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PHYSICS

BOOKS - MODERN PUBLICATION

COULOMB'S LAW

EXAMPLE

1. A polythene piece rubbed with wool is found to have a negative charge of $3 \times 10^{-7} C$. Estimate the number of electrons transferred (from which to which?)

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2. What is the force between two small charged spheres having charges of $2 \times 10^{-7}C$ and $3 \times 10^{-7}C$ placed 30 cm apart in air?

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3. Calculate the total positive (or negative) charge on a 3.11 g copper penny. Given Avogadro's number $= 6.023 \times 10^{23}\left(g^{-1}\right)mol^{-1}$, and atomic mass= $63.5g$.

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4. Two equal charges placed in air and separated by a distance of 2 m repel each other with a force of 10^{-4} N. Calculate the magnitude of either of the charges.

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5. The electrostatics force of repulsion between two positively charged ions carrying equal charge is $3.7 \times 10^{-9} N$ when these are separated by a distance of 5Å. How many electrons are missing from each ion?

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6. The electrostatic force on a small sphere of charge $0.4\mu C$ due to another small sphere of charge $-0.8\mu C$ in air is 0.2 N.

What is the distance between the two spheres?

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7. The electrostatic force on a small sphere of charge $0.4\mu C$ due to another small sphere of charge $-0.8\mu C$ in air is 0.2 N.

What is the force on the second spheres due to the first?

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8. A free ptih-ball of 8 g carries a positive charge of 5×10^{-8}C. What must be the nature and magntiude of charge that should be given to a second pith-ball fixed 5 cm vertically below the former pith-ball so that the upper pith-ball is stationary?

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9. Two insulated charged copper spheres A and B have their centres separated by a distance of 50 cm. What is the mutual force of electrostatic repulsion if the charge on each is $6.5 \times 10^{-7}C$? The radii of A and B are negligible compared to the distance of separation.

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10. Two insulated charged copper spheres A and B have their centres separated by a distance of 50 cm. What is the mutual force of electrostatic repulsion if the charge on each is $6.5 \times 10^{-7} C$? The radii of A and B are negligible compared to the distance of separation.

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11. What is the force of repulsion, the two spheres are placed in water?(dielectric constant of water = 80)

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12. Three point charges of +2muC ,-3muC and -3muC are kept at the vertices A, B and C respectivel of an equilaterla triangle of side 20 cm. What should be the sign and magnitude of the charge to be

placed at the mid-point M of side BC, so that the charge at A remains in equilibrium?

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13. The sphere A and B have identical sizes. A third sphere of the same size but uncharged is brought in contact with the first, then brought in contact with the second and finally removed from both. What is the new force of repulsion between A and B?

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14. Two poit charges of charge values Q and q are placed at a distance of x and x/2 respectively from a third charge of charge value 4q, all charges being in the same striahgt line. Calculate the magnitude and nature of charge Q, such that the net force experienced by the charge q is zero.

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15. Two pith-balls each weighing 10^{-3} kg are suspended from the same point by mans of silk threads 0.5 m long. On charging the pith-balls equally, they are found to repel each other to a distance of 0.2 m. Calculate the charge on each ball?

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16. Two small spheres each having mass m kg and charge q coulomb are suspended from a point by insultaing threads each l metre long but of negligible mass. If θ is the angle, each string makes with the vertical when equilibrium has been attained show that $q^2 = \left(4mgl^2 \sin^2\theta \tan\theta\right) 4\pi v_0$

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17. Three charges $10\mu C, 5\mu C$ and $-5\mu C$ are placed in air at the three corners A,B and C of an equilateral triangle of side 0.1m. Find the resultant force experiened by charge placed at corner A.

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18. ABC is an equilaterla triangle of side 10m and D is the middle point of BC. Charges of +100, -100 and +75 coulomb are placed at B, C and D respectively. What is the force experienced by 1 coulomb positive charge placed at A?

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19. Two charges each of +Q units are placed along a line. A third charge - q I placed between them. At what position and for what value of q, will the system be in equilibrium?

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20. Two identical point charges of charge Q are kept at a distance r from each other. A third point charge is placed on the line joining the above two charges, such that all the three charges are in equilibrium. Calculate the magnitude and location of the thrid charge.

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21. Two equally charged identical metal spheres A and b repel each other with a fore $2.0 \times 10^{-5} N$. Another identical uncharged sphere C is touched to A and the nplaced at the md point between A and B. What is the net electric force on C?

