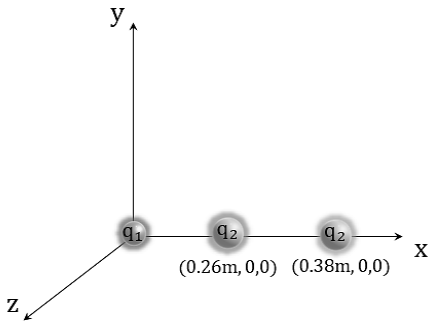
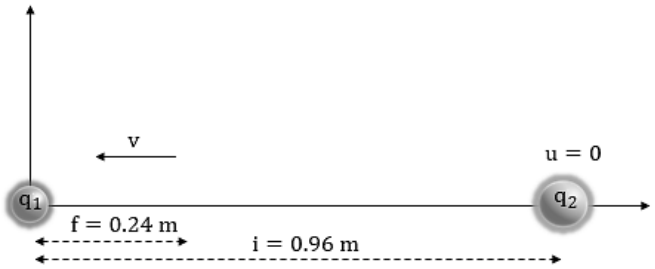
Q.1 A point charge $q_1 = -5.8\ \mu C$ is held stationary at the origin. A second charge $q_2 = +4.3\ \mu C$ moves from the point (0.26 m, 0,0) to (0.38 m, 0,0). Find the workdone by the electric force on q_2.



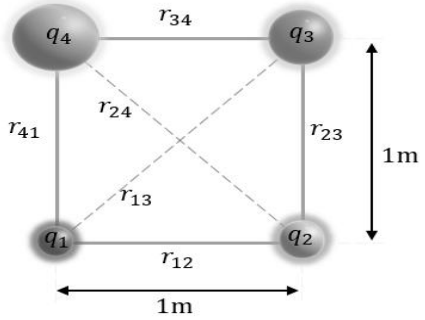
(A) -0.272 J **(B)** +0.272 J **(C)** -0.381 J **(D)** +0.381 J

Q.2 A point charge $q_1 = 9.1\ \mu C$ is held fixed at origin. A second point charge $q_2 = -0.42\ \mu C$ and a mass 3.2×10^{-4} kg is placed on the x-axis, 0.96 m from the origin. The second point charge is released at rest. What is its speed when it is 0.24 m from the origin?



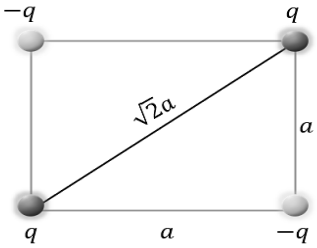
(A) 15 ms^{-1} **(B)** 26 ms^{-1} **(C)** 10 ms^{-1} **(D)** 42 ms^{-1}

Q.3 Four charges $q_1 = 1\ \mu C$, $q_2 = 2\ \mu C$, $q_3 = -3\ \mu C$ and $q_4 = 4\ \mu C$ are kept on the vertices of a square of side 1 m. Find the electric potential energy of this system of charges.



(A) $+7.62 \times 10^{-2}$ J **(B)** -7.62×10^{-2} J **(C)** $+2 \times 10^{-2}$ J **(D)** −0.1 J

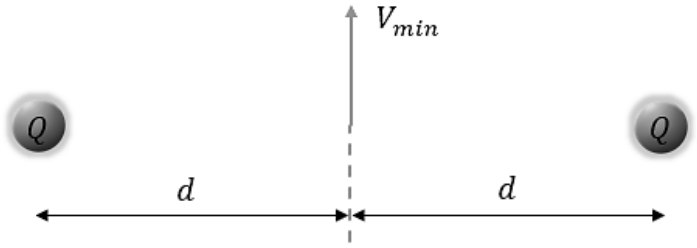
Q.4 Four charges +q, −q, +q and −q are placed in order on the four consecutive corners of a square of side a. The work done in interchanging the positions of any two neighbouring charges of the opposite sign is



Initial situation

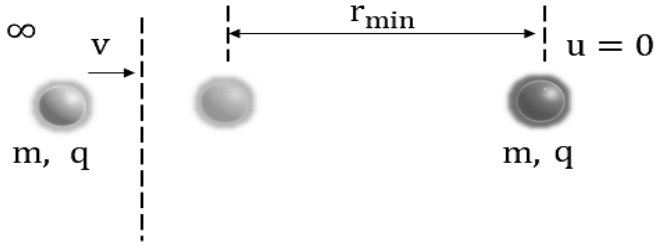
(A) $\frac{q^2}{4\pi\varepsilon_0 a}(-4+\sqrt{2})$ **(B)** $\frac{q^2}{4\pi\varepsilon_0 a}(4+2\sqrt{2})$ **(C)** $\frac{q^2}{4\pi\varepsilon_0 a}(4-2\sqrt{2})$ **(D)** $\frac{q^2}{4\pi\varepsilon_0 a}(4+\sqrt{2})$

Q.5 Two identical charges each having Q are fixed at a distance 2d apart. A third particle having a mass m and charge−Q is projected from the midpoint of the line joining the two charges along a direction perpendicular to the line joining the two charges. Find the minimum velocity to be imparted, such that −Q charge reaches infinity.



