1. The threshold frequency in a photoelectric experiment is most closely related to the

   A) brightness of the incident light
   B) thickness of the photoemissive metal
   C) area of the photoemissive metal
   D) work function of the photoemissive metal

2. When a source of dim orange light shines on a photosensitive metal, no photoelectrons are ejected from its surface. What could be done to increase the likelihood of producing photoelectrons?

   A) Replace the orange light source with a red light source.
   B) Replace the orange light source with a higher frequency light source.
   C) Increase the brightness of the orange light source.
   D) Increase the angle at which the photons of orange light strike the metal.

3. A metal surface emits photoelectrons when illuminated by green light. This surface must also emit photoelectrons when illuminated by

   A) blue light B) yellow light
   C) orange light D) red light

4. In the photoelectric effect, the speed of emitted electrons may be increased by

   A) increasing the frequency of the light
   B) decreasing the frequency of the light
   C) increasing the intensity of illumination
   D) decreasing the intensity of illumination

5. The threshold frequency for a photoemissive surface is 6.4×10^{14} hertz. Which color light, if incident upon the surface, may produce photoelectrons?

   A) blue B) green
   C) yellow D) red

6. The threshold frequency of a metal surface is in the violet light region. What type of radiation will cause photoelectrons to be emitted from the metal's surface?

   A) infrared light B) red light
   C) ultraviolet light D) radio waves

7. Photons with a frequency of 1.0×10^{20} hertz strike a metal surface. If electrons with a maximum kinetic energy of 3.0×10^{-14} joule are emitted, the work function of the metal is

   A) 1.0×10^{-14} J B) 2.2×10^{-14} J
   C) 3.6×10^{-14} J D) 6.6×10^{-14} J

8. The threshold frequency for a photoemissive surface is 1.0×10^{14} hertz. What is the work function of the surface?

   A) 1.0×10^{-14} J B) 6.6×10^{-20} J
   C) 6.6×10^{-48} J D) 2.2×10^{-28} J

9. The threshold frequency for a photoemissive surface is 4.0×10^{14} hertz. What is the work function of this surface?

   A) 1.2×10^{-19} J B) 2.6×10^{-19} J
   C) 6.0×10^{14} J D) 6.1×10^{47} J

10. The threshold frequency for a certain photoelectric surface is 6.5×10^{14} hertz. The work function of the surface is

    A) 1.2×10^{-48} J B) 4.3×10^{-19} J
    C) 7.5×10^{-18} J D) 9.8×10^{47} J

11. The work function of a photoelectric material can be found by determining the minimum frequency of light that will cause electron emission and then

    A) adding it to the velocity of light
    B) multiplying it by the velocity of light
    C) adding it to Planck's constant
    D) multiplying it by Planck's constant

12. Which determines the number of electrons emitted by a photoelectric material?

    A) intensity B) color
    C) frequency D) wavelength

13. The maximum kinetic energy of an electron ejected from a metal by a photon depends on

    A) the photon's frequency, only
    B) the metal's work function, only
    C) both the photon's frequency and the metal's work function
    D) neither the photon's frequency nor the metal's work function

14. The work function for a copper surface is 7.3×10^{-19} joule. If photons with an energy of 9.9×10^{-19} joule are incident on the copper surface, the maximum kinetic energy of the ejected photoelectrons is

A) 2.6×10^{-19} J B) 7.3×10^{-19} J
C) 9.9×10^{-19} J D) 1.7×10^{30} J

15. Photons with energies of 3.9×10^{-19} joule strike a photoemissive surface whose work function is 2.9×10^{-19} joule. The maximum kinetic energy of the ejected photoelectrons is

A) 1.0×10^{-19} J B) 7.5×10^{-20} J
C) 7.0×10^{-19} J D) 1.2×10^{-18} J

16. As the frequency of photons incident upon a photoemissive surface is increased, the maximum energy of the photoelectrons

A) decreases B) increases
C) remains the same

17. A certain photoemissive material with a work function of 1.3×10^{-19} joule is exposed to incident photons with an energy of 3.3×10^{-19} joule. The maximum kinetic energy that an ejected photoelectron can attain is closest to

A) 1.0×10^{-39} J B) 2.0×10^{-19} J
C) 3.0×10^{-19} J D) 4.0×10^{-19} J

18. When yellow light shines on a photosensitive metal, photoelectrons are emitted. As the intensity of the light is decreased, the number of photoelectrons emitted per second

A) decreases B) increases
C) remains the same

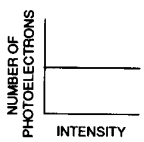
19. A beam of blue light causes photoelectrons to be emitted from a photoemissive surface. An increase in the intensity of the blue light will cause an increase in the

A) maximum kinetic energy of the emitted photoelectrons
B) number of photoelectrons emitted per unit of time
C) charge carried by each photoelectron
D) work function of the photoemissive surface

20. The threshold frequency of a photoemissive surface is 7.1×10^{14} hertz. Which electromagnetic radiation, incident upon the surface, will produce the greatest amount of current?