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22. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle 30° with each other. When suspended in a liquid of density $800 kgm^{-3}$, the angle remains the same. Wahat is the dielectric constant of the liquid? The density of the material of the sphere is 1600 kg m^{-3}

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23. Three particles, each of mass 1g and carrying a charge q , are suspended from a common point by insulating massless strings , each 100 cm long . if the particles are located at the corners of an equilateral triangle of side 3 cm, calculate the charge q on each particle.

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24. A small ball of mass 2×10^{-3} kg, having a charge 1 mu C, is suspended by a string of length 0.8 m. Another identical ball having the same charge is kept at the point of suspension. Determine the minimum horizontal velocity that should be imparted to the lower ball so that it can make a complete revolution.

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25. What kind of charges are produced on each a glass rod is rubbed with silk

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26. What kind of charges are produced on each an ebonite rod is rubbed with wool?

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27. An ebonite rod held in hand can be charged by rubbing with flannel but a copper rod cannot be charged like this.why?

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28. What does $q_1 + q_2 = 0$ signify in electrostatics?

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29. When a polythene piece is rubbed with wool, it acquires negative charge. Is there a transfer of mass from wool to polythene?

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30. A glass rod, when rubbed with silk cloth, acuires a charge 1.6×10^{-13} coulomb. What is charge on the silk cloth?

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31. What is the value of charge on electron? Is a charge less than this value possible?

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32. What do you mean by quantisation and Conservation of charge ?

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33. What is the least possible value of charge?

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34. Can a body have a charge of 0.8×10^{-19}C? justify your answer by comment.

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35. What is the basic cause of quantisation of charge?

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36. Name the experiment, which established quantum nature of electric charge.

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37. What do you understand by conservation of charge?

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38. What do you mean by quantisation and Conservation of charge ?

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39. Write two properties of electric charge.

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40. Is the mass of a body affected on charging?

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41. The force acting between two point charges q_1 and q_2 kept at the same distance apart in air is attractive or repulsive when $q_1 q_2 < 0$.

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42. If $q_1 q_2 > 0$, what is the nature of force between the two charges?

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43. State Coulomb's law in electrostatics.

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44. Give mathematical expression for Coulomb's law for electric charges.

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45. In Coulomb's law, on what factors the value of electrostatic force Constant 'K' depends ?

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46. What is the SI unit of ε_0?

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47. Give the SI unit of electrical permittivity of free space.

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48. Name the physical quantity, whose SI unit is farad/metre`

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49. Write down the value of absolute permittivity of free space (vaccum).

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50. What is the dimensional formula for ε_0?

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51. Is it possible to have the value of relative permittivity less than one?

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52. Define S.I. unit of electric charge.

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53. Define one coulomb charge.

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54. Calculate the number of electrons that constitute 1 coulomb of charge.

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55. How many electrons are present in one coulmb of charge?

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56. Electrostatic force between two charges is called central force.Why?

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57. Dielectric constant of water is 80. what is the permittivity?

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58. Force between two point electric charges kept at a distance of a part in air is F. if these charges are kept at the same distance in water, how does the force between them change?

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59. Two equal balls with equal positive charge q coulombs are suspended by two insuulating strings of equal length. What would be the effect on the force when a plastic sheet is ineserted between the two?

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60. State the limitations of Coulomb's law.

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61. Electrostatic force between two charges is called central force.Why?

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62. If the distance between two equal points charges is doubled and their individual charges are also doubled, what would happen to the force between them?

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63. What is the importance of superposition principle in electristatics?

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64. A comb run through one's dry hair attracts small bits of paper. Why? What happens, if the hair is wet or if it is a rainy day?

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65. Ordinary rubber is an isulator. But the special rubber tyres of aircrafts are made slightly conducting. Why is this necessary?

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66. Vehicles carrying inflammable materials usually have metallic ropes touching the ground during motion. Why?

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67. In filling the gasoline tank of an aeroplane, the metal nozzle of the hose from the gasoline truck is always carefully connected to the metal of the aeroplane by a wire, efore the nozzle is inserted in the tank . Explain why.

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68. When you touch a metal object like a door handle on a dry winter day, you are likely to see a spark and feel a definite shock. We usually explain this by saying that we have built up a static charge. Why does this not happen on a hmid day in the summer?

