Exam Review
Problem Set 2 (Fields)

1. Calculate the distance from the sun to Saturn, given the information that Saturn's period of revolution about the sun is 29.46 years.

2. Use the known period of 27.3 days for the motion of the moon about the earth and the distance from the earth to the moon is $3.84\times10^{8}\ m$ to calculate the radius of the orbit of an earth satellite that stays above the same point on the equator.

3. Compute the gravitational force between the sun $\left(M=1.99\times10^{30}\ kg\right)$ and the planet Uranus $\left(m=8.69\times10^{25}\ kg,\ r=19.2\ AU\right)$.

4. Calculate the mass of Jupiter from the knowledge that its satellite Io orbits at an average distance of $4.22\times10^{5}\ km$ from its center with an orbital period of $42.5\ h$.

5. Calculate the orbital period of Venus from knowledge of G, the mass of the sun $\left(M=1.99\times10^{30}\ kg\right)$, and the Venusian orbit radius of $1.08\times10^{11}\ m$.

6. Calculate the mass of the sun from the radius of the earth's orbit $\left(1.5\times10^{11}\ m\right)$, the earth's period in its orbit, and the gravitational constant G.

7. Assume that the orbit of the moon about the earth is a perfect circle with a center-to-center distance form earth to moon of $3.84\times10^{8}\ m$. (a) What is the gravitational force between the earth and the moon? (b) What is the speed of the moon in its orbit? Give your answer in meters per second.

8. An astronaut weighing $700\ N$ on earth travels to the planet Mars. What does the astronaut weigh on Mars? (The mass of Mars is $6.4\times10^{23}\ kg$. The radius of Mars is $3.38\times10^{6}\ m$.)

9. A point charge of $+6.3\ \mu C$ is located $0.15\ m$ from a second point charge of $-4.8\ \mu C$. What are the magnitude and direction of the force on each charge?

10. Two charges of equal magnitude exert an attractive force of $4.0\times10^{-4}\ N$ on each other. If the magnitude of each charge is $2.0\ \mu C$, how far apart are the charges?

11. Two charged Styrofoam balls are moved so that the force between them becomes twelve times greater than it was originally. What is the ratio of their new separation to their original separation?

12. Two point charges of magnitude $+9.0\ \mu C$ are separated by a distance $30.0\ cm$. A third charge of equal magnitude and opposite sign is placed midway between the two positive charges.

    a) What is the net electrostatic force on the end charges?

    b) What is the net electrostatic force on the middle charge?

13. Three equal charges are placed at the corners of an equilateral triangle $0.50\ m$ on a side. What are the magnitude and the direction of the force on each charge if the charges are $-3.7\ nC$?

14. What is the electric field strength E at a point $0.200\ m$ from a point charge of $+1.75\ \mu C$?

15. A proton of charge $q = +1.60 \times 10^{-19}\ C$ is placed in a region of uniform electric field with field strength $\varepsilon = 1.46 \times 10^{5}\ N/C$. What is the electric force on the proton?

16. A proton accelerates from rest to $3.00 \times 10^{6}\ m/s$ in $1.00 \times 10^{-6}\ s$ in a uniform electric field E. What is the magnitude of the electric field? (The proton has a mass $m_p = 1.67 \times 10^{-27}\ kg$ and a charge $q = +1.60 \times 10^{-19}\ C$.)

17. A charge of $+3.0 \times 10^{-6}\ C$ is located at the point $x = +0.10\ m$, $y = 0$. A second charge of $-3.0 \times 10^{-6}\ C$ is located at $x = -0.10\ m$, $y = 0$. What are the magnitude and the direction of the electric field at (a) the point $x = 0$, $y = 0$ and (b) the point $x = 0$, $y = +0.30\ m$?

18. What is the electric potential at a point $0.45\ m$ away from a point charge of $2.5\ mC$?

19. If $3.75 \times 10^{-4}\ J$ of work are required to move $13.7\ \mu C$ of charge from one point to another, what is the electric potential difference between the two points?

20. A proton of mass $m_p = 1.67 \times 10^{-27}\ kg$ and charge $q = +1.60 \times 10^{-19}\ C$ is accelerated from rest through an electric potential of $300\ kV$. What is its final velocity?

21. How much work is required to move an electron $0.015\ m$ through a uniform electric field of $7.65\ V/m$?

22. Alpha particles from a particular radioactive source have a speed of $1.85 \times 10^{7}\ m/s$. How large a magnetic field is required to bend the path of the particles into a circle of $0.580\ m$ radius? An alpha particle has a mass of $6.64 \times 10^{-27}\ kg$ and a charge of $3.20 \times 10^{-19}\ C$.

23. A proton of charge $+1.60 \times 10^{-19}\ C$ and mass $1.67 \times 10^{-27}\ kg$ is introduced into a region of $B = 1.15\ T$ with an initial velocity of $1.25 \times 10^{6}\ m/s$ perpendicular to B. What is the radius of the proton's path?

24. Suppose the electric field between the electric plates in the mass spectrometer shown below is $2.48\times10^{4}\ V/m$ and the magnetic fields $B = B' = 0.75\ T$. The source contains boron isotopes of mass numbers 10 and 11 (to get their masses, multiply by $1.67\times10^{-27}\ kg$). How far apart are the lines formed by the singly charged $(+e)$ ions of each type on the fluorescent film?