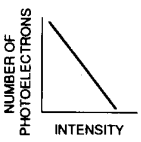
A) low-intensity infrared radiation
B) high-intensity infrared radiation
C) low-intensity ultraviolet radiation
D) high-intensity ultraviolet radiation

21. Which graph best represents the relationship between the intensity of light that falls on a photoemissive surface and the number of photoelectrons that the surface emits?

A) 

B) 

C) 

D) 

Base your answers to questions **22** through **24** on the information below.

Light of constant intensity strikes a metal surface. The frequency of the light is increased from 6.0×10^{14} cycles per second to 9.0×10^{14} cycles per second. Photoelectrons are emitted by the metal surface when the frequency reaches 8.0×10^{14} cycles per second.

22. As the frequency of the incident light increases, the photons striking the metal surface increase in

A) number B) energy
C) speed D) wavelength

23. The work function of the metal surface is approximately

A) 6.0×10^{-19} J B) 2.0×10^{-19} J
C) 5.3×10^{-19} J D) 4.0×10^{-19} J

24. If the intensity of the incident light were increased while the frequency was kept constant, the maximum kinetic energy of the emitted photoelectrons would

A) decrease B) increase
C) remain the same

25. Which occurs when the intensity of monochromatic light striking a photoemissive material increases?

A) The number of electrons emitted increases.
B) The number of electrons emitted decreases.
C) The energy of the emitted electrons increases.
D) The energy of the emitted electrons decreases.

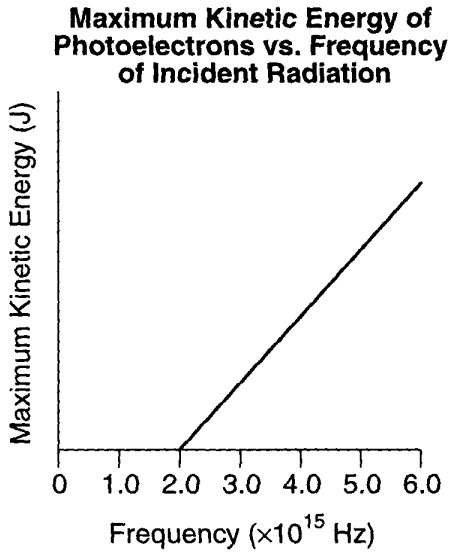
26. As the intensity of monochromatic light on a photoemissive surface increases, the maximum kinetic energy or the photoelectrons emitted

A) decreases B) increases
C) remains the same

27. The slope of a graph of photon energy versus photon frequency represents

A) Planck's constant
B) the mass of a photon
C) the speed of light
D) the speed of light squared

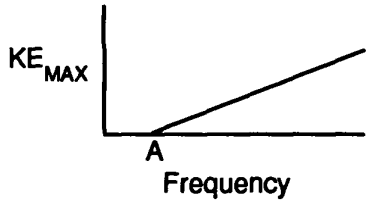
28. The graph below shows the maximum kinetic energy of photoelectrons ejected from a metal as a function of frequency of incident electromagnetic radiation



What is the work function of the metal?

A) 6.6×10^{-34} J B) 1.3×10^{-18} J
C) 2.0×10^{15} J D) 3.0×10^{48} J

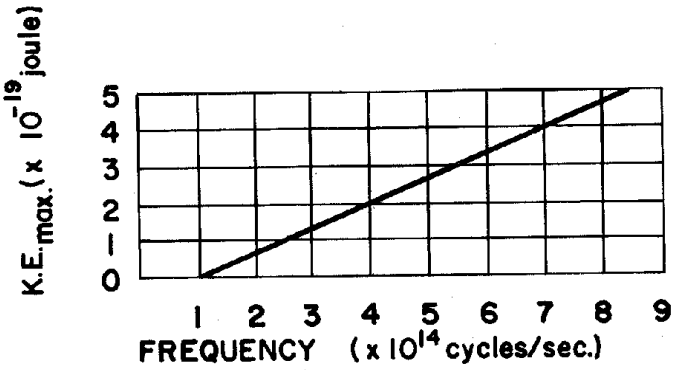
29. The graph below shows the relationship between the frequency of radiation incident on a photosensitive surface and the maximum kinetic energy (KE_{max}) of the emitted photoelectrons.



