Note: $\varepsilon_0 = 8.85 \times 10^{-12} C^2/Nm^2$, and $k_e = 9 \times 10^9 \, Nm^2/C^2$

Answer the following questions (55 Marks; 5 each):

1- What are differences between the velocity and the speed?
2- What is the SI unit of the coefficient of kinetic friction?
3- What is the momentum of a 2500-kg truck travelling at 60 m/s?
4- What is the SI unit of the shear modulus?
5- What is the SI unit of the tensile Stress?
6- Which of the following are vector quantities: Displacement, speed, torque, time, weight, speed, impulse, momentum?
7- Two charges of 12.3 nC and –21.15 nC are inside a cube, find the net electric flux through the surface of the cube?
8- What are differences between the torque and the work?
9- What is the angle between the electric field line and the equipotential surface?
10- A 1000-kg airplane moves in straight flight at constant speed. What is the net force on the airplane?
11- A 5 Kg object has initial velocity of $\vec{v}_i = 6\hat{i} + 2\hat{j}$ m/s and final velocity of $\vec{v}_f = 8\hat{i} + 6\hat{j}$, Find the impulse?

Solve the following Problems (45 Marks):

Problem 1 (15 Marks) Consider three point charges located at the three corners of Square of side $a = 10^{-1}m$. Where $q_1 = q_3 = 5\,nC$ and $q_2 = -2\,nC$. As shown in the figure.

(A) Find the resultant force (net force) exerted on q_3?
(B) Find the total potential at point D?
(D) Find the potential energy of the system of charges?
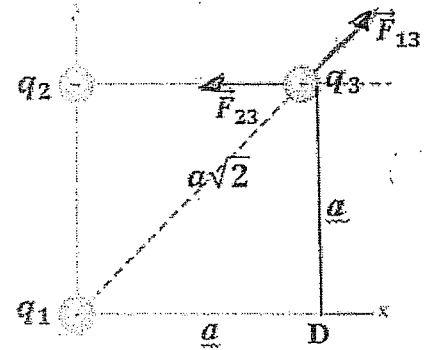
Problem 2 (15 Marks) A proton (charge $+e = 1.602 \times 10^{-19}C$) moves with velocity of $\vec{v} = 2\hat{i} - 4\hat{j} + \hat{k}$ (m/s) in a region in which the magnetic field is $\vec{B} = \hat{i} + 2\hat{j} - 3\hat{k}$ (T). (1)- What is the magnetite of the magnetic force this charge experience? (2)- What is the angle between the velocity and the magnetic field?

Problem 3: (15 Marks) A block of mass $m_1 = 15\,Kg$ on a horizontal frictionless surface is connected to a ball of mass $m_2 = 5\,Kg$ by a lightweight cord over a lightweight, frictionless pulley as shown in the Figure. A force of magnitude F=180 N at an angle $\theta = 30°$ with the horizontal is applied to the block as shown, and the block slides to the right. Determine the tension in the cord and the magnitude of the acceleration of the two objects. g = 10 m / s².
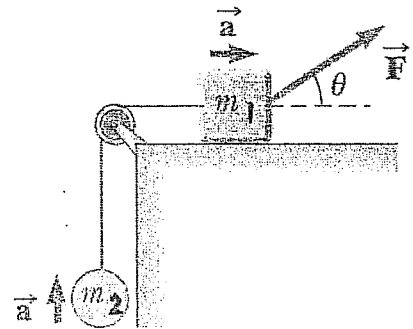
The end of questions Good luck

1- velocity — vector quantity $\sum \vec{v} = 0$, speed is scalar quantity ⊕

speed = $|\vec{v}|$ (5 Marks)

② — pure number without unit   (5 Marks)

③ $P = m\vartheta = 2500(60) = 150\,000$ kg m/s (5 Marks)

④ N/m^2 or Pa (5 Marks)

⑤ N/m^2 or Pa (5 Marks)

⑥ Displacement, torque, weight, impulse, momentum
                                    (5 Marks)

⑦ $\phi_E = \dfrac{q_1 + q_2}{\varepsilon_0} = -1000$ $\dfrac{Nm^2}{C}$ (5 Marks)

⑧ torque is vector quantity, Nm its unit, $\vec{\tau} = \vec{r} \times \vec{F}$

$\tau = rF\sin\theta$

Work is scalar quantity, its unit: Joule,

$W = \vec{F} \cdot \vec{\Delta r} = F\Delta r \cos\theta$ (5 Marks)

⑨ $90°$ (5 Marks)

⑩ $\sum F_{net} = 0$ (5 Marks)

⑪ $\vec{T} = \vec{\Delta p} = \vec{p}_f - \vec{p}_i = m\vec{v}_f - m\vec{v}_i = -10\hat{i} - 20\hat{j}$ (5 Marks)

problem ① (15 Marks)

① $\vec{F}_{net} = \left(F_{13}\cos 45 - F_{23}\right)\hat{i} + \left(F_{13}\sin 45\right)\hat{j}$

$$\vec{F}_{net} = -1.1\hat{i} + 7.9\hat{j} \ (N) \qquad \text{(5 Marks)} \qquad F_{13} = 11N \\ F_{23} = 9N$$

② $V = k_e \left[\dfrac{q_1}{r_1} + \dfrac{q_2}{r_2} + \dfrac{q_3}{r_3} \right] = 771.3 \ V \qquad \text{(5 Marks)}$

③ $U = k_e \left[\dfrac{q_1 q_2}{r_{12}} + \dfrac{q_1 q_3}{r_{13}} + \dfrac{q_2 q_3}{r_{23}} \right] = -19.3 \times 10^{-8} \ J$

<div style="text-align:right">(5 Marks)</div>

problem ② (15 Marks)

① $\vec{C} = \vec{v} \times \vec{B} = 10\hat{i} + 7\hat{j} + 8\hat{k}$ $\qquad$ (10 Marks)

$C = \sqrt{10^2 + 7^2 + 8^2} = 14.6 \ Tm/s$

$F_B = q|\vec{v} \times \vec{B}| = 2.34 \times 10^{18} \ N$

② $v = \sqrt{21}$, $B = \sqrt{14}$ $\qquad$ (5 Marks)

$C = vB\sin\theta \Rightarrow 14.6 = \sqrt{14}\sqrt{21}\sin\theta$

$\theta = \sin^{-1}\left(\dfrac{14.6}{\sqrt{14}\sqrt{21}}\right)^{\circ}$

problem ③ (15 Marks)

$T - m_2 g = m_2 a$ $\qquad$ (5 Marks)

$\boxed{T - 50 = 5a}$ ①

$F\cos\theta - T = m_1 a$ $\qquad$ (5 Marks)

$\boxed{155.9 - T = 15a}$ ②

$\boxed{F\sin\theta + n - m_1 g = 0}$ ③

$a = 5.449 \ m/s^2$, $T = 77 N$. $\qquad$ Ans ②, ① (5 Marks)