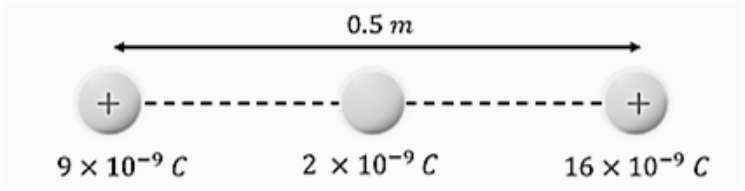
Q.1 Three charges $+4q$, Q and $+q$ are placed in a straight line such that the charge Q is equidistant from both the other charges. What should be the charge Q in order to make the net force on $+q$ to be zero?

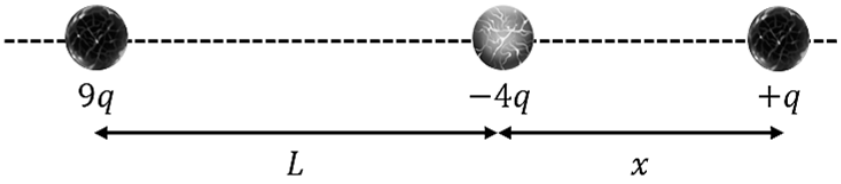
(A) $-q$ **(B)** $4q$ **(C)** $-\frac{q}{2}$ **(D)** $-2q$

Q.2 For the shown system of fixed charges, where should a third charge of 2 nC be placed, so that the system remains in equilibrium.



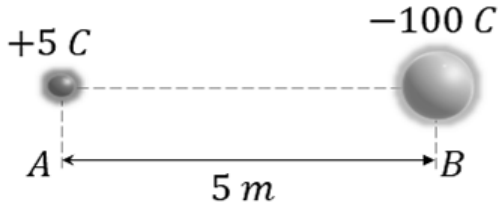
(A) 0.11 m from 9 nC charge towards right **(B)** 0.21 m from 9 nC charge towards right
(C) 0.31 m from 9 nC charge towards right **(D)** 0.41 m from 9 nC charge towards right

Q.3 For the given system of charges, where should a third charge placed +q be placed from negative charge, so that third charge experiences no net force



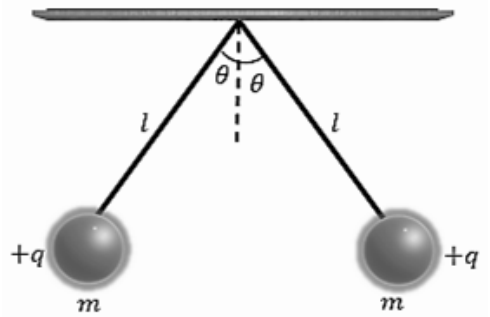
(A) 4 cm **(B)** 5 cm **(C)** 6 cm **(D)** 7 cm

Q.4 Find the distance of the point from A where the net electric field will be zero for the given configuration.



(A) 0.4 m towards left **(B)** 1.4 m towards left
(C) 2.4 m towards left **(D)** 3.4 m towards left

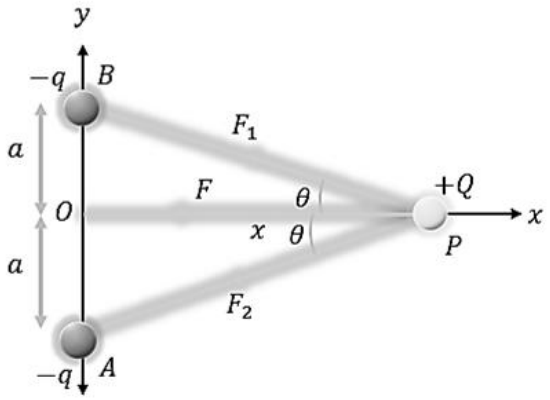
Q.5 Two identical small charged spheres each having a mass m hang in equilibrium as shown in figure. The angle made by any string with vertical is θ. Find the magnitude of charge on sphere.



