = 24\ V$$

b. What work will you do to move a charge equal to that of one proton from the negative to the positive plate?

$$W = qV = (1.60\times10^{-19}C)(24\ V) = {}^{+}3.8\times10^{-18}J$$

Positive because force and movement are in the same direction

23. An electron experiences a force of 2.8 x 10^{-4} N in an electric field. What is the magnitude of the electric field at this point?

$$E = \frac{F}{q} = \frac{2.8\times10^{-4}N}{1.60\times10^{-19}C} = 1.8\times10^{15}\ \frac{N}{C}$$

"Magnitude of..." means no direction

24. A 12.0 volt battery is connected to a 6.0 picofarad parallel plate capacitor. Calculate the charge on each plate.

Honors Equation

$$Q = CV = (6.0\times10^{-12}F)(12.0V) = 7.2\times10^{-11}C$$

25. An electron and a proton are 0.25 meter apart and left to float in deep space where the effects of gravity from other objects are negligible.

a. Calculate the electrostatic force they exert on each other.

Proton and electron attract

$$F_e = \frac{kq_1q_2}{r^2} = \frac{8.99\times10^{9}\ \frac{N\cdot m^2}{C^2}(1.60\times10^{-19}C)(1.60\times10^{-19}C)}{(0.25m)^2} = 3.7\times10^{-27}N\ \text{attract}$$

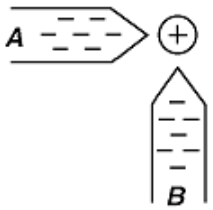
b. Calculate the gravitational force they exert on each other.

Gravity is ALWAYS attractive

$$F_G = \frac{Gm_1m_2}{r^2} = \frac{6.67\times10^{-11}\ \frac{N\cdot m^2}{kg^2}(9.11\times10^{-31}kg)(1.67\times10^{-27}kg)}{(0.25m)^2} = 1.62\times10^{-66}N\ \text{attract}$$

Mass of each listed on reference table

26. Two plastic rods, A and B, each possess a net negative charge of 1.0 x 10^{-3} coulomb. The rods and a positively charged sphere are positioned as shown below.



The sphere is attracted to both – down and left add up to choice B

Which vector *best* represents the resultant electrostatic force on the sphere?

A) 

B) 

C) 

D) 

27. Two identical spheres carry charges of + 0.6 coulomb and – 0.2 coulomb, respectively. If these spheres touch, the resulting charge on the first sphere will be

(A) + 0.2 C (B) + 0.4 C (C) + 0.8 C (D) – 0.3 C

$$q = \frac{q_{tot}}{\#} = \frac{^{+}0.6C + ^{-}0.2C}{2}$$

28. What is the magnitude of the electrostatic force experienced by <u>one elementary charge</u> at a point in an electric field where the electric field intensity is 3.0 x 10^{3} newtons per coulomb?

(A) 1.6 x 10^{-19} N (B) 4.8 x 10^{-16} N (C) 3.0 x 10^{3} N (D) 1.0 x 10^{3} N

$$F_e = Eq$$
$$F_e = (3.0\times10^{3}\,\tfrac{N}{C})(1.60\times10^{-19}C)$$

29. An object with +10 elementary charges is grounded and becomes neutral. What is the best explanation for this occurrence?

(A) The object gained 10 protons from the ground.
(B) The object gained 10 electrons from the ground.
(C) The object lost 10 electrons to the ground.
(D) The object lost 10 protons to the ground.

The object has a positive charge and needs to gain electrons to become grounded/neutral

30. If 15 joules of work is required to move 3.0 coulombs of charge between two points, the potential difference between these two points is

(A) 15 V (B) 3.0 V (C) 45 V (D) 5.0 V

$$V = \frac{W}{q} = \frac{15J}{3.0C}$$

31. A <u>neutral</u> atom must contain equal numbers of

(A) protons, neutrons, and electrons
(B) protons and electrons, only
(C) protons and neutrons, only
(D) electrons and neutrons, only