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69. Automobile ignition failure occurs in damp weather. 'Explain, why.

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70. Why Can one ignore quantisation of electric charge when dealing with macroscopic i.e., large scale charges?

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71. When a glass rod is rubbed with a silk cloth, charges appear on both. A similar phenomenon is observed with many other pairs of bodies. Explain how this observation is consitent with the law of conservation of charge.

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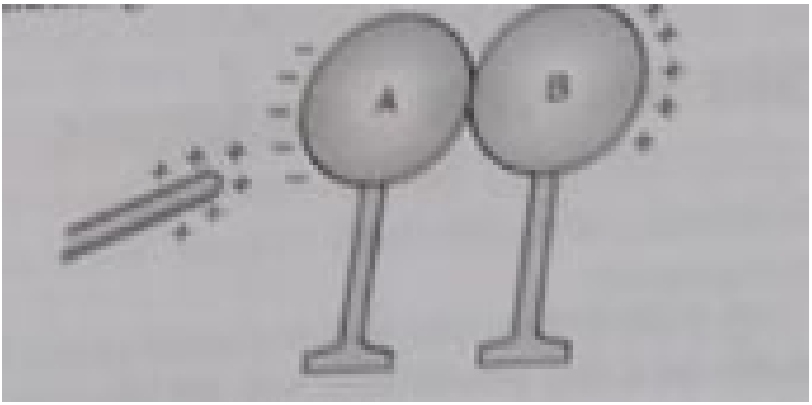
72. A glass rod rubbed with silk is brought close to two uncharged etallic spheres I contact with each other inducing charges on them

as show in the figure



Describe

what happens when the sphers are slightly separated

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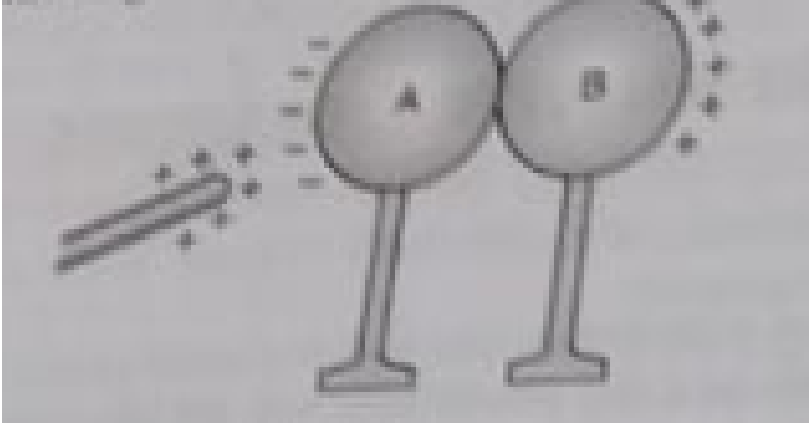
73. A glass rod rubbed with silk is brought close to two uncharged etallic spheres I contact with each other inducing charges on them as show in the figure



Describe what happens when the glass rod is subsequently removed.

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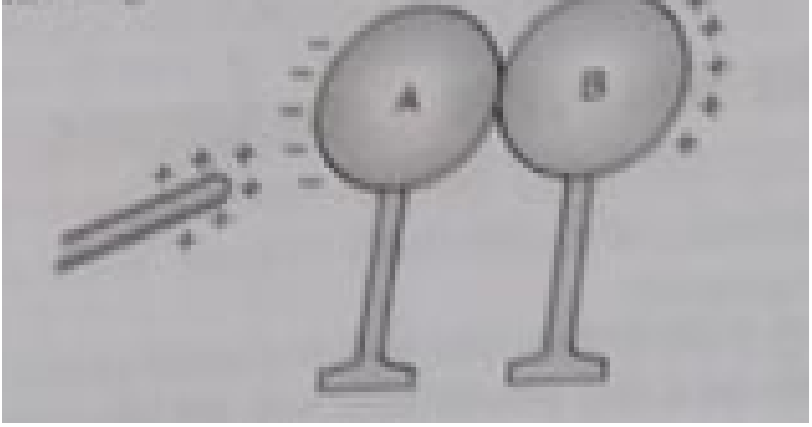
74. A glass rod rubbed with silk is brought close to two uncharged etallic spheres I contact with each other inducing charges on them as show in the figure



Describe what happens when the spheres are separated far apart.