The point labeled *A* on the graph represents the

A) incident photon intensity
B) photoelectron frequency
C) threshold frequency
D) work function energy

30. Base your answer to the following question on the graph below which shows the maximum kinetic energy of the photoelectrons ejected when photons of different frequencies strike a metal surface.



Compared to the energy of the bombarding photon, the energy of the emitted photoelectron is

A) less B) greater
C) the same

31. Two objects, *A* and *B* are rubbed together. If object *A* acquires an excess of 100 electrons object *B* must have

A) gained 100 electrons
B) gained 100 protons
C) lost 100 electrons
D) lost 100 protons

32. Two metal spheres having charges of $+4.0 \times 10^{-6}$ coulomb and $+2.0 \times 10^{-5}$ coulomb, respectively, are brought into contact and then separated. After separation, the charge on each sphere is

A) 8.0×10^{-11} C B) 8.0×10^{-6} C
C) 2.1×10^{-6} C D) 1.2×10^{-5} C

33. A glass rod is given a positive charge by rubbing it with silk. The rod has become positive by

A) gaining electrons B) gaining protons
C) losing electrons D) losing protons

34. Sphere *A* carries a charge of +2 coulombs and an identical sphere *B* is neutral. If the spheres touch one another and then are separated, the charge on sphere *B* would be

A) +1 C B) +2 C C) 0 C D) +4 C

35. When a plastic rod is rubbed with wool, the wool acquires a positive charge because

A) electrons are transferred from the wool to the rod
B) protons are transferred from the wool to the rod
C) electrons are transferred from the rod to the wool
D) protons are transferred from the rod to the wool

36. When hair is combed with a hard rubber comb, the hair becomes positively charged because the comb

A) transfers protons to the hair
B) transfers electrons to the hair
C) removes protons from the hair
D) removes electrons from the hair

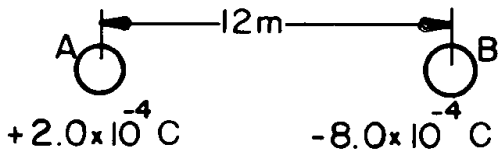
37. Two neutral materials are rubbed together and there is a transfer of electrical charge from one material to the other. The net electrical charge for the system

A) increases as electrons are transferred
B) increases as protons are transferred
C) remains constant as electrons are transferred
D) remains constant as protons are transferred

38. One of two identical metal spheres has a charge of +q, and the other sphere has a charge of –q. The spheres are brought together and then separated. Compared to the total charge on the two spheres before contact, the total charge on the two spheres after contact is

A) less B) greater
C) the same

Base your answers to questions **39** and **40** on the diagram below which represents a system consisting of two charged metal spheres with equal radii.



39. If spheres *A* and *B*, as represented in the diagram, were touched together and then separated, the net charge on the two spheres would

A) decrease B) increase
C) remain the same

40. If the two spheres were touched together and then separated, the charge on sphere *A* would be

A) -6.0×10^{-4} C B) 2.0×10^{-4} C
C) -3.0×10^{-4} C D) -8.0×10^{-4} C

41. After two neutral solids, *A* and *B*, were rubbed together, solid *A* acquired a net negative charge. Solid *B*, therefore, experienced a net

A) loss of protons
B) increase of protons
C) loss of electrons
D) increase of electrons

42. A rod and a piece of cloth are rubbed together. If the rod acquires a charge of $+1 \times 10^{-6}$coulomb, the cloth acquires a charge of.

A) 0 C B) $+1 \times 10^{-6}$ C
C) -1×10^{-6} C D) $+1 \times 10^{6}$ C

43. After a neutral object loses 2 electrons, it will have a net charge of

A) –2 elementary charges
B) +2 elementary charges
C) -3.2×10^{-19} elementary charge
D) $+3.2 \times 10^{-19}$ elementary charge

44. Base your answer to the following question on the diagram below which shows two identical metal spheres. Sphere *A* has a charge of +12 coulombs and sphere *B* is a neutral sphere.

When spheres *A* and *B* are in contact, the total charge of the system is

A) neutral B) +6 C C) +12 C D) +24 C

45. When a rubber rod is rubbed with fur, the rod becomes negatively charged due to the transfer of

A) electrons to the fur
B) protons to the fur
C) electrons to the rod
D) protons to the rod

46. An object is charged positively when rubbed with a piece of silk. The object became charged by

A) losing electrons B) gaining protons
C) losing neutrons D) gaining positrons

47. A positively charged body must have

A) an excess of neutrons
B) an excess of electrons
C) a deficiency of protons
D) a deficiency of electrons

