Q.1 Two-point charges $+q$ and $-q$ are held fixed at $(-a, 0)$ and $(a, 0)$ respectively of a $x-y$ coordinate system, then

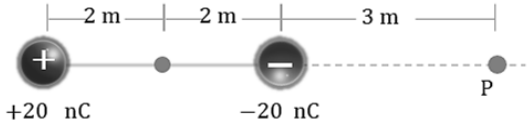
(A) the electric field $\vec{E}$ at all points on the x $-$ axis has same direction

(B) $\vec{E}$ at all points on the y $-$ axis is along $\hat{i}$

(C) $\vec{E}$ at all points on the y $-$ axis is along $-\hat{i}$

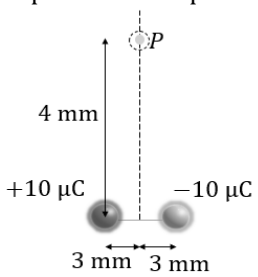
(D) $\vec{E}$ at all points on the y $-$ axis is along $\hat{j}$

Q.2 Find the net electric field at an axial point P of a dipole as shown in figure



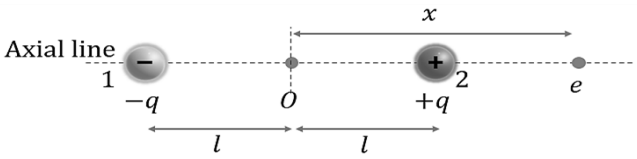
(A) 16.3 N/C **(B)** 15.3 N/C **(C)** 14.3 N/C **(D)** 12.3 N/C

Q.3 Find the net electric field at an equatorial point P of a dipole as shown in figure.



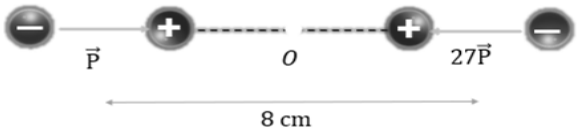
(A) 1.3×10^9 N/C **(B)** 2.3×10^9 N/C **(C)** 3.3×10^9 N/C **(D)** 4.3×10^9 N/C

Q.4 The magnitude of force due to an electric dipole of dipole moment 3.6×10^{-29} C $-$ m on an electron 25 nm from the centre of the dipole along the dipole axis is



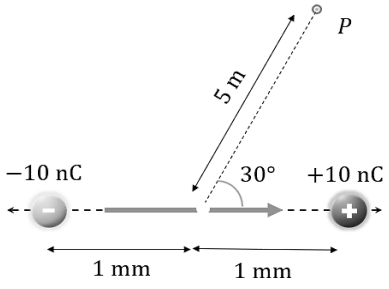
(A) 6.6×10^{-15} N **(B)** 7.8×10^{-15} N **(C)** 9.4×10^{-15} N **(D)** 12×10^{-15} N

Q.5 Two short electric dipoles of moment P and $27P$ are placed as shown below. If at the point O the electric field is zero between the dipoles, then the distance of the point O from the centre of first dipole is



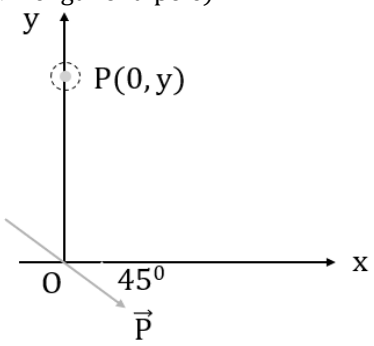
(A) 2 cm **(B)** 4 cm **(C)** 6 cm **(D)** 8 cm

Q.6 Find the magnitude of electric field due to a dipole at a point P along the line joining point P and centre of dipole as shown in figure.