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75. A positively charged glass rod attracts a suspended pith-ball. Does it imply that te pith-ball is negatively charged?

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76. Calculate the Coulomb.s force between two α particles separated by a distance of $3.2 \times 10^{-15} m$

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77. calculate the Coulomb.s force between two protons separated by $1.6 \times 10^{-15} m$

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78. calculate the Coulomb.s force between a proton and electroon separated by $0.8 \times 10^{-15} m$

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79. Force of attractio between two point electric charges placed at a distance .d. in a medium is F. What distance apart should these be kept in the same medium, so that between them beComes $F/3$

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80. State Coulomb's law, explain its vector form and define SI unit of electric charge. State two limitations of Coulomb's law.

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81. What is the importance of Coulomb's law in vector form?

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82. State the limitations of Coulomb's law.

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83. Is Coulomb's law in electrostatics applicable in all situations?

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84. Bring out a comparision between the nature of electrostaic and gravitational forces.

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85. A bird perches on a bare high-power line and nothing happens to the bird. A man standing on the ground touches the same line and gets of fatal shock. Why?

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86. Give the principle of superposition.

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87. Four point charges $q_A = 2\mu C$, $q_B = -5\mu C$. $q_c = 2\mu C$, and $q_D = -5\mu C$ are located at the corners of a square ABCD of side 10 cm. What is the force on a charge of $1\mu C$ placed at the centre of the square?

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88. Two identical point charges of charge Q are kept at a distance r from each other. A third point charge is placed on the line joining the above two charges, such that all the three charges are in equilibrium. Calculate the magnitude and location of the thrid charge.

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89. A charge q is placed at the centre of line joining two equal charges Q. Show that the system of three charges will be in equilibrium if q = -Q/4

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90. State the significane of the Millikan experiment.

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91. In the Millikan experiment, oil droplets were found to have the following charges $: 1.56 \times 10^{-19} C, 4.88 \times 10^{-19} C, 1.64 \times 10^{-19} C$ and $4.76 \times 10^{-19} C$. Use these data to determine a value for the elementary charge. Explain your working.

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92. If you accumulate a static charge and then touch a wooden frame of a door, you often find no spark or shock, although there would be, you touched the metal handle. Why?

Watch Video Solution

93. If you accumulate a static charge and then touch a wooden frame of a door, you often find no spark or shock, although there would be, you touched the metal handle. Why?

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94. Two metallic spheres of exactly equal masses are taken. One is giv en a positive charge q Coulomb and the other an equal negative charge by friction. Are their masses after charging equal?

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95. Suppose we have a large number of identical particles, very small in size. Any two of them at 10 cm separation repel with a force of 3 x 10^-10N.find the value of charge

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96. Suppose we have a large number of identical particles, very small in size. Any two of them at 10 cm separation repel with a force of 3 x 10^-10N. If one of them is at 10 cm from a group of n others, how strongly do you expet it to be repelled?

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97. Suppose we have a large number of identical particles, very small in size. Any two of them at 10 cm separation repel with a force of 3 x 10^-10N. Suppose you measure the repulsion and find it $6 \times 10^{-6} N$. How many particles were there in the group?

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98. It is now believed that protons and neutrons (which constitute nuclei of ordinary matter) are themselves built out of more elementary units called quarks. A proton and a neutron consist of three quarks each. Two types of quarks, the so called 'up' quark (denoted by u) of charge + $(2/3)$ e, and the 'down' quark (denoted by d) of charge $(-1/3)$ e, together with electrons build up ordinary matter. (Quarks of other types have also been found which give rise to different unusual varieties of matter.) Suggest a possible quark composition of a proton and neutron.

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99. Can a charged body attract another uncharged body? Explain.

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100. why does a charged glass rod attract a piece of paper?

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101. Can two balls having same kind of charge on them attract each other? Explain.

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102. The electric force of repulsion on a tiny charged conducting sphere A as a function of its separation form a large conducting sphere B. The sphere B has 10 times the charge on the sphere A. Explain the behaviour of the force between separation 2 cm and 1 cm.

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103. A charge having magnitude Q is divided into two parts q and (Q-q) . If the two parts exerts a maximum force of repulsion on each other, then find the ratio Q/q.

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104. Check that the ratio $k\frac{e^2}{G}m_e m_p$ is dimensionless. Look up a table of physical constants and determine the value of this ratio.