48. Which net charge could be found on an object?

A) +4.80 10^{-19} C B) +2.40 10^{-19} C
C) –2.40 10^{-19} C D) –5.60 10^{-19} C

49. A particle could have a charge of

A) 0.8×10^{-19} C B) 1.2×10^{-19} C
C) 3.2×10^{-19} C D) 4.1×10^{-10} C

50. If an object has a net negative charge of 4.0 coulombs, the object possesses

A) 6.3×10^{18} more electrons than protons
B) 2.5×10^{19} more electrons than protons
C) 6.3×10^{18} more protons than electrons
D) 2.5×10^{19} more protons than electrons

51. A subatomic particle could have a charge of

A) 5.0×10^{-20} C B) 8.0×10^{-20} C
C) 3.2×10^{-19} C D) 5.0×10^{-19} C

52. Which quantity of excess electric charge could be found on an object?

A) 6.25×10^{-19} C
B) 4.80×10^{-19} C
C) 6.25 elementary charges
D) 1.60 elementary charges

53. What is the net electrical charge on a magnesium ion that is formed when a neutral magnesium atom loses two electrons?

A) -3.2×10^{-19} C B) -1.6×10^{-19} C
C) $+1.6 \times 10^{-19}$ C D) $+3.2 \times 10^{-19}$ C

54. Oil droplets may gain electrical charges as they are projected through a nozzle. Which quantity of charge is *not* possible on an oil droplet?

A) 8.0×10^{-19} C B) 4.8×10^{-19} C
C) 3.2×10^{-19} C D) 2.6×10^{-19} C

55. A metal sphere has a net negative charge of 1.1×10^{-6} coulomb. Approximately how many more electrons than protons are on the sphere?

A) 1.8×10^{12} B) 5.7×10^{12}
C) 6.9×10^{12} D) 9.9×10^{12}

56. An object possessing an excess of 6.0×10^{6} electrons has a net charge of magnitude

A) 2.7×10^{-26} C B) 5.5×10^{-24} C
C) 3.8×10^{-13} C D) 9.6×10^{-13} C

57. An object can *not* have a charge of

A) 3.2×10^{-19} C B) 4.5×10^{-19} C
C) 8.0×10^{-19} C D) 9.6×10^{-19} C

58. What is the smallest electric charge that can be put on an object?

A) 9.11×10^{-31} C B) 1.60×10^{-19} C
C) 9.00×10^{9} C D) 6.25×10^{18} C

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

A) 1.60×10^{-19} C B) 4.80×10^{-19} C
C) 3.00×10^{0} C D) 4.80×10^{19} C

60. If a small sphere possesses an excess of 5 electrons, the charge on the sphere is

A) -3.2×10^{-20} C B) -8.0×10^{-19} C
C) -8.0×10^{19} C D) -3.2×10^{20} C

61. An alpha particle consists of two protons and two neutrons. The alpha particle's charge of +2 elementary charges is equivalent to

A) 8.0×10^{-20} C B) 3.2×10^{-19} C
C) 1.2×10^{19} C D) 3.2×10^{19} C

62. Which net charge could be found on an object?

A) $+3.2 \times 10^{-18}$ C B) $+2.4 \times 10^{-19}$ C
C) -1.8×10^{-18} C D) -0.80×10^{-19} C

63. A metal sphere having an excess of +5 elementary charges has a net electric charge of

A) 1.6×10^{-19} C B) 8.0×10^{-19} C
C) 5.0×10^{0} C D) 3.2×10^{19} C

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

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

65. The coulomb is a unit of

A) resistance B) power
C) charge D) force

66. A sphere has a net excess charge of -4.8×10^{-19} coulomb. The sphere must have an excess of

A) 1 electron B) 1 proton
C) 3 electrons D) 3 protons

67. What is the charge of a proton?

A) 9.1×10^{-31} C B) 1.7×10^{-27} C
C) 1.6×10^{-19} C D) 6.3×10^{18} C

68. Which electric charge is possible?

A) 8.0×10^{-20} C B) 2.4×10^{-19} C
C) 3.2×10^{-19} C D) 6.32×10^{-18} C

69. A sphere has a negative charge of 6.4×10^{-7} coulomb. Approximately how many electrons must be removed to make the sphere neutral?

A) 1.6×10^{-8} B) 9.8×10^{5}
C) 6.4×10^{26} D) 4.0×10^{12}

70. Which magnitude of charge could not be found on an object?

A) -0.8×10^{-19} C B) -1.6×10^{-19} C
C) $+1.6 \times 10^{-19}$ C D) $+3.2 \times 10^{-19}$ C

71. The diagram below represents two electrically charged identical-sized metal spheres, *A* and *B*.

If the spheres are brought into contact, which sphere will have a net gain of electrons?