(A) 2.0×10^{-3} N/C **(B)** 3.5×10^{-3} N/C **(C)** 3.0×10^{-3} N/C **(D)** 2.5×10^{-3} N/C

Q.7 A short dipole is placed at origin of coordinate system in $x - y$ plane as shown in figure. Find the electric field at point $P(0,\ y)$. ($y >>$ length of dipole)

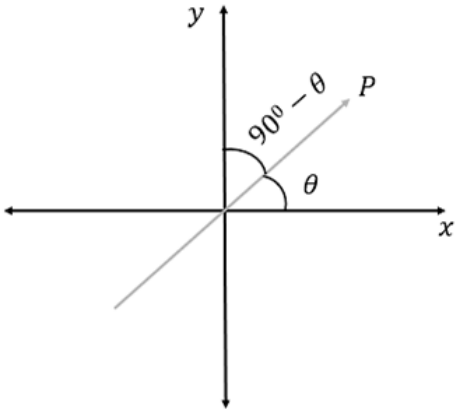


(A) $\frac{Kp}{2y^3}[-2\hat{i} - \hat{j}]$ **(B)** $\frac{2Kp}{y^3}[-2\hat{i} - \hat{j}]$ **(C)** $\frac{\sqrt{2}Kp}{y^3}[-\hat{i} - 2\hat{j}]$ **(D)** $\frac{Kp}{\sqrt{2}y^3}[-\hat{i} - 2\hat{j}]$

Q.8 A sample of HCl gas is placed in an electric field of 2.5×10^4 N/C. The dipole moment of each HCl molecule is 3.4×10^{-30} C − m. Find the maximum torque that can act on a molecule.

(A) 6.5×10^{-26} N − m **(B)** 7.5×10^{-26} N − m **(C)** 8.5×10^{-26} N − m **(D)** 9.5×10^{-26} N − m

Q.9 An electric dipole has a fixed dipole moment $\vec{p}$, which makes angle θ with respect to x − axis. When system is subjected to an electric field $\vec{E}_1 = E\ \hat{\imath}$, it experiences a torque $\vec{\tau}_1 = -\tau\ \hat{k}$. When subjected to another electric field $\vec{E}_2 = \sqrt{3}E\ \hat{\jmath}$, it experiences a torque $\vec{\tau}_2 = -\vec{\tau}_1$. The angle θ is



(A) 45° **(B)** 60° **(C)** 90° **(D)** 30°

Q.10 An electric dipole of dipole moment p is placed in a uniform electric field E in stable equilibrium position. Its moment of inertia about the centroidal axis is I. If it is displaced slightly from its mean position, find the period of small oscillations.

(A) $2\pi\sqrt{\frac{I}{pE}}$ **(B)** $\pi\sqrt{\frac{I}{pE}}$ **(C)** $\frac{1}{2\pi}\sqrt{\frac{pE}{I}}$ **(D)** $2\pi\sqrt{\frac{IE}{p}}$

WORK SHEET

Ideal Gas Equation

Q.1 Air in a cylinder is suddenly compressed by a piston which is then maintained at the same position. As time passes, pressure of the gas

(A) Increases

(B) Decreases

(C) Remain the same

(D) May increase or decrease depending on the nature of gas

Weight inside moving Lift

Q.2 A man is inside a lift. When the lift is moving up with certain acceleration, the apparent change in weight is 25 %. When the lift moves down with double the acceleration, the apparent change in weight is

(A)25 % **(B)**50 % **(C)**75 % **(D)**40 %

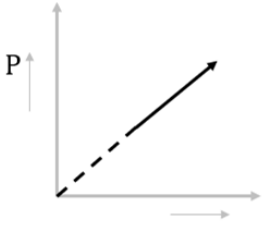
Circular Motion

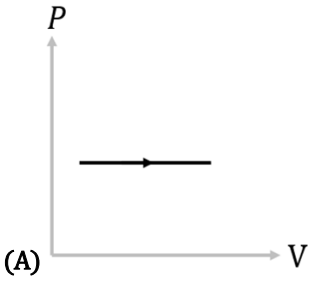
Q.3 A table with smooth horizontal surface is rotating at a speed ω about its axis. A groove is made on the surface along a radius and a particle is gently placed inside the groove at a distance e from the center. Find the speed v of the particle with respect to the table as its distance from the center becomes l.

(A)$v = \omega l$ **(B)**$v = \omega(l - e)$ **(C)**$v = \frac{\omega(l+e)}{2}$ **(D)**$v = \omega\sqrt{l^2 - e^2}$

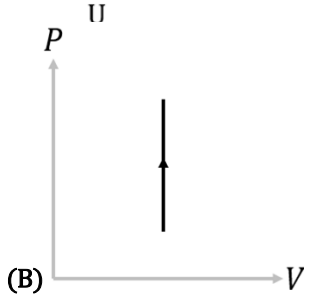
1st Law of Thermodynamics

Q.4 The given $P - U$ graph shows the variation of internal energy of an ideal gas with an increase in pressure. Which of the following $P - V$ graphs are equivalent to this graph?

