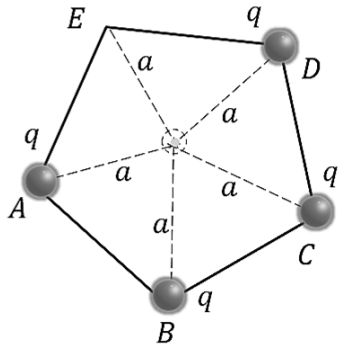
Q.1 Four particles each having a charge q are placed on the four vertices of a regular pentagon. The distance of each corner from the centre is a. Find the electric field at the centre of the pentagon.

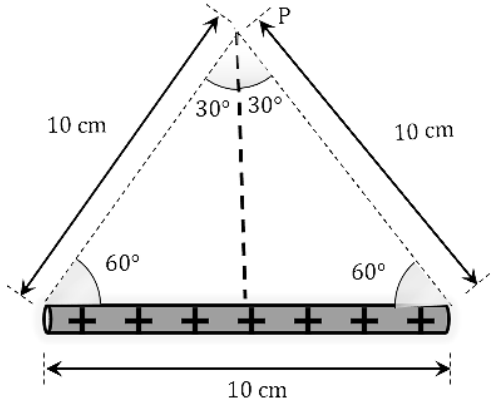


(A) $\frac{kq}{a^2}$ **(B)** $\frac{kq}{\sqrt{2}a^2}$ **(C)** $\frac{kq}{2a^2}$ **(D)** $\frac{kq}{\sqrt{3}a^2}$

Q.2 An infinite number of identical charges, each $+q$ *coulomb*, are placed along x −axis at x=1m, 3m, 9m, ... Calculate the electric field at the point $x = 0$ due to these charges.

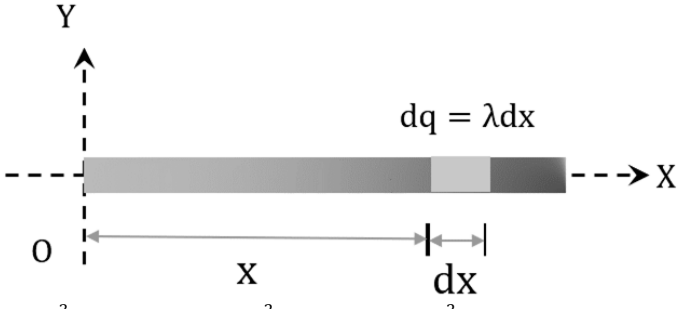
(A) $\frac{1}{4\pi\varepsilon_0}\frac{9q}{8}$ NC^{-1} **(B)** $\frac{1}{4\pi\varepsilon_0}\frac{9q}{8}$ NC^{-1} **(C)** $\frac{1}{4\pi\varepsilon_0}\frac{9q}{7}$ NC^{-1} **(D)** $\frac{1}{4\pi\varepsilon_0}\frac{9q}{5}$ NC^{-1}

Q.3 A 10 cm long rod carries a charge of $+50$ μC distributed uniformly along its length. Find the magnitude of the electric field at a point 10 cm from both the ends of the rod.



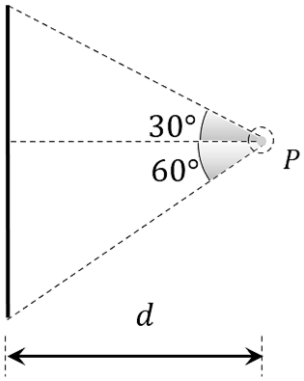
(A) 4.2×10^7 N/C **(B)** 5.2×10^7 N/C **(C)** 6.2×10^7 N/C **(D)** 7.2×10^7 N/C

Q.4 The linear charge density of a thin rod of length l varies with the distance x from the left-most end as $\lambda = \lambda_0 x^2 (0 \le x \le l)$. The total charge on the rod is



(A) $\frac{\lambda_0 l^3}{3}$ **(B)** $\frac{\lambda_0 l^3}{4}$ **(C)** $\frac{2\lambda_0 l^2}{3}$ **(D)** $\frac{\lambda_0 l^2}{3}$

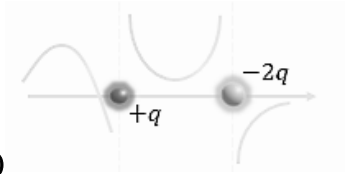
Q.5 Find the net electric field due to a finite wire of linear charge density λ C/m at a point P located at a perpendicular distance d as shown in the figure.