What does the ratio signify.

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105. Explain quantisation of charge.

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106. Which is bigger, a coulomb or charge ona n electron?

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107. How many electrons must be removed from a conductor so that it acquires a charge of $3.5nC$?

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108. What is the amount of charge possessed by 1 kg of electrons? Given that mass of an electron is $9.1 \times 10^{31} kg$.

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109. A polythene piece rubbed with wool is found to have a negative charge of $3 \times 10^{-7} C$. Estimate the number of electrons transferred (from which to which?)

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110. Assme that each of copper atom has one free electron estimate the number of free electrons in 1 mg of copper. Given that atomic weight of copper 63.5 and Avogadro number = 6.02×10^{23}. What is the charge possessed by these free electrons?

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111. Estimate the number of free electrons in 1 g of water and the negative charge possessed by the. Given that Avogadro number $= 6.02 \times 10^{23}$ and molecular weight of water = 18

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112. Two equal charges placed in air separated by a distance 3 m repel each other with force 0.1 g f. Calculate the magnitude of either of the charges.

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113. Two electrons have bene removed from each atom. Find the distance between two such atoms, if they repel each other with a fore of $8.8 \times 10^{-9} N$, when placed in free space.

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114. How far apart should the two electrons be , if the force each exerts on the other is equal to the weight of the electron? Given that

$\upsilon_{)} = 8.854 \times 10^{-12} SIunit, e = 1.6 \times 10^{19} C$ and $m_e = 9.1 \times 10^{-31}$ kg.

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115. Calculate the magnitude of the electrostatic force exerted by the proton on the electron in the hydrogen atom and compare it with the weight of the electron. Given that mass of electron is 9.1×10^{-31} kg, charge on electron is 1.6×10^{-19}C and radius of hydrogen atom is 0.53 $\overset{\circ}{A}$.

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116. Two identical balls each have a mass of 10 g. What charges should these balls be given so that their interaction eq3ualizes the force of universal gravitation acting between them? The radii of the balls may be ignored in comparison to distance between them.

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117. What equal charges would have to be placed on earth and moon to neutralize their gravitational force of attraction ? Given that mass of earth $= 10^{25}$ kg and mass of moon = $10^{23} kg$.

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118. Calculate the ratio of electrostatic to gravitational force between two electrons placed at a certain distance in air. $Given t\widehat{m}_e = 9.1 \times 10^{31} kg, e = 1.6 \times 10^{19} C$ and $G = 6.6 \times 10^{17} Nm^2 kg^{-2}$

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119. Two point charges of $+2\mu C$ and $+6\mu C$ repel each other with a force of 12 N. If each is given additional charge of $-4\mu C$, what will be the new force ?

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120. A pith-ball A of mass 9×10^{-5} kg carries a chargeof $+5\mu c$. What must be the magnitude and sign of the charge on a pith-ball B held 2 cm directly above the pith-ball . A such that the pith-ball. A remains stationary?

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121. Two points charges q_1 and q_2 are 3 m apart and their combined charge is $20\mu C$. If one repels the other with a force of 0.075 N, what are the two charges?

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122. The force between two equal charges placed in a medium at a distance of 9 cm from each other is 16 dyne. On increasing one of the charges by 56 statC, it is found that the distance between the charges must be changed by 3 cm in order to keep the force between them the same Calculate the magnitude of the charges and the dielectric constant of the medium . Given $: 1C = 3 \times 10^9 statC.$

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123. The distance between two equal balls having unlike charges is 2cm. The radii of the balls are much less than the distance between them. The balls attract each other with a force of 36×10^{-5}N. After the ball have been connected by a wire and latter has been removed, the balls repel each other with a force of 20. $25 \times 10^{-5} N$. Determine the original charges on the balls

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124. Two charged particles having charge $5uC$ each are joined by an insulating string of length 1 m and the system is placed on a smooth horizontal table. Find the tension in the string.

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125. Two small spheres each of mass 10 mg are suspended from a poimt by threads 0.5 m long. They are equally charged and repel each other to a distance of 0.28 m. If $g = 10ms^{-2}$, what is the charge on each ?

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126. Two small spheres each of mass $10^6 kg$ are suspended from a point by silk threads 50 cm long. These are equally charged and repel each other to a distance of 20 cm apart. Calculate the charge on each sphere. $Takeg = 10ms^{-2}$

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127. Two pith-balls each of mass 5×10^{-4} kg are suspended from the same point by silk threads 0.2 m long equal charges are given

to the balls, which separate, until the threads enclose an angle of 30°, Calculate the charge on each pith-ball.