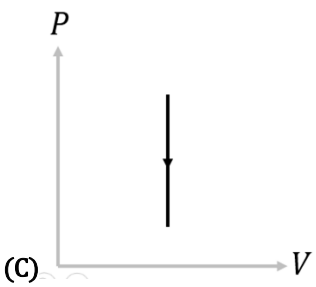




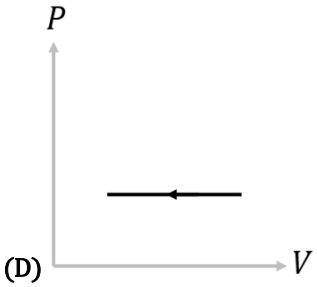
(A)



(B)



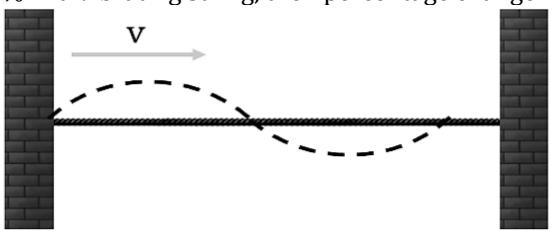
(C)



(D)

Speed in a Medium

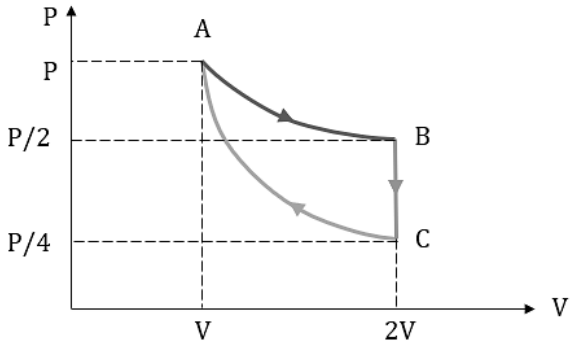
Q.5 If tension is increased by 4% in a vibrating string, then percentage change in speed of wave will be



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

Work Done

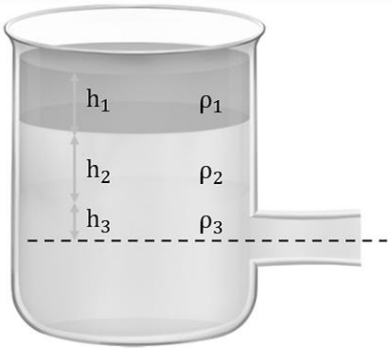
Q.6 Consider the following PV diagram. AB is an isothermal process during which the temperature is 400 K. BC is an isochoric process and CA is an adiabatic process. If 1 mole of diatomic gas undergoes the cycle, then find the total work done by the gas. [ln 2 = 0.7]



(A)−110R **(B)**220R **(C)**110R **(D)**−220R

Bernoulli's Principle

Q.7 An open large tank with a nozzle attached contains three immiscible, inviscid fluids as shown. Assuming that the changes in h_1, h_2 and h_3 are negligible, the instantaneous discharge velocity is



(A) $\sqrt{2gh_3\left(1+\frac{\rho_1}{\rho_3}\frac{h_1}{h_3}+\frac{\rho_2}{\rho_3}\frac{h_2}{h_3}\right)}$ **(B)** $\sqrt{2g(h_1+h_2+h_3)}$

(C) $\sqrt{2g\left(\frac{\rho_1 h_1+\rho_2 h_2+\rho_3 h_3}{\rho_1+\rho_2+\rho_3}\right)}$ **(D)** $\sqrt{2g\left(\frac{\rho_3 h_2 h_3+\rho_2 h_3 h_1+\rho_3 h_1 h_2}{\rho_1 h_1+\rho_2 h_2+\rho_3 h_3}\right)}$

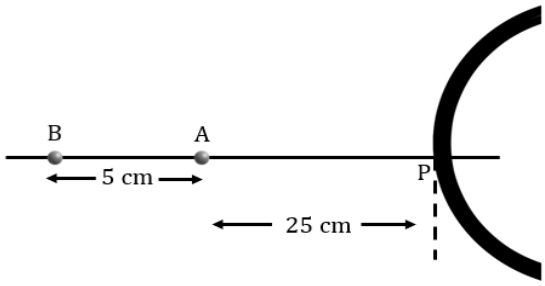
Reflection of Light

Q.8 A ray of light is incident on a plane mirror along a vector $(\hat{i}+\hat{j}-\hat{k})$. The normal on incident point is along $(\hat{i}+\hat{j})$. The unit vector along the reflected ray is