Total charge must be zero

32. What is the net static electric charge on a metal sphere having an excess of +3 elementary charges?

(A) 4.8 x 10^{19} C (B) 1.6 x 10^{-19} C (C) 4.8 x 10^{-19} C (D) 3.0 x 10^{0} C

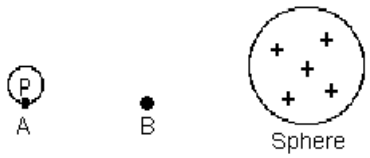
$$3e\left(\frac{1.60\times10^{-19}C}{1e}\right)$$

33. Compared to the charge on a proton, the charge on an electron has the

(A) opposite sign and a smaller magnitude
(B) same sign and a smaller magnitude
(C) same sign and the same magnitude
(D) opposite sign and the same magnitude

Electron: - 1.60 x 10^{-19}C
Proton: + 1.60 x 10^{-19}C

34. The diagram below shows proton P located at point A near a positively charged sphere.

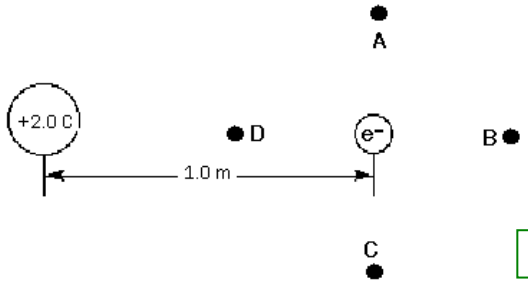


$$V = \frac{W}{q} = \frac{6.4 \times 10^{-19}\,J}{1.60 \times 10^{-19}\,C}$$

If 6.4 x 10^{-19} joule of work is required to move the proton from point A to point B, the potential difference between A and B is

(A) 6.4 V (B) 4.0 x 10^{-19} V (C) 4.0 V (D) 6.4 x 10^{-19} V

35. An electron is located 1.0 meter from a + 2.0 coulomb charge, as shown in the diagram below.

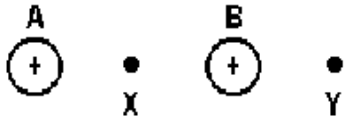


Positive attracts the negative

The electrostatic force acting on the electron is directed toward point

(A) B (B) A (C) D (D) C

36. Two equal positive charges, A and B, are positioned as shown below



Electric field leaves the positive and repel each other, cancels in the middle

At which location is the electric field intensity due to these two charges equal to zero?

(A) Y (B) B (C) A (D) X

37. Three identical metal spheres are mounted on insulating stands. Initially sphere A has a net charge of q and spheres B and C are uncharged. Sphere A is touched to sphere B and removed. The sphere A is touched to sphere C and removed. What is the final charge on sphere A?

(A) $\frac{q}{3}$ (B) $\frac{q}{4}$ (C) q (D) $\frac{q}{2}$

A & B touch: each gets ½ q
then
A & C touch and split A's ½q in half

38. Moving a point charge of 3.2 x 10^{-19} C between points A and B in an electric field requires 4.8 x 10^{-19} J of energy. What is the potential difference between these two points?

(A) 1.5 V (B) 2.0 V (C) 3.0 V (D) 0.67 V

$$V = \frac{W}{q} = \frac{4.8 \times 10^{-19}\,J}{3.2 \times 10^{-19}\,C}$$

39. When charge is transferred from one object to another, which of the following are actually transferred?

(A) electrons (B) protons (C) neutrons (D) quarks (E) photons

40. Two conducting spheres of equal size have a charge of -3C and +1 C, respectively. A conducting wire is connected from the first sphere to the second. What is the new charge on each sphere?

(A) – 4 C (B) + 4 C (C) – 1 C (D) + 1 C (E) zero

Questions 41 through 43 refer to the following diagram of two charged +Q and –4C.

41. The net electric field is zero nearest which point?

(A) A (B) B (C) C (D) D (E) E

42. At which point does the net electric field vector point to the left?

(A) A (B) B (C) C (D) D (E) E

43. At which point would a small positive charge q feel the greatest force?

(A) A (B) B (C) C (D) D (E) E

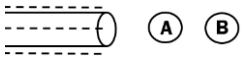
44. If the electric force between two charges is attractive, which of the following must be true?