(A) $q = \sqrt{\frac{4l^2 mg \tan\theta \sin^2\theta}{k}}$ **(B)** $q = \sqrt{4kl^2 mg \cos\theta \sin^2\theta}$

(C) $q = \sqrt{\frac{4l^2 mg \sin^2\theta}{k \tan\theta}}$ **(D)** $q = \sqrt{2l^2 mg \sin^2\theta}$

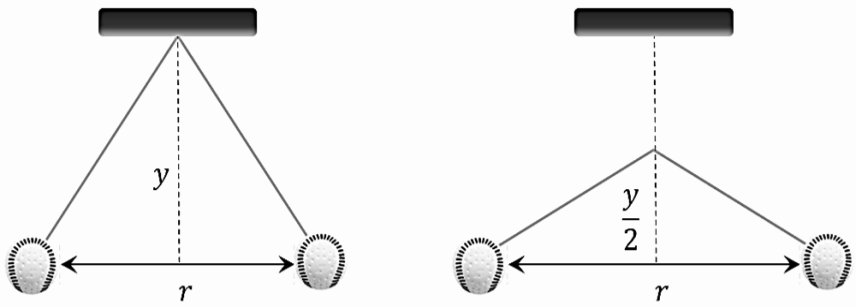
Q.6 Two equal negative charges each of charge $-q$ are fixed at points $(0, a)$ and $(0, -a)$ on the y $-$axis. A positive point charge Q is released from rest at point $(2a, 0)$ on the x $-$axis. The charge Qwill



(A) Execute simple harmonic motion about the origin.
(B) Move to the origin and remain at rest there.
(C) Move to infinity.
(D) Execute oscillatory but not simple harmonic motion.

Q.7 Two positive and equal charges are fixed at certain distance. A third charge (small) is placed in between the line joining of the two charges and it experiences zero net force due to the other two
(A) The equilibrium is stable if small charge is positive
(B) The equilibrium is stable if small charge is negative
(C) The equilibrium is always stable
(D) The equilibrium is not stable

Q.8 Two pith balls carrying identical charges are suspended from a common point by strings of equal lengths, the equilibrium separation between them is r. Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now will be.

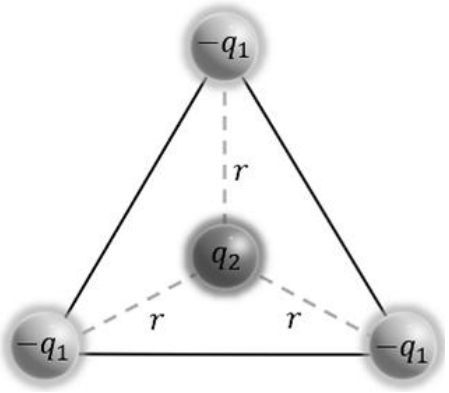


(A) $\frac{2r}{\sqrt{3}}$ **(B)**$\frac{2r}{3}$ **(C)**$\left(\frac{1}{\sqrt{2}}\right)^2$ **(D)**$\frac{r}{2^{1/3}}$

Q.9 Two identical charged spheres suspended from a common point by two massless strings of lengths l, are initially at a distance d($d << l$) apart because of their mutual repulsion. The charges begin to leak from both the spheres at a constant rate. As a result, the spheres approach each other with a velocity v. Which of the following correctly represent the variation of v as a function of the distance x between the spheres.

(A)$v \propto x^{-\frac{1}{2}}$ **(B)**$v \propto x^{-1}$ **(C)**$v \propto x^{\frac{1}{2}}$ **(D)**$v \propto x^{-\frac{1}{2}}$

Q.10 Three equal negative charges, $-q_1$ each, form the vertices of an equilateral triangle. A particle of mass m and a positive charge q_2 is constrained to move along a line perpendicular to the plane of triangle and through its centre which is at a distance r from each of the negative charges as shown in the figure. The whole system is kept in gravity free space. Find the time period of vibration of the particle for small displacement from equilibrium position.



