Physics 2

Set 2

1. Please calculate the total negative charge on the electrons in 1 mol of helium (atomic number 2, molar mass 4)

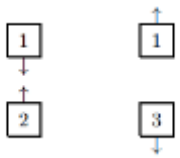
2. To make an uncharged object have a negative charge we must:
   A. add some atoms
   B. remove some atoms
   C. add some electrons
   D. remove some electrons
   E. write down a negative sign

3. To make an uncharged object have a positive charge:
   A. remove some neutrons
   B. add some neutrons
   C. add some electrons
   D. remove some electrons
   E. heat it to cause a change of phase

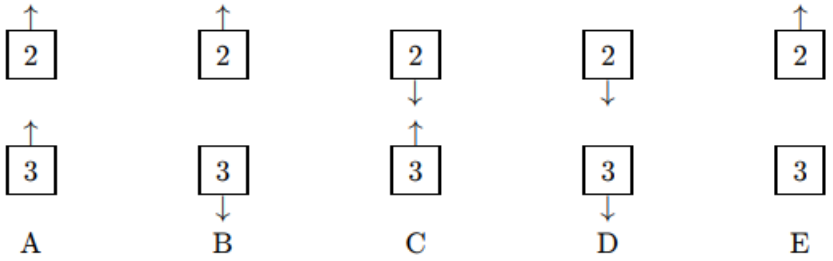
4. An electrical insulator is a material:
   A. containing no electrons
   B. through which electrons do not flow easily
   C. that has more electrons than protons on its surface
   D. cannot be a pure chemical element
   E. must be a crystal

5. A conductor is distinguished from an insulator with the same number of atoms by the number of:
   A. nearly free atoms
   B. electrons
   C. nearly free electrons
   D. protons
   E. molecules

6. The diagram shows two pairs of heavily charged plastic cubes. Cubes 1 and 2 attract each other and cubes 1 and 3 repel each other.



Which of the following illustrates the forces of cube 2 on cube 3 and cube 3 on cube 2?

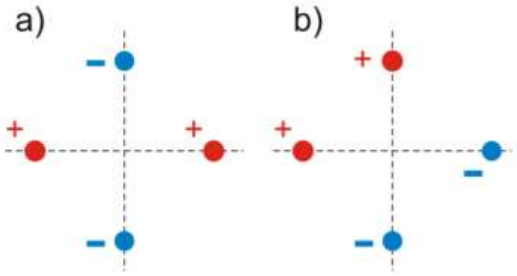


7. Using Coulomb's law, please calculate the force of electrostatic attraction between an electron and a proton in a hydrogen atom. Assume $r = 5 \cdot 10^{-11}$ m. Compare this force with the gravitational attraction between these particles. The mass of the proton $m_p = 1.67 \cdot 10^{-27}$ kg and the mass of the electron $m_e = 9.11 \cdot 10^{-31}$ kg. The gravitational constant $G = 6.7 \cdot 10^{-11}$ Nm^2/kg^2 .

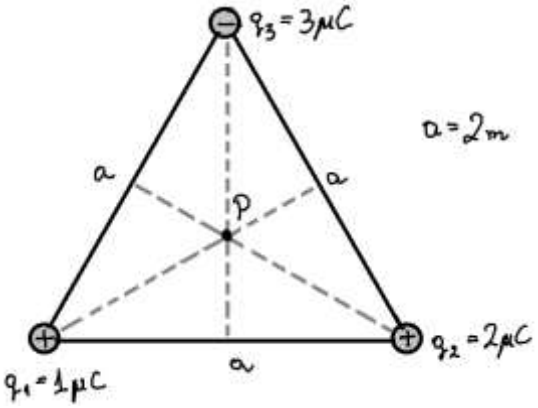
E 8. A small object has charge Q. Charge q is removed from it and placed on a second small object. The two objects are placed r = 1 m apart. Please find q if the force that each object exerts on the other has a maximal magnitude.

E 11. Two point charges q and 4q are located in air at a distance d from each other. Please find points on a straight line passing through these charges the electric field will be equal 0.