(A) One charge is positive and the other charge is negative
(B) Both charges are positive
(C) Both charges are negative
(D) The two charges must be equal in magnitude
(E) The force must be directed toward the larger charge

45. Two charges q_1 and q_2 are separated by a distance r and apply a force F to each other. If both charges are doubled, and the distance between them is halved, the new force between them is

(A) ½ F (B) 2F (C) 4F (D) 8F (E) 16F

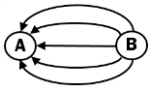
46. Two uncharged spheres A and B are near each other. A negatively charged rod is brought near one of the spheres.



The far right side of sphere B is

(A) uncharged (B) neutral (C) positive (D) negative (E) equally positive and negative

47. Two charges A and B are near each other, producing the electric field lines shown.



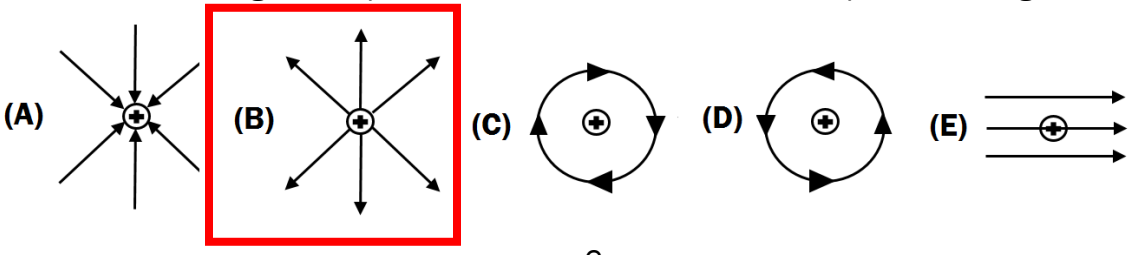
What are the two charge of A and B, respectively?

(A) +, + (B) – , – (C) +, – (D) –, + (E) 0, 0

48. A force of 40 N acts on a charge of 0.25 C in a region of space. The electric field at the point f the charge is

(A) 10 N/C (B) 100 N/C (C) 160 N/C (D) 40 N/C (E) 0.00625 N/C

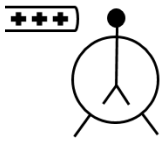
49. Which of the following best represents the electric field around a positive charge?



50. Electric potential

(A) is a vector quantity
(B) is proportional to the work done in an electric field
(C) is always equal to the electric field
(D) is zero when a charge is in an electric field
(E) is measured in N/C

51. A neutral electroscope is shown below. If a positively charged rod is brought near the knob of the electroscope, which of the following statements is true?



(A) The electroscope can be charged negatively without touching the knob and using only a grounding wire
(B) The electroscope can be charged positively without the positively charged rod touching the knob and using only a grounding wire
(C) The leaves of the electroscope are negatively charged
(D) The knob of the electroscope is positively charged

Questions 52 and 53 refer to the following:

Two charged parallel plates are oriented as shown.

The following particles are placed between the plates, one at a time:

I. electron
II. proton
III. neutron

52. Which of the particles would move to the right between the plates?

(A) I and II, only (B) I and III, only (C) II and III, only (D) II only (E) I only

53. Which of the particles would not experience a force while between the plates?

(A) I and II, only (B) II and III, only (C) I only (D) III only (E) I, II, and III

Answers:

17. a. See sheet in classroom
b. 3.8×10^{8} N right
c. ¼ (9.5×10^{7N})
d. 1.18×10^{19}
e. – 0.83 C
18. $+1.1 \times 10^{-18}$ J
19. $+1.68 \times 10^{-18}$ J
20. 2.7×10^{13} e⁻
21. $E = 8.2 \times 10^{7}$ N/C out
$F = 1.3 \times 10^{-11}$ N attract
22. a. V = 24 V
b. $+3.8 \times 10^{-18}$ J
23. 1.8×10^{15} N/C
24. 7.2×10^{-11} C
25. a. 3.7×10^{-27} N attract
b. 1.6×10^{-66} N attract

26. B
27. A
28. B
29. B
30. D
31. B
32. C
33. D
34. C
35. C
36. D
37. B
38. A
39. A
40. C
41. A
42. E
43. D
44. A
45. E
46. D
47. D
48. C
49. B
50. B
51. A
52. D
53. D