A) *A*, only
B) *B*, only
C) both *A* and *B*
D) neither *A* nor *B*

72. Metal sphere *A* has a charge of –2 units and an identical metal sphere, *B*, has a charge of –4 units. If the spheres are brought into contact with each other and then separated, the charge on sphere *B* will be

A) 0 units
B) –2 units
C) –3 units
D) +4 units

73. A positively charged glass rod attracts object *X*. The net charge of object *X*.

A) may be zero or negative
B) may be zero or positive
C) must be negative
D) must be positive

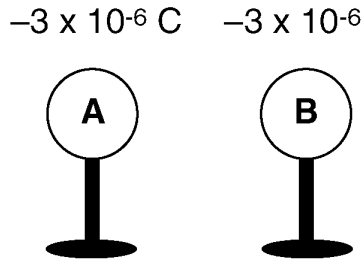
74. A balloon is rubbed against a student's hair and then touched to a wall. The balloon "sticks" to the wall due to

A) electrostatic forces between the particles of the balloon
B) magnetic forces between the particles of the wall
C) electrostatic forces between the particles of the balloon and the particles of the wall
D) magnetic forces between the particles of the balloon and the particles of the wall

75. A negatively charged plastic comb is brought close to, but does not touch, a small piece of paper. If the comb and the paper are attracted to each other, the charge on the paper

A) may be negative or neutral
B) may be positive or neutral
C) must be negative
D) must be positive

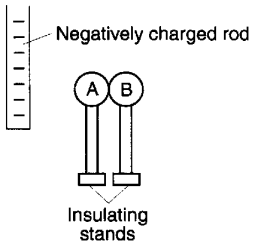
76. The diagram below shows two identical metal spheres, *A* and *B*, on insulated stands. Each sphere possesses a net charge of -3×10^{-6} coulomb.



If the spheres are brought into contact with each other and then separated, the charge on sphere *A* will be

A) 0 C
B) $+3 \times 10^{-6}$ C
C) -3×10^{-6} C
D) -6×10^{-6} C

77. Two electrically neutral metal spheres, *A* and *B*, on insulating stands are placed in contact with each other. A negatively charged rod is brought near, but does not touch the spheres, as shown in the diagram below.



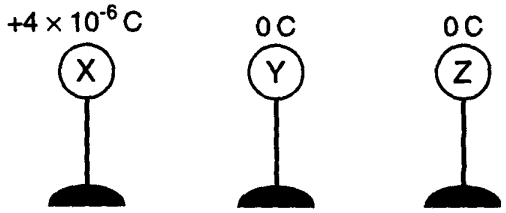
How are the spheres now charged?

A) *A* is positive and *B* is positive.
B) *A* is positive and *B* is negative.
C) *A* is negative and *B* is positive.
D) *A* is negative and *B* is negative.

78. Metal sphere *A* has a charge of +12 elementary charges and identical sphere *B* has a charge of +16 elementary charges. After the two spheres are brought into contact, the charge on sphere *A* is

A) –2 elementary charges
B) +2 elementary charges
C) +14 elementary charges
D) +28 elementary charges

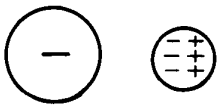
79. The diagram below shows the initial charge and position of three metal spheres, *X*, *Y*, and *Z* on insulating stands.

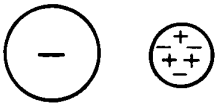


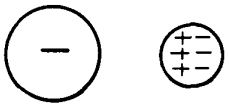
Sphere *X* is brought into contact with sphere *Y* and then removed. Then sphere *Y* is brought into contact with sphere *Z* and removed. What is the charge on sphere *Z* after this procedure is completed?

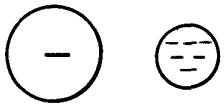
A) $+1 \times 10^{-6}$ C B) $+2 \times 10^{-6}$ C
C) $+3 \times 10^{-6}$ C D) $+4 \times 10^{-6}$ C

80. A small, uncharged metal sphere is placed near a larger, negatively charged sphere. Which diagram best represents the charge distribution on the smaller sphere?

A) 

B) 

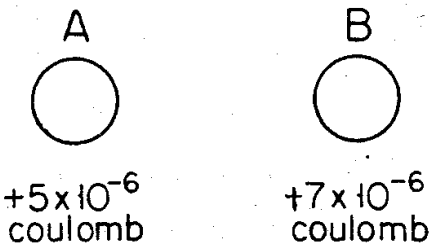
C) 

D) 

81. A neutral rubber rod is rubbed with fur and acquires a charge of -2×10^{-6} coulomb. The charge on the fur is

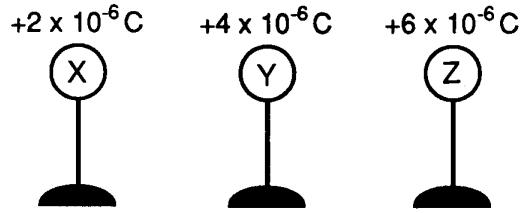
A) $+1 \times 10^{-6}$ C B) $+2 \times 10^{-6}$ C
C) -1×10^{-6} C D) -2×10^{-6} C

82. Two identical metal spheres, charged as shown in the diagram below, are brought into contact and then separated. What will be the charge on sphere *A* after separation?