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128. Two similar small metallic spheres are suspended by eal threads from the same point. When either sphere is given a similar charge of 36 statC. The distance between them is 6 cm. If the length of each thread is 5 cm, find the mass of each sphere and the tension in each thread.

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129. Two similar small metallic spheres are suspended by eal threads from the same point. When either sphere is given a similar charge of 36 statC. The distance between them is 6 cm. If the length

of each thread is 5 cm, find the mass of each sphere and the tension in each thread.

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130. Two free point charges each of +4q and +q are placed at a distance a apart. Where should a third point charge Q be placed between them so that the entire system is in equilibrium?

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131. Three equally harged objects are located as shown in the figure

the electric force exerted by the object A on B is $3.0 \times 10^{-6} N$. What electric force C exert upon B?

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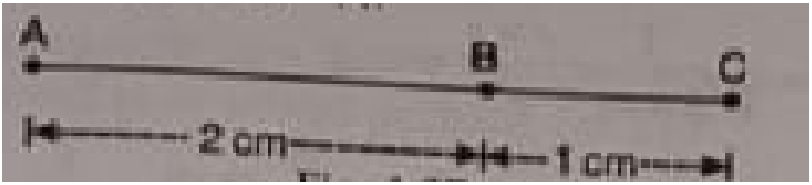
132. Three equally charged objects are located as shown in the figure



the electric force exerted by the object A on B is $3.0 \times 10^{-6} N$. What is the net electric force on B?

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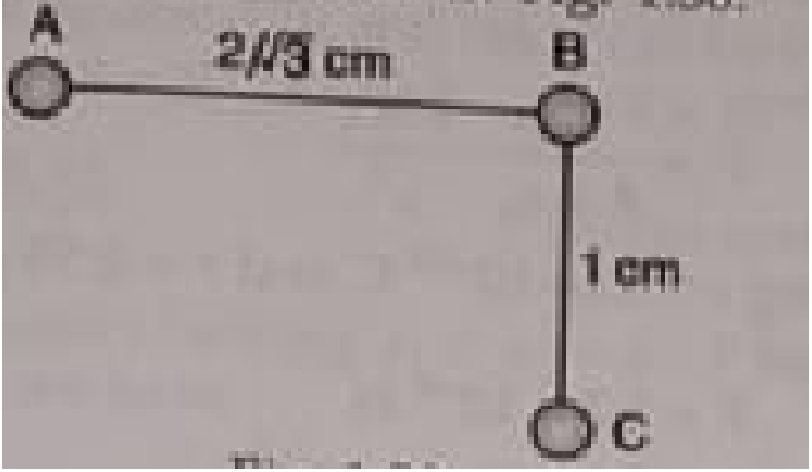
133. Three small charged spheres, with equal charges on them are placed as shown in the figure



A and C are fixed in position and B can move C exerts a force of $4 \times 10^{-6} N on B$. What force A exerts on B?

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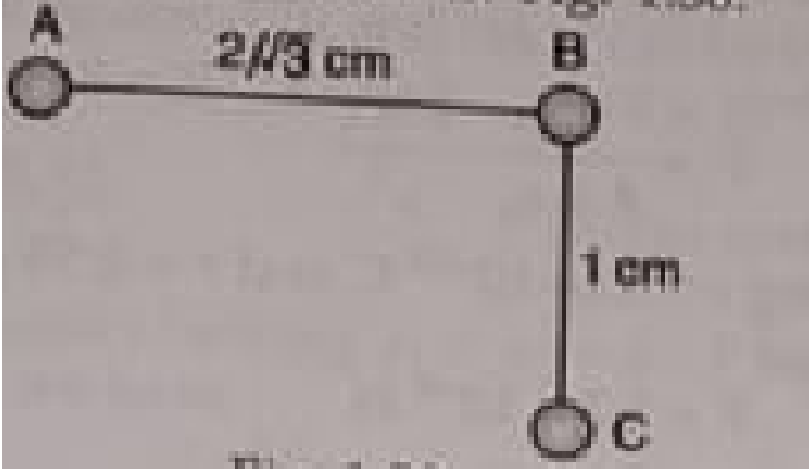
134. Three small charged spheres, with equal charges on them are placed as shown in the figure



A and C are fixed in position and B can move C exerts a force of $4 \times 10^{-6} N$ on B. What is the net force on B?