12. Please find the magnitude of electric field at the centre of the system of four charges shown in the figures below. All the charges are at equal distances *a* from the centre and have equal absolute values Q



E 13. Three charges are placed at the vertices of an equilateral triangle (as shown in the figure).



Please:

a) calculate the force (magnitude) exerted by charges 1 and 2 on charge 3,

b) determine the electric field magnitude in the center of the triangle (at point P)

14. Charge is placed on the surface of a 2.7-cm radius isolated conducting sphere. The surface charge density is uniform and has the value $6.9 \cdot 10^{-6} C/m^2$. Please:
a) find the total charge on the sphere,
a) determine the electric field inside the sphere.

15.The charge q is evenly distributed on non-conductive ball with a radius R. Calculate the electric field as a function of distance r from the centre of the ball: outside the ball and inside the ball.

16. When a piece of paper is held with one face perpendicular to a uniform electric field the flux through it is 25 Nm^2/C. Please find:

a) the flux when the paper is turned 25° with respect to the field,

b) magnitude of the electric field vector, if dimensions of the piece of paper are: 30 cm and 50 cm.

17. A point charge is placed at the center of a spherical Gaussian surface. The electric flux is changed if:

A) the sphere is replaced by a cube of the same volume
B) the sphere is replaced by a cube of one-tenth the volume
C) the point charge is moved off center (but still inside the original sphere)
D) the point charge is moved to just outside the sphere
E) a second point charge is placed just outside the sphere

18. A conducting sphere of radius 0.01 m has a charge of $1.0 \cdot 10^{-9}$ C deposited on it. Please determine the magnitude of the electric field just outside the surface of the sphere.

19. Please calculate the electric field around the infinitely long linear bar. It is charged with density λ.

20. A long line of charge with λ_E charge per unit length runs along the cylindrical axis of a cylindrical shell which carries a charge per unit length of λ_c. Please find the charge per unit length on the inner and outer surfaces of the shell.

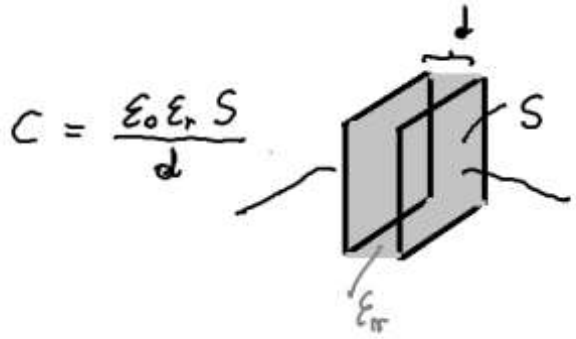
21. Please determine the electric field generated by:

- one plane charged with a surface density σ,
- two parallel planes, one of which is charged with a surface density σ_1 and the other with σ_2.

22. Positive charge is distributed uniformly throughout a non-conducting sphere. Please discuss the dependency of electric potential *vs*. the distance from the centre of the sphere.

E 23. Each plate of a capacitor stores a charge of magnitude 1 mC when a 100-V potential difference is applied. Please find the capacitance and capacitor energy (energy cumulated in electric field inside the capacitor).

24. Please prove that the capacitance C of a parallel-plate capacitor with plate area S and plate separation d is given by:



E 25. Charge is distributed uniformly on the surface of a large flat plate. The electric field for r_1 = 2 cm from the plate is 30 N/C. Please determine the electric field for r_2 = 4 cm from the plate.

26. A 2μF and a 1μF capacitor are connected in (a) parallel ; (b) in series and a potential difference U = 40 V is applied across the combination. Please find the charge stored on each capacitor and the energy of each capacitor.

E 27. The plate areas and plate separations of five parallel plate capacitors are

capacitor 1: area A_0, separation d_0

capacitor 2: area $2A_0$, separation $2d_0$

capacitor 3: area $2A_0$, separation $d_0/2$

capacitor 4: area $A_0/2$, separation $2d_0$

capacitor 5: area A_0, separation $d_0/2$

Please rank these according to their capacitances, least to greatest.

E 28. A parallel-plate capacitor has a plate area of 0.2 m^2 and a plate separation of 0.1 mm. Please find the potential difference across the plates if the charge on each plate has a magnitude of $4 \cdot 10^{-6}$ C.