(A) $\frac{1}{\sqrt{3}}(\hat{i}+\hat{j}+\hat{k})$ **(B)** $-\frac{1}{\sqrt{3}}(\hat{i}+\hat{j}+\hat{k})$ **(C)** $\frac{1}{\sqrt{3}}(-\hat{i}-\hat{j}+\hat{k})$ **(D)** $\frac{(\hat{i}-\hat{j}-\hat{k})}{\sqrt{3}}$

Mirror Formula

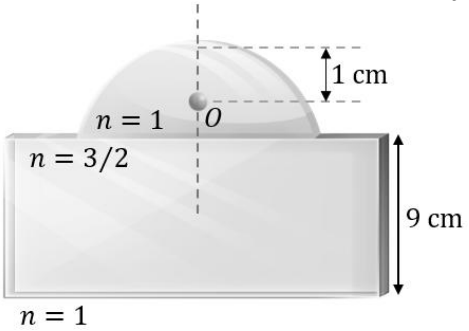
Q.9 A convex mirror of focal length 10 cm is shown in the figure. A linear object AB = 5 cm is placed along the optical axis. Point A is at a distance of 25 cm from the pole of the mirror. The length of image of AB is



(A) 2.5 cm **(B)** 0.36 cm **(C)** 0.64 cm **(D)** 0.75 cm

Image Formation in Concave Mirror

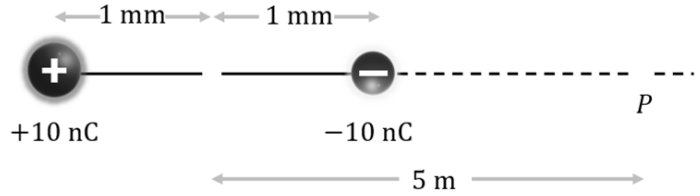
Q.10 A concave mirror of focal length 2 cm is placed on a glass slab as shown in the figure. The image of point object O formed due to reflection at mirror and then refraction by the slab



(A) is virtual and at 2 cm from the pole of the concave mirror.
(B) is virtual and on the pole of the mirror
(C) is real and on the object itself
(D) is virtual and on the object itself

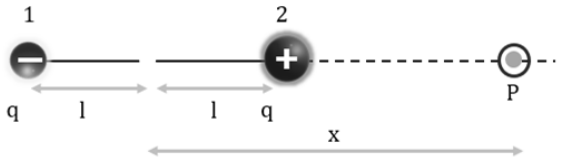
Electric Field Due to a Dipole

Q.11 Find the net electric field at an axial point P of a dipole as shown in the figure.



(A) 1.50×10^{-3} N/C **(B)** 2.25×10^{-3} N/C **(C)** 1.88×10^{-3} N/C **(D)** 2.88×10^{-3} N/C

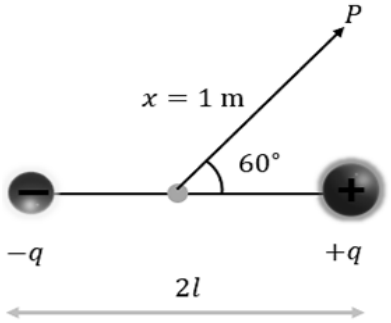
Q.12 Two charges each of 1 μC but opposite in sign are 1 cm apart. The electric field at a distance 10 cm from the mid-point on the axial line of this dipole is



(A) 18×10^4 N/C **(B)** 20×10^4 N/C **(C)** 36×10^4 N/C **(D)** 40×10^4 N/C

Electric Field Due to a Dipole

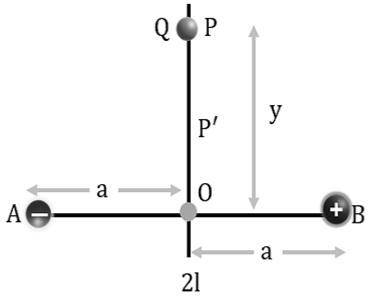
Q.13 What is the magnitude of electric field intensity due to a short dipole of moment of magnitude 2×10^{-8} C − m at a point 1 m from the centre of the dipole, when the line joining the point to the centre of the dipole makes an angle of 60° with the dipole axis?



