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~ Electrostatics ~
Important Numerical Questions

1. Calculate the value of two equal charges if they repel one another by a force of 1.0N when situated 1m apart in vacuum. If the space between them is filled with an insulating medium whose relative permitivity is 10, calculate the new force between them.
   (Ans: 1.05×10^{-5}C, 0.1N)

2. An α-particle is a nucleus of doubly ionized helium. It has a mass m of 6.68×10^{-27} kg and a charge q of +2e or 3.2×10^{-19} C. Compare the force of electrostatic repulsion between two α-particles with the force of gravitational attraction between them.
   (Ans: $F_e = 3.1 \times 10^{35} F_g$)

3. How many excess electrons must be placed on each of two small spheres spaced 3cm apart if the force of repulsion between the spheres is to be 10^{-19} N?
   (Ans: 625)

4. How far does the electron of a hydrogen atom have to be removed from the nucleus for the force of attraction to equal the weight of the electron at the surface of the earth?
   (Ans: 5.08m)

5. Two point charges +1μC and +4μC are placed at a distance of 0.12m from each other. Determine the point on the line joining two charges where net force acting on the unit positive charge is zero.
   (Ans: 0.04m from 1μC)

6. Two charges of magnitude +3.6μC and -3.6μC are placed at the corners A and B of an equilateral triangle ABC of side 6cm. Find the force experienced by a charge +2μC placed at C.
   (Ans: 18N, 60˚)

7. Three equal charges of 4×10^{-7}C are located at the corners of a right angled triangle whose sides are 6.0cm, 8.0cm and 10.0cm respectively. Find the force exerted on the charge located at 90˚ angles.
   (Ans: 0.459N, 29.36˚)

8. An electron of charge 1.6×10^{-19}C is situated in uniform electric field of intensity 12000Vm^{-1}. Find the time it takes to travel 1cm from rest.
   (Ans: 3×10^{-9}s)

9. Two point charges of magnitude 1.0×10^{-8}C and 2.0×10^{-8}C are 30cm apart in air. Find the electric field at a point midway between them.
   (Ans: $4 \times 10^{3} NC^{-1}$)

10. Two small spheres of charge +10 and +40μC are placed 6cm apart. Find the location of a point between them where the field strength is zero.
    (Ans: 0.02m)

11. Two charges -1μC and 2μC are placed at the corners A and B of an equilateral triangle ABC of side 2m. Calculate the electric field at C.
(Ans: $3897.11NC^{-1}$, 90°)

12. The point A, B and C form an equilateral triangle of side 1cm. Point charges of 1μC magnitude are placed at A and B. Find the electric field at C due to these charges when both charges are positive.
(Ans: $1.55x10^{8}NC^{-1}$, 30°)

13. How many excess electrons must be added to an isolated spherical conductor 32cm in diameter to produce an electric field of 1150N/C just outside the surface?
(Ans: $2.04x10^{10}$)

14. A hollow spherical conductor of radius 12cm is charged to $6x10^{-6}$C. Find the electric field strength at the surface of sphere, inside the sphere at 8cm and at distance 15cm from the sphere.
(Ans: $0.375x10^{7}NC^{-1}$, 0, $0.24x10^{7}NC^{-1}$)

15. A charged oil drop of radius $1.3x10^{-6}$m is prevented from falling under gravity by the vertical field between two horizontal plates charged to a difference of potential 8340V. The distance between the plates is 16mm and the density of oil is $920kgm^{-3}$. Calculate the magnitude of the charge on the drop.
(Ans: $1.62x10^{-19}$C)

16. A charged oil drop remains stationary when situated between two parallel horizontal metal plates between which there is an electric field of intensity 2×10^{4} Vm^{-1}. If the mass of the drop is 4.8×10^{-15}kg, find the number of electrons attached to the drop.
(Ans: 15)

17. Two large parallel metal plates carry opposite charges. They are separated by 0.1m and the potential difference between them is 500 V. (a) What is the magnitude of electric field, if it is uniform, in the region between the plates? (b) Compute the work done by this field on a charge of 2×10^{-9}C as it moves from the higher potential plate to the lower.
(Ans: (a) $5000Vm^{-1}$ (b) $1x10^{-6}$J)

18. A total electric charge of 4.0×10^{-9}C is distributed uniformly over the surface of a sphere of radius 0.20m. If the potential is zero at a point at infinity, what is the value of the potential (a) at a point on the surface of the sphere (b) at a point inside the sphere, 0.10m from the center?
(Ans: (a) 180V (b) 180V)