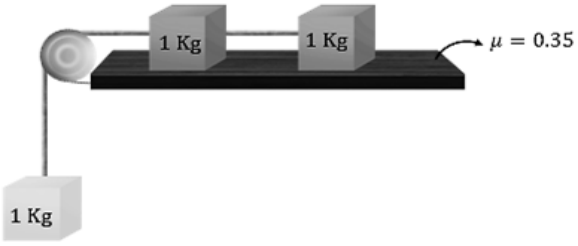
(A) $2\pi\sqrt{\frac{4\pi\epsilon_0 mr^3}{3q_1q_2}}$ **(B)** $2\pi\sqrt{\frac{4\pi\epsilon_0 mr^3}{q_1q_2}}$ **(C)** $2\pi\sqrt{\frac{3\pi\epsilon_0 mr^3}{4q_1q_2}}$ **(D)** $2\pi\sqrt{\frac{\pi\epsilon_0 mr^3}{3q_1q_2}}$

WORK SHEET

Q.1 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)** 4 sec **(C)** 6 sec **(D)** 2 sec

Q.2 The pulley and strings shown in the figure below are massless. Find the Acceleration of system. (Take g = 10 m/s^2)

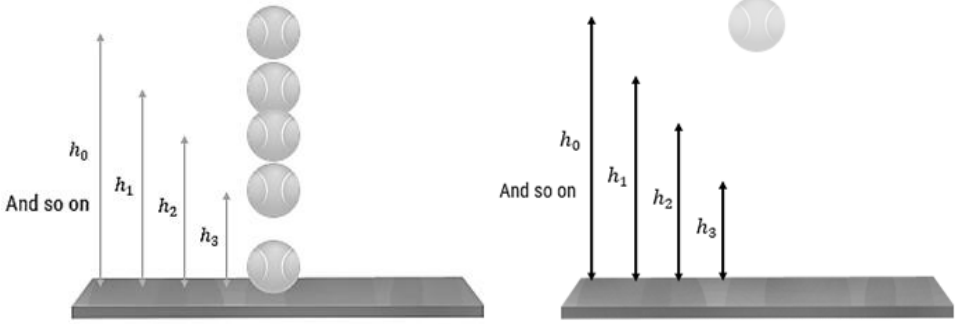


(A) 2m/s^2 **(B)** 1 m/s^2 **(C)** 1.5 m/s^2 **(D)** 2.5 m/s^2

Q.3 A machine gun is mounted on a 2000 kg car on a horizontal frictionless surface. At some instant the gun fires bullets of mass 10 gm with a velocity of 500 m/sec with respect to the car. The number of bullets fired per second is ten. The average thrust on the system is

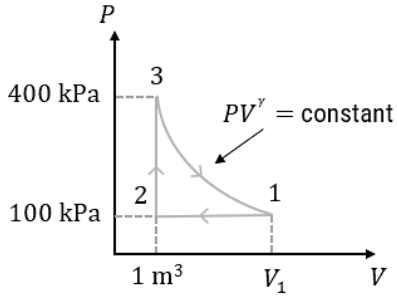
(A) 550 N **(B)** 50 N **(C)** 250 N **(D)** 250 Dyne

Q.4 A body falls from a height'h' on a horizontal surface and rebounds. Then it falls again and rebounds and so on. If the coefficient of restitution is 1/2, then the total distance travelled by the ball before coming to rest is (neglect air resistance)



(A) $\frac{2h}{3}$ **(B)** $\frac{3h}{2}$ **(C)** $\frac{5h}{2}$ **(D)** $\frac{5h}{3}$

Q.5 A thermodynamic cycle with an ideal gas as working fluid is shown below. If the specific heats of the working fluid are constant and the value of specific heat ratio γ is 1.4, the thermal efficiency (in %) of the cycle is