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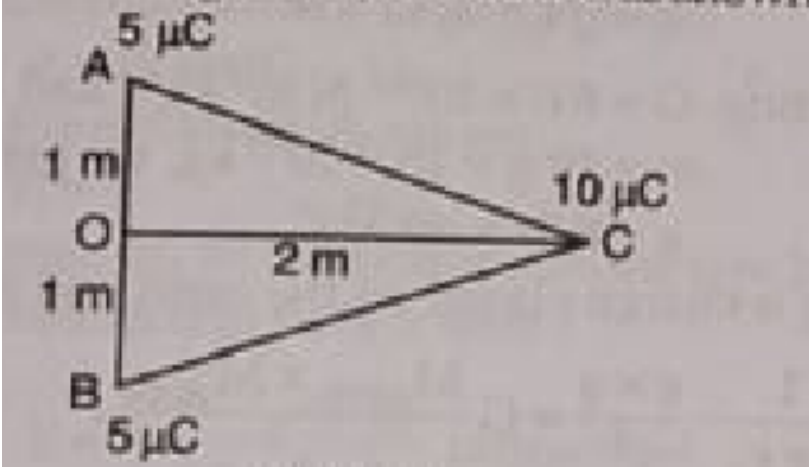
135. Two equal positive charges, each of $5\mu C$ interact with a third positive charge of $10\mu C$ situated as shown in the figure.



Find the magnitude and direction of the force experinced by the charge of $10\mu C$

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136. Three equal charges, each haing a charge of $+2 \times 10^{-6} C$ are placed at the three corners of a right angled triangle of sides 3 cm, 4 cm and 5 cm. Find the force on the charge at the right -angled corner.

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137. Two charges of $+2 \times 10^{-8} C$ and $-10^{-8} C$ are placed at points A and B respectively. Find the resultant force on a charge of $1 \mu C$ held at point P, such that $AP = 10 cm$, $BP = 5 cm \angle \angle APB = 90^{\circ}$

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138. Charges of $+5 \mu C$, $+10 \mu C$ and $-10 \mu C$ are placed in air at the corners A,B and C of an equilateral triangle ABC, having each side equal to 5 cm. Determine the resultant force on the charge at A.

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139. Four charges +q'+q' - q and -q are placed respe tively at the four croners A,B,C and D respectively of a square of side a .

Calcualte the force on a charge Q placed at the centre of the square.

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140. Two opposite corners of a square carry Q charges each and the other two opposite corners of the square carry q charge each. If the resutlant force on Q is zero, how are Q and q related?

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141. A copper atom consists of copper nucleus surrounded by 29 electrons. The atomic weight of copper is $63.5 mole^{-1}$. Let us now take two pieces of copper each weighing 10g. Let us trandfer one elcetron from one piece to another for every 100 atoms in that piece. What will be the Coulomb force between the two pieces after

the trandfer of electrons, if they are 1cm apart? Avogadro number= $6 \times 10^{23} \text{mol } e^{-1}$, charge on an electron =-$1.6 \times 10^{-19} C$.

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142. A paritcle of mass m and carrying charge $-q_1$ is movign around a charge $+q_2$ along a circular path of radius r. Prove that period of revolution of the charge $-q_1$ about $+q_2$ is given by $T = \sqrt{\frac{16\pi^3 \upsilon_0 m r^3}{q_1 q_2}}$