A) -1×10^{-6} C B) $+1 \times 10^{-6}$ C
C) $+6 \times 10^{-6}$ C D) $+12 \times 10^{-6}$ C

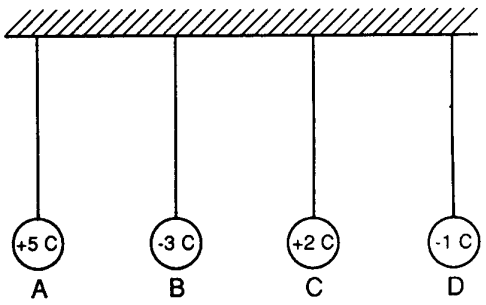
83. The diagram below shows the initial charge and position of three identical metal spheres, *X*, *Y*, and *Z* , which have been placed on insulating stands.



All three spheres are simultaneously brought into contact with each other and then returned to their original positions. Which statement best describes the charge of the spheres after this procedure is completed?

A) All the spheres are neutral.
B) Each sphere has a net charge of $+4 \times 10^{-6}$ coulomb.
C) Each sphere retains the same charge that it had originally.
D) Sphere *Y* has a greater charge than spheres *X* or *Z*.

84. The diagram below shows four charged metal spheres suspended by strings. The charge of each sphere is indicated.



If spheres *A*, *B*, *C*, and *D* simultaneously come into contact, the net charge on the four spheres will be

A) + 1 C B) + 2 C C) + 3 C D) + 4 C

85. 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) +0.8 C B) +0.2 C
C) –0.3 C D) +0.4 C

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

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

87. Which part of an atom is most likely to be transferred as a body acquires a static electric charge?

A) proton B) neutron
C) electron D) positron

88. Sphere *A* has a charge of $+2 \times 10^{-6}$ coulomb and is brought into contact with a similar sphere, *B*, which has a charge of -4×10^{-6} coulomb. After it is separated from sphere *B*, sphere *A* will have a charge of

A) -1×10^{-6} C B) -2×10^{-6} C
C) $+2 \times 10^{-6}$ C D) $+6 \times 10^{-6}$ C

89. A metal sphere with an excess of 11 electrons touches an identical metal sphere with an excess of 15 electrons. After the spheres touch, the number of excess electrons on the second sphere is

A) 26 B) 2 C) 13 D) 4

90. A body will maintain a constant negative electrostatic charge if the body

A) maintains the same excess of electrons
B) maintains the same excess of protons
C) continuously receives more electrons than it loses
D) continuously receives more protons than it loses

91. Two identical conducting spheres carry charges of +3 coulombs and –1 coulomb, respectively. If the spheres are brought into contact and separated, the final charge on each will be

A) +1 C B) +2 C C) –1 C D) –2 C

92. Two electrons are separated by a distance of 3.00×10^{-6} meter. What are the magnitude and direction of the electrostatic forces each exerts on the other?

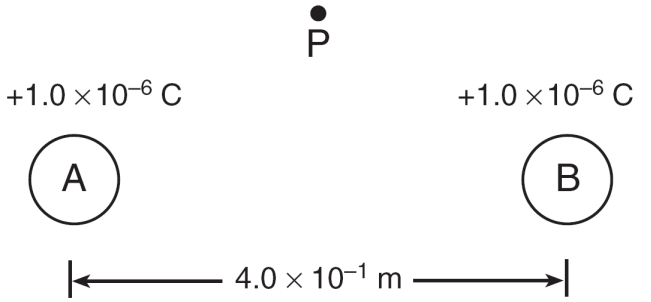
A) 2.56×10^{-17} N away from each other
B) 2.56×10^{-17} N toward each other
C) 7.67×10^{-23} N away from each other
D) 7.67×10^{-23} N toward each other

93. What is the magnitude of the electrostatic force between two electrons separated by a distance of 1.00×10^{-8} meter?

A) 2.56×10^{-22} N B) 2.30×10^{-20} N
C) 2.30×10^{-12} N D) 1.44×10^{-1} N

94. Base your answer to the following question on the information and diagram below.

Two small metallic spheres, *A* and *B*, are separated by a distance of 4.0×10^{-1} meter, as shown. The charge on each sphere is $+1.0 \times 10^{-6}$ coulomb. Point *P* is located near the spheres.