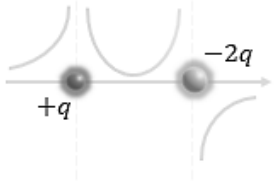
(A) $\sqrt{2}\frac{K\lambda}{d}$ **(B)** $2\sqrt{2}\frac{K\lambda}{d}$ **(C)** $\frac{K\lambda}{\sqrt{2}d}$ **(D)** $\frac{1}{2\sqrt{2}}\frac{K\lambda}{d}$

Q.6 Which of the following graphs correctly represents the variation of $\vec{E}$ vs r for two-point charges $+q$ and $-2q$ kept some distance apart along the line joining these two charges?

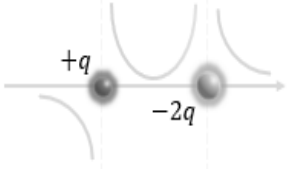
(A)



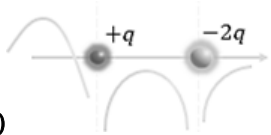
(B)



(C)



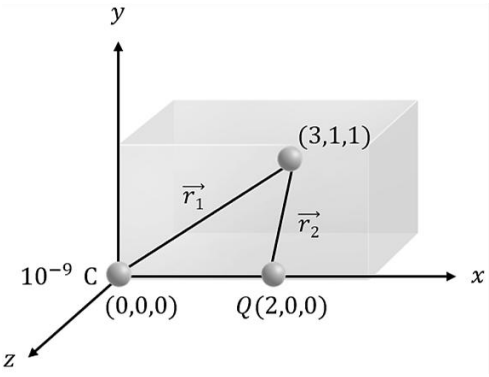
(D)



Q.7 A point charge(+10 nC) is kept at point P(1,2,3) and a test charge is kept at point Q(3,4,5). Find the electric field experienced by the test charge. [Assume distances in meter]

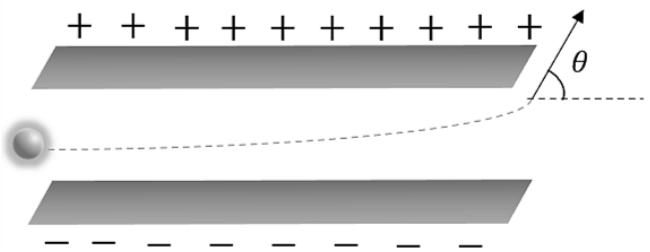
(A) $2.2(\hat{\imath}+\hat{\jmath}+\hat{k})$ N/C **(B)** $3.3(\hat{\imath}+\hat{\jmath}+\hat{k})$ N/C **(C)** $4.4(\hat{\imath}+\hat{\jmath}+\hat{k})$ N/C **(D)** $5.5(\hat{\imath}+\hat{\jmath}+\hat{k})$ N/C

Q.8 A charge 10^{-9} C is located at the origin of a coordinate system and another charge Q at (2,0,0). If the $x-$ component of the electric field at (3,1,1) is zero, calculate the value of Q.



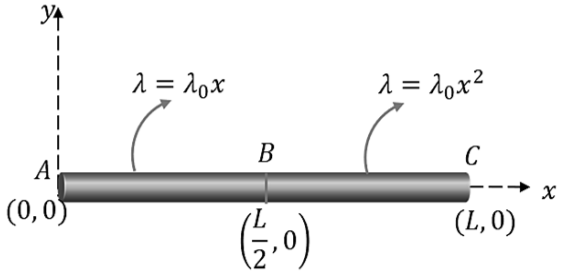
(A) 4.3×10^{-10} C **(B)** 2.3×10^{-10} C **(C)** -4.3×10^{-10} C **(D)** -2.3×10^{-10} C

Q.9 A uniform electric field E is created between two parallel and oppositely charged plates as shown in figure. An electron enters the field symmetrically between the plates with a speed v_0. The length of each plate is l. Find the angle of deviation (which is given by θ in the figure) of the path of the electron as it comes out of the field in terms of mass of electron m and charge e. (Acceleration due to gravity can be neglected)



(A) $\theta = \tan^{-1}\left(\frac{2eEl}{mv_0^2}\right)$ **(B)** $\theta = \tan^{-1}\left(\frac{eEl}{mv_0^2}\right)$ **(C)** $\theta = \cot^{-1}\left(\frac{2eEl}{mv_0^2}\right)$ **(D)** $\theta = \tan^{-1}\left(\frac{eE}{mv_0^2}\right)$

Q.10 The linear charge density of a thin rod of length l is given by $\lambda = \lambda_0 x, \left[0 \le x < \frac{l}{2}\right]$ and $\lambda = \lambda_0 x^2, \left[\frac{l}{2} \le x \le l\right]$. Find the total charge on rod. (x is measure from one end of the rod).