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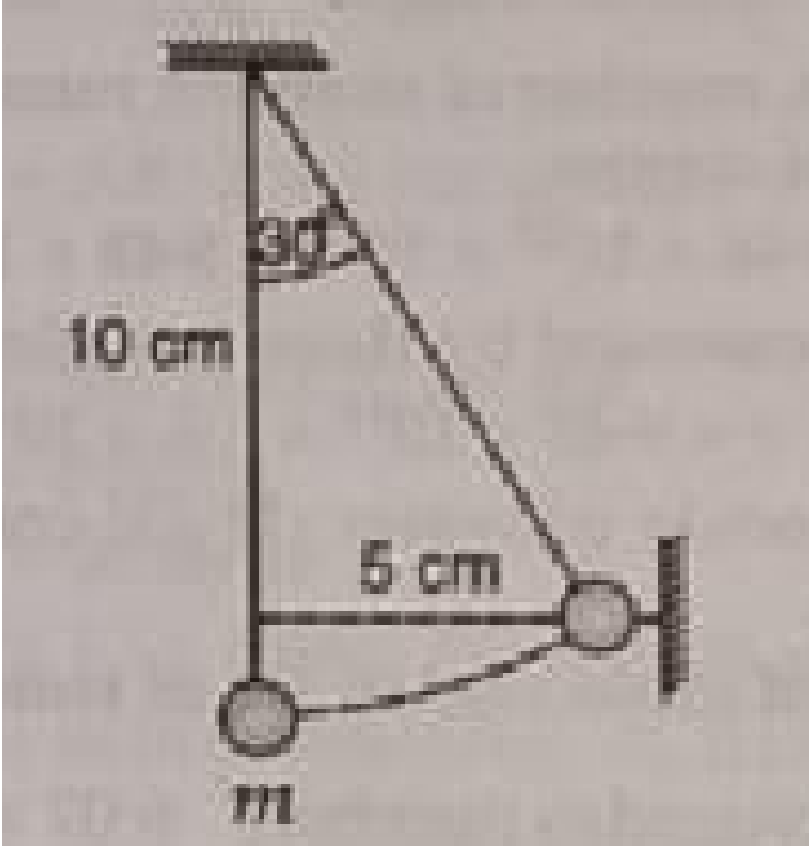
143. A small cork ball with a mass 0.58 g is suspended from a thread 10 cm long. Another ball is fixed at a distance 10 cm from the point of suspension and at a distance of 5 cm from the thread as shown in the figure



What shoud the magnitude of the like and equal charges on the balls be t deflect the thread through 30° ?

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144. Two point electric charges of value q and 2q are kept at a distance d apart from each other in air. A third charge Q is to be

kept along the same line in such a way that the net force action on q and 2q is zero. Calculate the position of charge Q in terms of q and d.

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145. Two fixed point charge 4Q and 2Q are separated by a distance x. where should a third point charge q be placed for ti to be in equilibrium?

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146. Two free point charges each of +4q and +q are placed at a distance a apart. Where should a third point charge Q be placed between them so that the entire system is in equilibrium?

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147. It is required to hod four equal point charges +q in equilibrium at the corners of a square . Find the point charge that will do this, if placed at the centre of the square.

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EXERCISE

1. Explain conservation of charge giving two examples.

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2. Discuss Conservation of charge.

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3. Explain quantisation of charge.

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4. Give six properties of electric charge.

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5. State Coulomb's law and derive definition of a unit charge (coulomb).

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6. State and explain Coulomb's law of force in electrostatics. What are its limitations? Define one coulomb of charge using this law.

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7. State Coulomb's law, explain its vector form and define SI unit of electric charge. State two limitations of Coulomb's law.

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8. Write the vector form of force acting between two charges q_1 and q_2 having $\vec{r}_1$ and $\vec{r}_2$ as their position vectors respectively.

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9. State Coulomb's law in electrostatics.

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10. State Coulomb's law in vector form and prove that $\vec{F}_{21} = -\vec{F}_{12}$ where letters have their usual meanings.

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11. What is meant by continuous charge distribution? Describe different types of continuous charge distribution and give expression for total charge in each case.

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12. Define surface charge density. Obtain expression for force on a charge q due to a continuous distribution of charges over a surface.

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13. Explain the terms quantization of charge

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14. Discuss Conservation of charge.

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15. Explain the terms addtive nature of charge.

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16. Define dielectric constant of a medium in terms of fore between two electic charges.

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17. Explain , what is meant by dielectric constant. Give some example.

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18. State and explain Coulomb's law of force in electrostatic. What is the SI unit of charge and hence define one coulomb of charge using this law?

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19. State Coulomb's law in electrostatics. Express the same in SI units. Mention two similarities and two dissimilarities between electrostaic and gravitational interactions.

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20. What is the importance of Coulomb's law in vector form?

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21. State the principle of superposition and use it to obtain the expression for the total electric force exerted at a point harge due to an assembly of n discrete point charges.

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22. Find an expression for the total force acting on a given charge due to a number of other charges, when the source charges are point charges.

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23. Distinguish between linear, surface and volume charge density. Obtain expression for force on a charge q due to continuous distribution of charge over a volume.

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