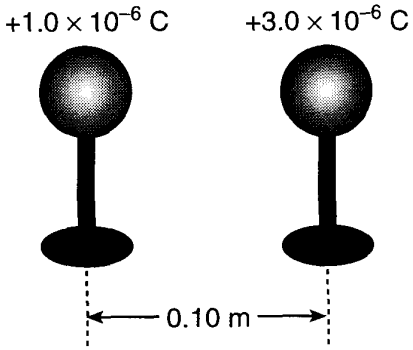
What is the magnitude of the electrostatic force between the two charged spheres?

A) 2.2×10^{-2} N B) 5.6×10^{-2} N
C) 2.2×10^{4} N D) 5.6×10^{4} N

95. What is the approximate electrostatic force between two protons separated by a distance of 1.0×10^{-6} meter?

A) 2.3×10^{-16} N and repulsive
B) 2.3×10^{-16} N and attractive
C) 9.0×10^{21} N and repulsive
D) 9.0×10^{21} N and attractive

96. The diagram below shows two metal spheres charged to $+1.0 \times 10^{-6}$ coulomb and $+3.0 \times 10^{-6}$ coulomb, respectively, on insulating stands separated by a distance of 0.10 meter.

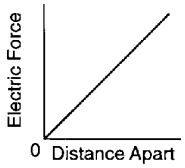


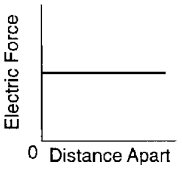
The spheres are touched together and then returned to their original positions. As a result, the magnitude of the electrostatic force between the spheres changes from 2.7 N to

A) 1.4 N B) 1.8 N C) 3.6 N D) 14 N

97. Which graph best represents the relationship between the magnitude of the electric force between two identical spheres possesing +1.0 coulomb of charge and –1.0 coulombs of charge respectivly, as well as the distance between them?

A)


B)


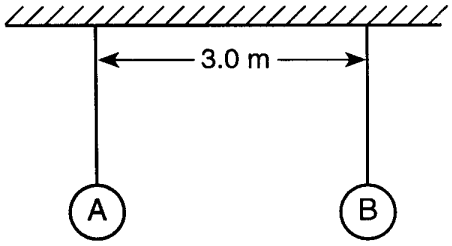
C)


D)


98. A point charge of $+3.0 \times 10^{-7}$ coulomb is placed 2.0×10^{-2} meter from a second point charge of $+4.0 \times 10^{-7}$ coulomb. The magnitude of the electrostatic force between the charges is

A) 2.7 N B) 5.4×10^{-2} N
C) 3.0×10^{-10} N D) 6.0×10^{-12} N

99. The diagram below shows two metal spheres suspended by strings and separated by a distance of 3.0 meters. The charge on sphere *A* is $+5.0 \times 10^{-4}$ coulomb and the charge on sphere *B* is $+3.0 \times 10^{-5}$ coulomb.



Which statement best describes the electrical force between the spheres?

A) It has a magnitude of 15 N and is repulsive.
B) It has a magnitude of 45 N and is repulsive.
C) It has a magnitude of 15 N and is attractive.
D) It has a magnitude of 45 N and is attractive.

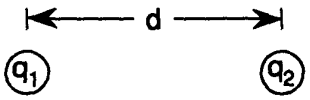
100. The electrical force of attraction between two point charges is *F*. The charge on one of the objects is quadrupled and the charge on the other object is doubled. The new force between the objects is

A) 6F B) 2F C) $\frac{1}{2}$F D) 8F

101. An electric force *F* exists between two charged spheres. If the quantity of charge on each sphere is doubled, the electric-force between the two spheres will be equal to

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

102. The diagram represents two charges, q_1 and q_2, separated by a distance d.



Which change would produce the greatest increase in the electrical force between the two charges?

A) doubling charge q_1, only
B) doubling *d*, only
C) doubling *d* and charge q_1, only
D) doubling *d* and charges q_1 and q_2

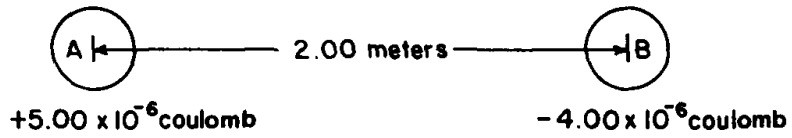
103. Two charges that are 2 meters apart repel each other with a force of 2×10^{-5} Newton. If the distance between the charges is decreased to 1 meter, the force of repulsion will be

A) 1×10^{-5} N B) 5×10^{-6} N
C) 8×10^{-5} N D) 4×10^{-5} N

104. What is the magnitude of the electrostatic force between a charge of $+3.0 \times 10^{-5}$ coulomb and a charge of $+6.0 \times 10^{-6}$ coulomb separated by 0.30 meter?

