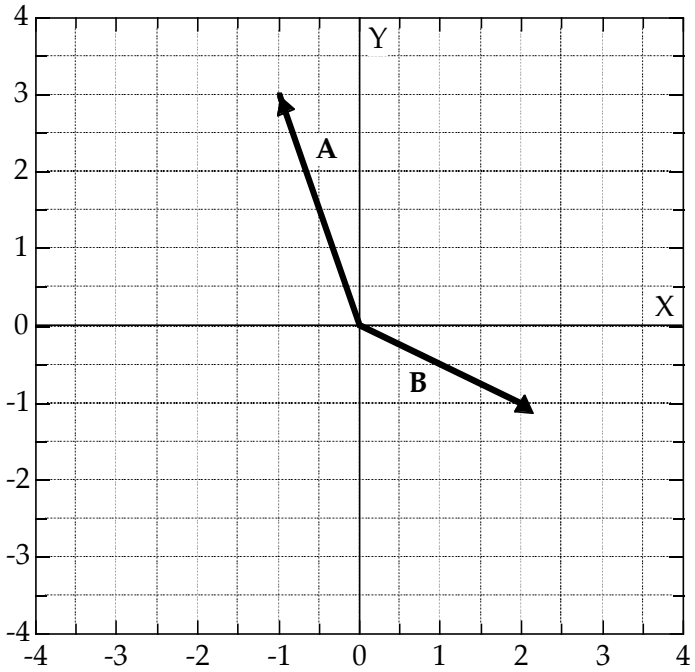
1. Consider vectors **A** and **B** in the sketch.



A. Sketch the sum $\vec{\mathbf{S}} = \vec{\mathbf{A}} + \vec{\mathbf{B}}$ and the difference $\vec{\mathbf{D}} = \vec{\mathbf{A}} - \vec{\mathbf{B}}$.

B. What are the **x** and **y** components of **S**?

C. Rank the magnitudes of the vectors $|\vec{\mathbf{A}}|$, $|\vec{\mathbf{B}}|$, $|\vec{\mathbf{D}}|$, $|\vec{\mathbf{S}}|$ (use >, <, =). Justify your answer.

D. What is the dot product $\vec{\mathbf{A}} \bullet \vec{\mathbf{B}}$?

E. What is the cross product $\vec{\mathbf{A}} \times \vec{\mathbf{B}}$? In which direction does it point?

2. Consider a point particle at rest at the origin with mass $m = 9 \times 10^{-31}$ kg. A force $\vec{\mathbf{F}} = 1.8 \times 10^{-15} N \ \hat{\mathbf{x}}$ acts on the particle from time $0 \le t < 10^{-9}$ sec. There is no force on the particle for $t < 0$ sec or $t \ge 10^{-9}$ sec.
(This is similar to an electron in the electric field across a light socket).

A. What are the acceleration vector **a**, velocity vector **v** and displacement vector **x** at times:

i) $t_1 = -0.5$ nsec

ii) $t_2 = +0.5$ nsec

iii) $t_3 = +1.0$ nsec

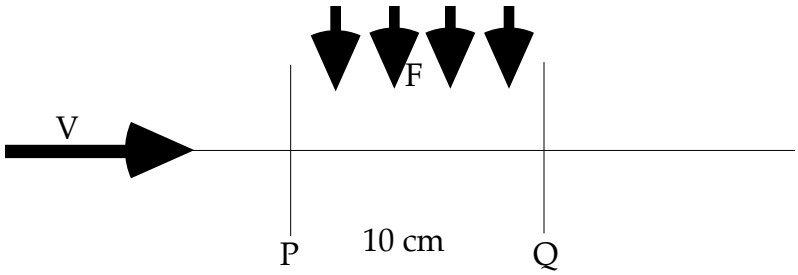
iv) $t_4 = +2.0$ nsec

B. What is the kinetic energy at time $t = 1.0$ sec?

C. Find the work done on the particle.

3. Consider a point particle with mass $m = 9 \times 10^{-31}$ kg moving with constant velocity in the **x**-direction: $\vec{\mathbf{v}} = v_o \ \hat{\mathbf{x}} = 3.3 \times 10^{+6} \ m/s \ \hat{\mathbf{x}}$. A constant force $\vec{\mathbf{F}} = -4.5 \times 10^{-17} N \ \hat{\mathbf{y}}$ acts on the particle over a 10 cm path.
(These numbers are similar to an electron moving through the deflection plates in TV or computer monitor)

A. On the drawing below, sketch the path taken by the particle. Label parts of the path as straight lines, parabolas, circular arcs, etc.



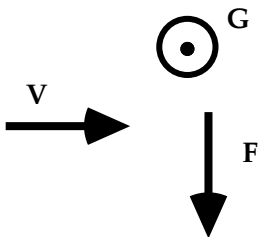
B. What is the time t_o taken by the particle to travel through the force region (10 cm wide)?

C. What is the **x**-component of the velocity as the particle passes through plane Q?

D. What is the **z**-component of the velocity at plane Q?

E. What is the **y**-component of the velocity at plane Q?

4. A point particle is acted on by a force that is *always* perpendicular to its velocity, $\vec{\mathbf{F}} = \vec{\mathbf{v}} \times \vec{\mathbf{G}}$ (**G** is a vector. In the case at the right, **G** is perpendicular to **v**).
(This happens when an electron moves through a magnetic field)



A. Does this force do work on the particle? Why or why not?

B. The particle will follow a circular path. Why?

C. Find the radius of the circular path in terms of the mass m, the velocity v and the force generating field G.

5. The gravitational force of mass M_1 acting on mass M_2 is given by $\vec{\mathbf{F}}_G = -\frac{GM_1M_2}{r_{12}^2}\hat{\mathbf{r}}_{12}$,
where $G = 6.67 \times 10^{-11}\ \mathrm{Nm^2/kg^2}$. Sodium (Na) has atomic weight 23 g/mole; Chlorine (Cl) has atomic weight 35 g/mole. The mass of a proton or neutron is 1.7×10^{-24} g. 1 mole = 6×10^{23} atoms.

a) What is the magnitude of the gravitational force on a Na atom exerted by a Cl atom when separated by 2.36×10^{-8} cm? (the interatomic spacing in salt)

b) How does the gravitational force exerted by the Na on the Cl compare to the gravitational force of the Cl on the Na? Explain your reasoning.