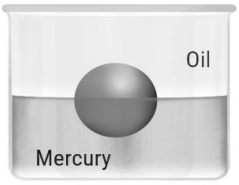


(A) 21 **(B)**42 **(C)**2.1 **(D)**0.21

Q.6 If a black wire of platinum is heated, then it's colour first appears to be red, then yellow and finally white. This observation can be understood on the basis of

(A) Wien's Displacement law **(B)**Newton's law of cooling
(C) Expansion on heating **(D)**None of these

Q.7 A vessel contains oil (density 0.8 g/cm^3) over mercury (density 13.6 g/cm^3). A homogeneous sphere floats with half its volume immersed in mercury and the other half in oil. The density of the material of the sphere in g/cm^3 is

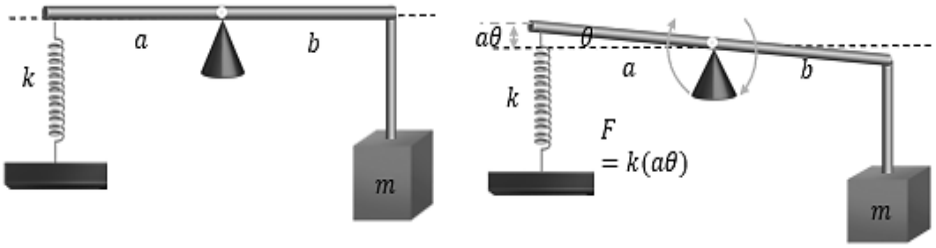


(A) 3.3 **(B)**6.4 **(C)**7.2 **(D)**12.8

Q.8 Water from a tap emerges vertically downwards with an initial speed of 1 m/s. If the cross-sectional area of tap is 10^{-4} m^2 then find the cross-sectional area of stream 0.15 m below the tap.

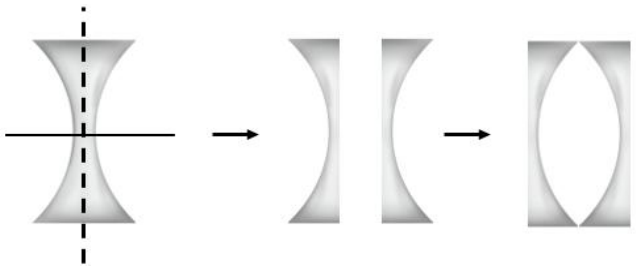
(A)5×10^{-4} m^2 **(B)**1×10^{-4} m^2 **(C)**5×10^{-5} m^2 **(D)**2×10^{-5} m^2

Q.9 A small block is connected to a massless rod, which in turn is attached to a spring of force constant k as shown in fig. The block is displaced down slightly, and left free. Find the time period of oscillation of system.



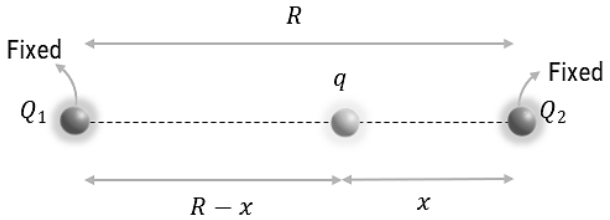
(A)$2\pi\left(\frac{b}{a}\right)\sqrt{\frac{m}{k}}$ **(B)**$2\pi\left(\frac{a}{b}\right)\sqrt{\frac{m}{k}}$ **(C)**$2\pi\left(\frac{b}{a}\right)\sqrt{\frac{k}{m}}$ **(D)**$2\pi\left(\frac{a}{b}\right)\sqrt{\frac{k}{m}}$

Q.10 A symmetrical bi-concave thin lens is cut into two identical halves and arranged as shown. What will be the effective focal length of the arrangement?