(A) $\frac{\sigma}{\rho-\sigma}$ **(B)** $\frac{\rho}{\rho-\sigma}$ **(C)** $\frac{\sigma}{\sigma+\rho}$ **(D)** $\frac{\sigma}{\sigma+\rho}$

WORK SHEET

Dimensional Analysis

Q.1 Force acting on a particle is 10 N. If units of length and time are doubled and the unit of mass is halved then find the numerical value of force in the new system of units.

(A)2.5 **(B)** 3.5 **(C)**4.5 **(D)**5.5

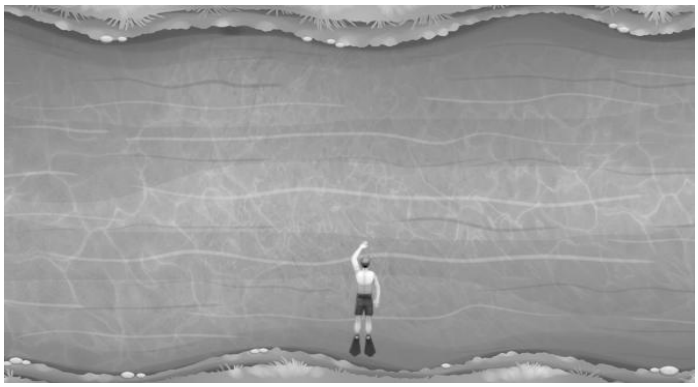
Newton's Laws of Motion

Q.2 Two blocks of mass 10 kg and 2 kg respectively are connected by an ideal string passing over a fixed smooth pulley as shown in figure. A monkey of mass 8 kg starts climbing the string with a constant acceleration of 2 ms^{-2} with respect to the string at t = 0. Initially, the monkey is 2.4 m from the pulley. Find the time taken by the monkey to reach the pulley.

(A)8 sec **(B)** 6 sec **(C)** 4 sec **(D)**2 sec

Relative Motion

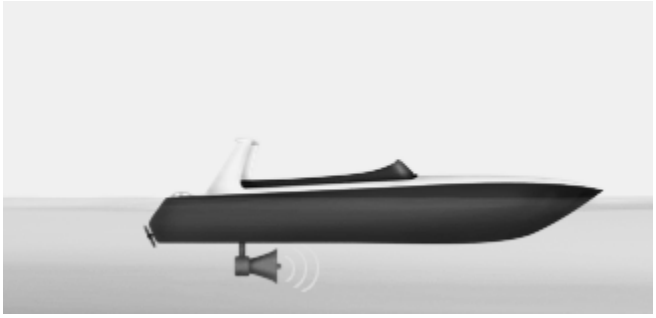
Q.3 A swimmer can swim in still water with speed v and the river flowing with velocity $\frac{v}{2}$. To cross the river in the shortest distance, he should swim making an angle θ with the upstream. What is the ratio of the time taken to swim across in the shortest time to that in swimming across over the shortest distance?



(A)sinθ **(B)**cosθ **(C)**tanθ **(D)**cotθ

Apparent Frequency

Q.4 A boat is travelling in a river with a speed of 10 m/s along the stream flowing with a speed of 2 m/s. From this boat, a sound transmitter is lowered into the river through a rigid support. The wavelength of the sound emitted from the transmitter inside the water is 14.45 mm. Assume that attenuation of sound in water and air is negligible. What will be the frequency detected by a receiver kept underwater downstream? [Given: Bulk modulus of water = 2.088×10^9 Pa]



(A)100696 Hz **(B)**236006 Hz **(C)**200696 Hz **(D)**54000 Hz

Angular Momentum

Q.5 A particle of mass 3 kg moves along a straight line $4y - 3x = 2$ (x and y are in m) with constantvelocity 5 m/s. The magnitude of its angular momentum about the origin is