(A) 170 N/C **(B)** 193 N/C **(C)** 200 N/C **(D)** 238 N/C

Electric Field Due to a Dipole

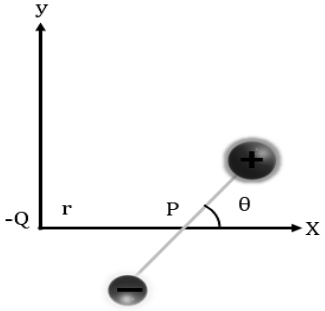
Q.14 Charges −q and +q located at A and B respectively and OP is perpendicular to line AB. A charge Q is placed at P, where OP = y(y >> 2a). The charge Q experiences an electrostatics force F. If Q is now moved along the equatorial line to P′ such that OP′ = y/3, the force experienced by charge Q will be close to(Assume y/2 >> 2a)



(A) F/3 **(B)** F/27 **(C)** 9F **(D)** 27F

Electric Field Due to a Dipole at a General Point in Space

Q.15 A point negative charge $-Q$ is placed at a distance r from a dipole with dipole moment P in the $x-y$plane as shown in figure. The $x-$ component of force acting on the charge $-Q$ is



(A) $-\frac{PkQ}{r}\cos\theta\,\hat{i}$ **(B)** $\frac{PkQ}{r}\cos\theta\,\hat{i}$ **(C)** $-\frac{2PkQ}{r^3}\cos\theta\,\hat{i}$ **(D)** $\frac{2PkQ}{r^3}\cos\theta\,\hat{i}$

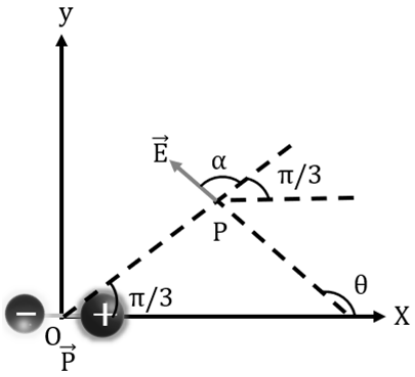
Electric Field Due to a Dipole

Q.16 At a faraway distance r along the axis from an electric dipole, the electric field is E. Find the electric field at distance $2r$ along the perpendicular bisector.

(A) $-\frac{E}{4}$ **(B)** $-\frac{E}{16}$ **(C)** $\frac{E}{2}$ **(D)** E

Electric Field Due to a Dipole at a General Point in Space

Q.17 A very short electric dipole is placed along the x −axis at the origin O. A point P is at a distance of 20 cm from this origin such that OP makes an angle $\frac{\pi}{3}$ with the x-axis. If the electric field at P makes an angle θ with the x-axis, the value of θ would be



(A) $\frac{\pi}{3}$ **(B)** $\frac{\pi}{3}+\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$ **(C)** $\frac{2\pi}{3}$ **(D)** $\tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$

Dipoles

Q.18 An electric dipole is placed in an electric field generated by a point charge. Then

(A) net electric force on the dipole must be zero

(B) net electric force on the dipole may be zero

(C) torque on the dipole due to the field must be zero

(D) torque on the dipole due to the field may be zero

Torque on a Dipole

Q.19 Two charges of -4 μC and $+4$ μC are placed at points A(1, 0, 4) and B(2, −1, 5) located in an electric field $\vec{E}=0.20\hat{i}$ Vcm^{-1}. The torque acting on the dipole is

(A) 8×10^{-5} Nm **(B)** $\frac{8}{\sqrt{2}}\times10^{-5}$ Nm **(C)** $8\sqrt{2}\times10^{-5}$ Nm **(D)** $2\sqrt{2}\times10^{-5}$ Nm

Torque on a Dipole

Q.20 Two charges -4 μC and $+4$ μC are placed at the points A(1,0,4) and B(2, −1,5) located in a uniform electric field $\vec{E}=20\,\hat{i}$ N/C. The torque acting on the dipole has a magnitude of

(A) 0.1×10^{-4} Nm **(B)** 1.13×10^{-4} Nm **(C)** 2.5×10^{-4} Nm **(D)** 3.7×10^{-4} Nm

ANSWER KEY

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