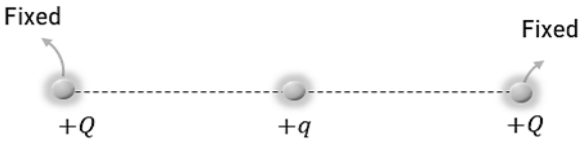
(A) $\frac{-2R}{(\mu-1)}$ **(B)** $\frac{-R}{2(\mu-1)}$ **(C)** $\frac{R}{(\mu-1)}$ **(D)** $\frac{2R}{(\mu-1)}$

Q.11 Three charges $+Q_1$, $+Q_2$ and q are placed on a straight line such that q is somewhere in between $+Q_1$, $+Q_2$. If this system of charges is in equilibrium, what should be the magnitude and sign of charge q?



(A) $\frac{Q_1Q_2}{(\sqrt{Q_1}+\sqrt{Q_2})^2}$, +ve **(B)** $\frac{Q_1+Q_2}{2}$, +ve **(C)** $\frac{Q_1Q_2}{(\sqrt{Q_1}+\sqrt{Q_2})^2}$, −ve **(D)** $\frac{Q_1+Q_2}{2}$, $-ve$

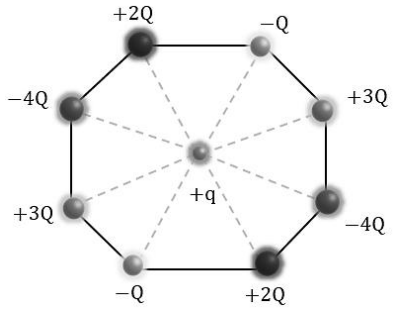
Q.12 In a system of equilibrium of charges, when a charged body $(+q)$ is displaced from its equilibrium position, the net force is[Assume charges $+Q$ to be fixed and consider only axial displacement]



(A) away from the original position **(B)** towards the original position
(C) zero **(D)** Any of the option a or b

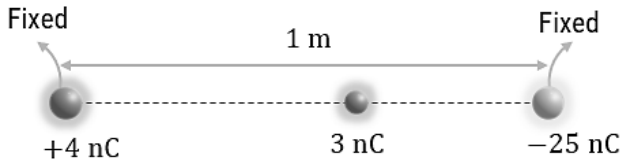
Q.13 Nine-point charges placed at the vertices of an octagon and centre of an octagon as shown in the figure.

Net force experienced by +q charge at the center of the octagon is zero. If any two charges are removed simultaneously from the vertex, it observed that net force on charge +q is still zero, then the charge will be



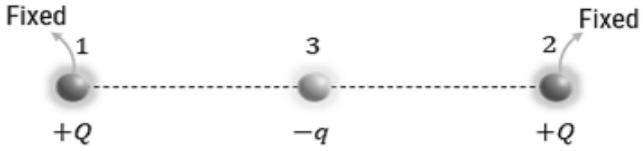
(A) +3Q and + 2Q **(B)** +Q and − Q
(C) −4Q and + 3Q **(D)** any pair of diagonally opposite charges

Q.14 For the shown system of fixed charges, where should a third charge of 3 nC be placed, so that the system remains in equilibrium.



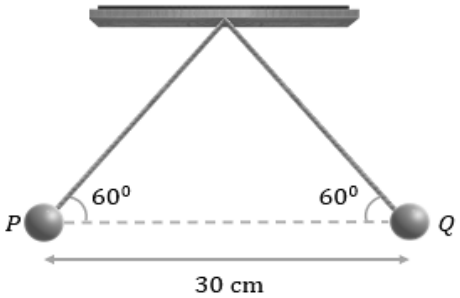
(A)0.37 m from 4 nC charge toward left **(B)**0.47 m from 4 nC charge toward left
(C)0.57 m from 4 nC charge toward left **(D)**0.67 m from 4 nC charge toward left

Q.15 For the given arrangement of charges, charges 1 and 2 are fixed. A third charge at mid of line joining charges 1 and 2 is kept. Net force on third charge is directed toward original position if it is displaced along



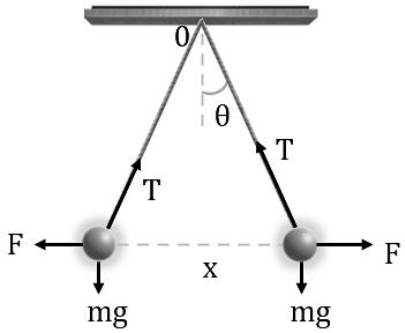
(A) axial line **(B)**equatorial line **(C)**Both a and b **(D)**None of these

Q.16 Two small identical balls P and Q, each of mass $\frac{\sqrt{3}}{10}$ gram, carrying identical charges are suspended by threads of equal lengths. At equilibrium, they position themselves as shown in the figure, what is the charge on each ball?