(A)12 kgm^2/s **(B)**6 kgm^2/s **(C)**4.5kgm^2/s **(D)**8kgm^2/s

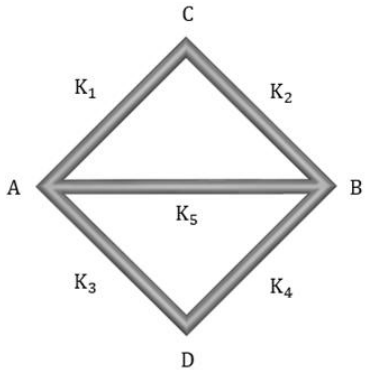
Wave Motion

Q.6 A stretched wire fixed at both ends is oscillating in the third overtone mode. Equation of the transverse stationary wave produced in this wire is $y = A\sin(6\pi x)\sin(20\pi t)$ (x is in m and t in seconds). Find the length of the wire.

(A) $\frac{2}{3}$ m **(B)** $\frac{3}{2}$ m **(C)** $\frac{4}{3}$ m **(D)** $\frac{3}{4}$ m

Conduction Law

Q.7 Five rods of same dimensions are arranged as shown in figure. They have thermal conductivities K_1, K_2, K_3, K_4 and K_5. When points A and B are maintained at same temperatures, no heat flows through the central rod if



(A) $K_1 = K_4$ and $K_2 = K_3$ **(B)** $K_1K_4 = K_2K_3$ **(C)** $K_1K_2 = K_3K_4$ **(D)** None of these

Thermodynamic

Q.8 A gaseous mixture enclosed in a vessel consists of 1 gmmole of a gas A with $\gamma = 5/3$ and another gas B with $\gamma = 7/5$ at a temperature T. The gases A and B do not react with each other and are assumed to be ideal. Find the number of gmmoles of the gas B if γ for the gaseous mixture is $\frac{19}{13}$.

(A) 1 **(B)** 2 **(C)** 3 **(D)** 4

Combinations of Lenses & Mirrors

Q.9 A point object is placed at a distance of 20 cm from a thin plano-convex lens of focal length 15 cm($\mu = 1.5$). The curved surface is silvered. The final image will form at

(A) 60 cm left of AB **(B)** 30 cm left of AB **(C)** $\frac{20}{7}$ cm left of AB **(D)** $\frac{20}{7}$ cm right of AB

Snell's Law

Q.10 In figure, a light ray refracts from material 1 into a thin layer of material 2, crosses that layer, and then is incident at the critical angle on the interface between materials 2 and 3. The angle θ is

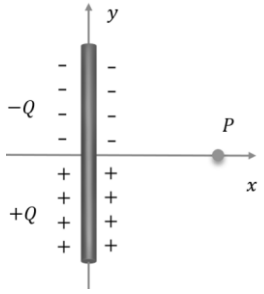
(A) $\sin^{-1}\left(\frac{13}{15}\right)$ **(B)** $\sin^{-1}\left(\frac{13}{16}\right)$ **(C)** $\cos^{-1}\left(\frac{13}{15}\right)$ **(D)** $\cos^{-1}\left(\frac{13}{16}\right)$

Electric Field Due to a Line of Charge Not on Its Axis

Q.11 For a finite line charge, find the electric field in a direction parallel to the axis of the line charge at point P.

(A)3.4 N/C **(B)**4.4 N/C **(C)**5.4 N/C **(D)**6.4 N/C

Q.12 A finite line charge has $-Q$ uniformly distributed on upper half and $+Q$ uniformly distributed on lower half as shown.Find the direction of electric field at point P.



(A) Along positive $x-$ axis **(B)**Along negative $x-$ axis

(C) Along the positive $y-$ axis **(D)**Along negative $y-$ axis

Q.13 For the given semi-infinite rod of uniformly distributed line charge,find the net electrified at point p.

(A)3.4×10^5 N/C **(B)**4.4×10^5 N/C **(C)**5.4×10^5 N/C **(D)**6.4×10^5 N/C

Q.14 For a finite line charge, the net electric field at the non-axial point P is directed toward the line PQ where PQ makes an angle θ with the axis of line charge. Find the value of θ.