19. What distance must an electron move in a uniform potential gradient $200Vcm^{-1}$ in order to gain kinetic energy $3.2x10^{-18}$J? ($e=1.6x10^{-19}$C, $m_e=9x10^{-31}$kg)
(Ans: $9.87x10^{-4}$m)

20. An electron is liberated from a hot filament and attracted by an anode of potential 1200V positive with respect to the filament. What is the speed of the electron when it strikes the anode? (e/m of the electron is $1.8x10^{11}Ckg^{-1}$)
(Ans: $2.08x10^{7}ms^{-1}$)

21. An electron is liberated from the lower of two large parallel metal plates separated by a distance 20mm. The upper plate has a potential of 2400V relative to the lower. How long does the electron take to reach it? ($e/m=1.8x10^{11}Ckg^{-1}$)
(Ans: $1.36x10^{-9}$s)

22. Three equal charges 1.8×10^{-6}C each are located at the corners of an equilateral triangle ABC whose sides are 6cm. Calculate the electric potential at a point midway between AB.
(Ans: 13.91×10^{5}V)

23. Small charges of $+2 \times 10^{-9}$C, -2×10^{-9}C, $+3 \times 10^{-9}$C and -6×10^{-9}C are placed at the corners of a square of diagonal 0.20m. Calculate the electric potential at the centre.
(Ans: -270V)

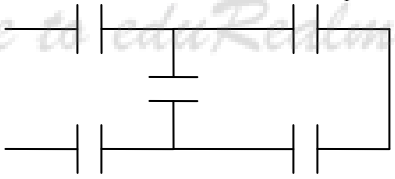
24. A small positively charged particle X moving with a velocity of 10^{7}ms^{-1} approaches head-on a fixed particle Y having a positive charge of 2×10^{-17}C. If the mass of X is 7×10^{-27}kg and its charge is 3.2×10^{-19}C, calculate the closest distance of approach of X to Y.
(Ans: 1.7×10^{-13}m)

25. A sheet of paper 40mm wide and 1.5×10^{-2}mm thick between metal foils of the same width is used to make a 2.0μF capacitor. If the dielectric constant of the paper is 2.5, what length of paper is required?
(Ans: 33.9m)

26. A thundercloud and the earth can be regarded as a parallel plate capacitor. Taking the area of the thundercloud to be 50km^2, its height above the earth as 1km and its potential 100KV, calculate the energy stored.
(Ans: 2.2×10^{3}J)

27. The three capacitors 3μF, 10μF and 15μF are connected in series with a 100V cell. What is the charge and potential difference on each capacitor?
(Ans: 200μC, 66.7V, 20V, 13.3V)

28. In the given capacitor circuit applied potential between ab is 220V, what is the equivalent capacitance of the network between a and b? Given $C_1 = C_5 = 8.4\mu F$ and $C_2 = C_3 = C_4 = 4.2\mu F$.



(Ans: 2.52×10^{-6}F)

29. A parallel plate air capacitor has a capacitance of 10^{-9}F. What potential difference is required for a charge of 0.5×10^{-6}C on each plate? What is the total energy stored?
(Ans: 500V, 1.25×10^{-4}J)

30. A 1μF capacitor and 2μF capacitor are connected in parallel across a 1200V supply line. Find the charge on each capacitor. The charged capacitors are now disconnected from the line and from each other and reconnected with the terminals of unlike sign together. Find the final voltage across each.
(Ans: 1.2×10^{-3}C, 2.4×10^{-3}C, 400V)

31. Two capacitors of capacitances 4μF and 6μF respectively are connected in series and combination connected momentarily across a 100V battery. The charged capacitors are now isolated and then connected in parallel, similar charged plates being connected together. What would be the resulting potential difference across the combination?
(Ans: 48V)

32. A capacitor of capacitance 4μF is charged to potential of 100V and another of capacitance 6μF is charged to potential of 200V. These capacitors are now joined with plates of like charge connected together. Calculate (i) the potential across each after joining (ii) the total electric energy before joining (iii) the total electric energy after joining.
(Ans: (i) 160V (ii) 0.14J (iii) 0.128J)

33. A charged 20μF capacitor A is connected to an electrostatic voltmeter of infinite resistance and negligible capacitance which reads 500V. A 0.25μF capacitor B is now connected in parallel with A. The capacitor B is then disconnected from A. Calculate the charge on capacitor A and B separately and the final reading of voltmeter.
(Ans: 9876.6μC, 123.46μC, 493.93V)