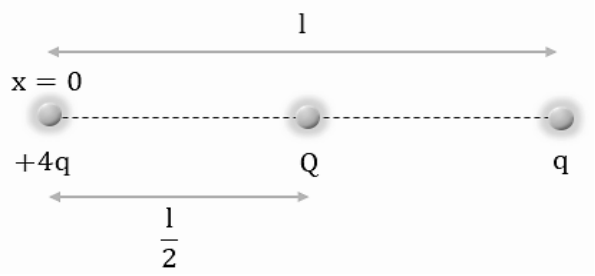
(A) 10^{-3} C **(B)**10^{-5} C **(C)**10^{-7} C **(D)**10^{-9} C

Q.17 Two charged balls are attached by silk threads of length l to the same point. Their velocity is K/√x, where K is a constant and x is the distance between the balls, x is very small in comparison to l. The rate of leakage of charge is (take $l/mg = 10$, $K = 4\sqrt{2}$)



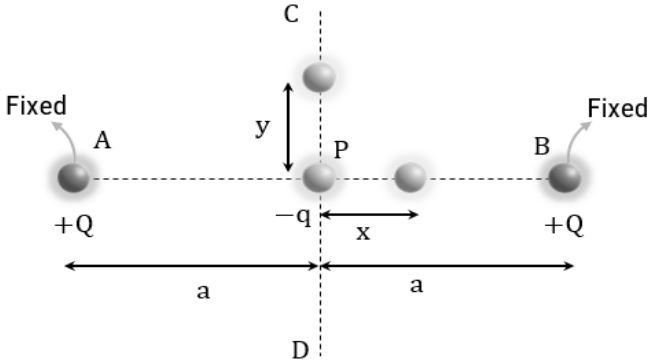
(A) 10^{-5} C/sec **(B)**2×10^{-5} C/sec **(C)**3×10^{-5} C/sec **(D)**10^{-3} C/sec

Q.18 Three charges +4q , Q and q are placed in a straight line of length l at points 0 , l/2 and l distance way from one end respectively. What should be Q in order to make the net force on q to be zero.



(A) – q **(B)**4q **(C)**$-\frac{q}{2}$ **(D)**$-2q$

Q.19 For the arrangement shown in Fig., the two positive charges, $+Q$ each, are fixed. Mark out the correct statement(s) regarding a third charged particle q placed at midpoint P that can be displaced along or perpendicular to the line connecting the charges.



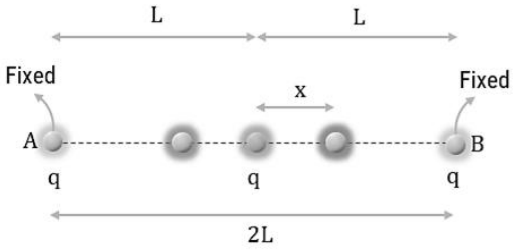
(A) The particle will perform S.H.M. for $x << a$

(B) The particle will oscillate about P but not harmonically for any x

(C) The particle will perform S.H.M. for $y << a$

(D) The particle will not oscillate about P, when y is comparable to a

Q.20 A particle of mass m and charge +q is midway between two fixed charged particles, each having a charge +q and at a distance 2L apart. The middle charge is displaced slightly along the line joining the fixed charges and released. The time period of oscillation is proportional to



(A) $L^{1/2}$ **(B)**L **(C)**$L^{3/2}$ **(D)**L^2

ANSWER KEY

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