(A)$\tan^{-1}(10)$ **(B)**$\tan^{-1}(2)$ **(C)**$\tan^{-1}(14)$ **(D)**$\tan^{-1}(26)$

Electric Field

Q.15 Five-point charges, $+q$ each, are placed at the five vertices of a regular hexagon. The distance of centre of the hexagon from any of the vertices is a. The electric field at the centre of the hexagon is

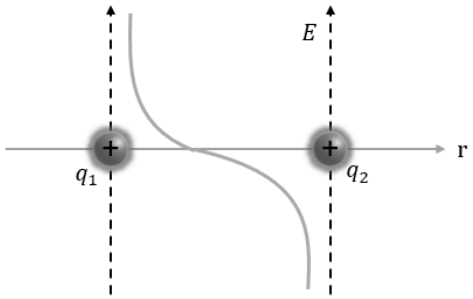
(A)$\frac{q}{4\pi\epsilon_0 a^2}$ **(B)**$\frac{q}{8\pi\epsilon_0 a^2}$ **(C)**$\frac{q}{16\pi\epsilon_0 a^2}$ **(D)**Zero

Superposition of Electric Fields

Q.16 Two equal negative point charges $-$q are fixed at points $(0, a)$ and $(0, -a)$ on the y $-$axis. A positive point charge Q is in rest at point $(2a, 0)$ on the x $-$axis. The net electric field on Q due to both $-$q charges will be $\left(\frac{1}{4\pi\epsilon_0}=k\right)$

(A)$\frac{4qk}{3a^2}$ **(B)**$\frac{qk}{a^2}$ **(C)**$\frac{4qk}{5\sqrt{5}a^2}$ **(D)**$\frac{4qk}{25a^2}$

Q.17 The variation of electric field between two charges q_1 and q_2 along the line joining the charges is plotted against the distance r from q_1 (taking the direction from q_1 to q_2 as positive) as shown in the figure. Find the correct statement among the following is

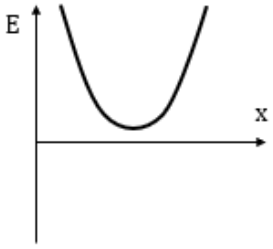


(A)q_1 and q_2 are positive and $|q_1|<|q_2|$ **(B)**q_1 and q_2 are positive and $|q_1|>|q_2|$

(C)q_1 is positive and q_2 is negative $|q_1|<|q_2|$ **(D)**q_1 and q_2 are negative and $|q_1|<|q_2|$

Electric Field

Q.18 Two-point charges a and b whose magnitudes are same are positioned at a certain distance from each other along the positive x − axis. a is placed at the origin. A graph is plotted between the electric field strength and distance x (measured from a). E is taken to be positive if it is along the line joining the two charges from a to b. From the graph it can be decided that

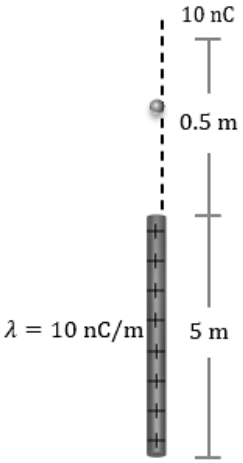


(A) a is positive, b is negative
(B) a and b both are positive
(C) a and b both are negative
(D) a is negative, b is positive

Q.19 Two charges Q&−Q are kept at some distance, so that the electric field at the midpoint is $\vec{E}$. Find the force on Q due to the field of −Q. (charges are isolated)

(A) $\frac{Q\vec{E}}{2}$ **(B)** $\frac{Q\vec{E}}{4}$ **(C)** $4Q\vec{E}$ **(D)** $\frac{Q\vec{E}}{8}$

Q.20 What mass of a point charge kept above the finite line charge at the axial line can be balanced by the electric field produced by the finite line charge.



(A) 0.6×10^{-7} kg **(B)** 1.6×10^{-7} kg **(C)** 2.6×10^{-7} kg **(D)** 3.6×10^{-7} kg

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(A)	(A)	(B)	(A)	(A)	(A)	(C)	(C)	(B)	(A)
WORK SHEET										
Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(A)	(B)	(A)	(A)	(B)	(D)	(B)	(B)	(C)	(B)
Q.	11	12	13	14	15	16	17	18	19	20
Sol.	(D)	(C)	(D)	(C)	(A)	(C)	(C)	(A)	(D)	(B)