A) 1.8×10^{-3} N B) 5.4×10^{-2} N
C) 5.4×10^{0} N D) 1.8×10^{1} N

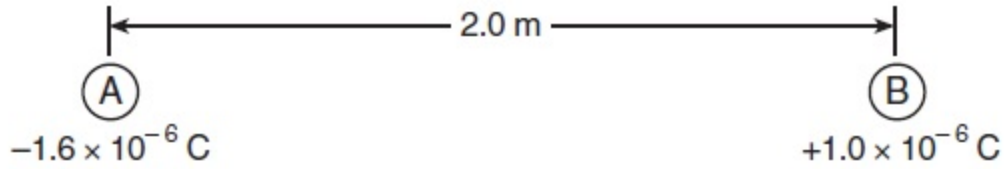
105. Base your answer to the following question on the diagram below which represents two small, charged conducting spheres, identical in size, located 2.00 meters apart.



The force between these spheres is

A) $1.80 \times 10^{-2}\,\mathrm{N}$ B) $3.60 \times 10^{-2}\,\mathrm{N}$
C) $4.50 \times 10^{-2}\,\mathrm{N}$ D) $9.00 \times 10^{-2}\,\mathrm{N}$

Base your answers to questions **106** and **107** on the diagram below and on your knowledge of physics. The diagram represents two small, charged, identical metal spheres, *A* and *B* that are separated by a distance of 2.0 meters.



106. If the two spheres were touched together and then separated, the charge on sphere A would be

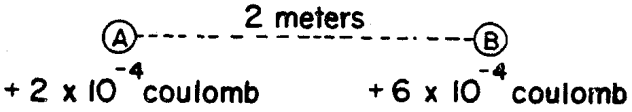
A) $-3.0 \times 10^{-7}\,\mathrm{C}$ B) $-6.0 \times 10^{-7}\,\mathrm{C}$
C) $-1.3 \times 10^{-6}\,\mathrm{C}$ D) $-2.6 \times 10^{-6}\,\mathrm{C}$

107. What is the magnitude of the electrostatic force exerted by sphere *A* on sphere *B*?

A) $7.2 \times 10^{-3}\,\mathrm{N}$ B) $3.6 \times 10^{-3}\,\mathrm{N}$
C) $8.0 \times 10^{-13}\,\mathrm{N}$ D) $4.0 \times 10^{-13}\,\mathrm{N}$

108. Base your answer to the following question on the information and diagram below.

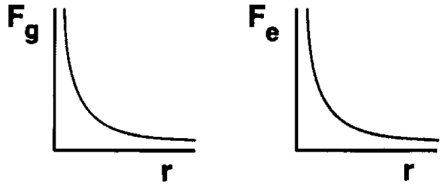
Two conducting spheres, *A* and *B*, are separated by a distance of 2 meters between centers. Sphere *A* has a charge of $+2 \times 10^{-4}$ coulomb, and sphere *B* has a charge of $+6 \times 10^{-4}$ coulomb.

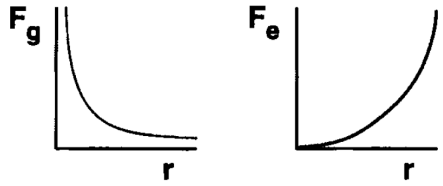


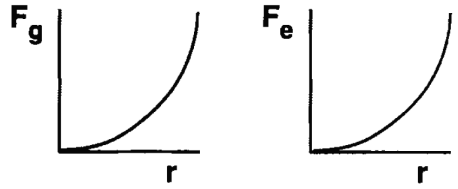
The force that these two spheres exert upon each other is

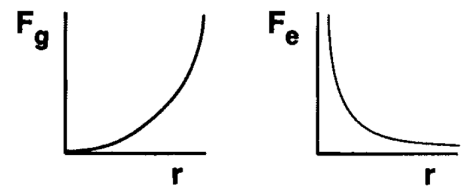
A) 9.0×10^{9} N B) 5.4×10^{2} N
C) 3.0×10^{-8} N D) 2.7×10^{2} N

109. The distance between an electron and a proton is varied. Which pair of graphs best represents the relationship between gravitational force, F_g, and distance, r, and the relationship between electrostatic force, F_e, and distance, r, for these particles?

A) 

B) 

C) 

D) 

110. If the distance separating an electron and a proton is halved, the magnitude of the electrostatic force between these charged particles will be

A) unchanged B) doubled
C) quartered D) quadrupled