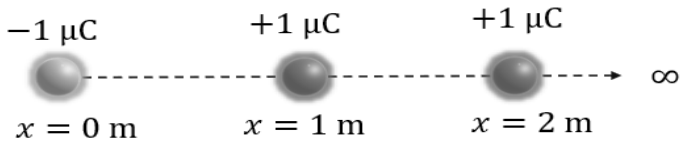
(A) $\sqrt{\frac{KQq}{md}}$ **(B)** $2\sqrt{\frac{KQq}{md}}$ **(C)** $\sqrt{\frac{KQq}{2md}}$ **(D)** $\frac{1}{2}\sqrt{\frac{KQq}{md}}$

Q.6 A point charge q having mass m is projected from a long distance with speed v towards another stationary particle of same mass and charge. The distance of closest approach of the particles is:



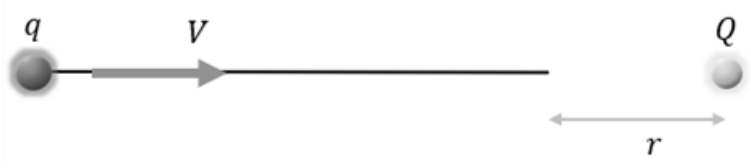
(A) $\frac{q^2}{2\pi\varepsilon_0 mv^2}$ **(B)** $\frac{2q^2}{\pi\varepsilon_0 mv^2}$ **(C)** $\frac{q^2}{\pi\varepsilon_0 mv^2}$ **(D)** Zero

Q.7 Two-point charges $q_1 = -1$ μC and $q_2 = +1$ μC are located on the x— axis, at $x = 0$ m and at $x = 1$ m respectively. The work that must be done by an external force to bring a third point charge $q_3 = +1$ μC from infinity to $x = 2$ m is



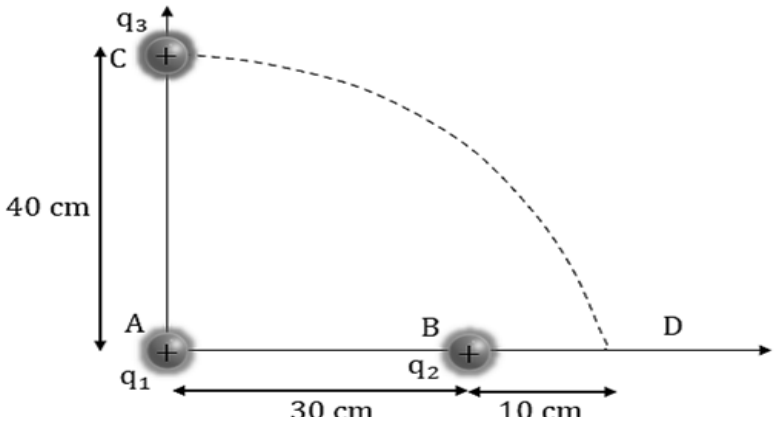
(A) 1.5×10^{-3} J **(B)** 4.5×10^{-3} J **(C)** 2.5×10^{-3} J **(D)** 3×10^{-3} J

Q.8 A charged particle q is shot from a large distance towards another charged particle Q which is fixed, with a speed v. It approaches Q up to a closest distance r and then returns. If q was given a speed 2v, the distance of closest approach would be



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

Q.9 Two charges q_1 and q_2 are placed 30 cm apart as shown in the figure. A third charge q_3 is moved along the arc of a circle of radius 40 cm from C to D. The change in potential energy of the system is $\frac{xq_3}{4\pi\epsilon_0}$ where x is



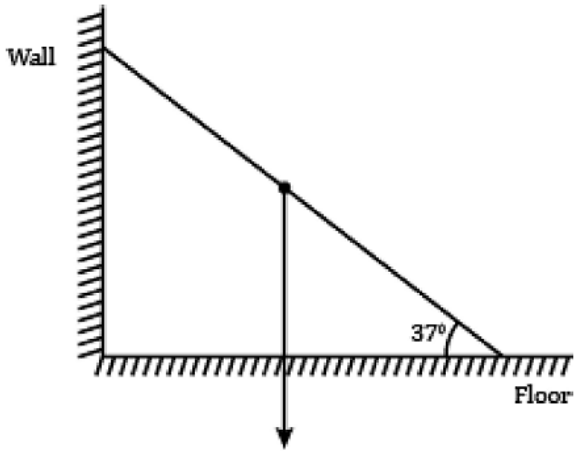
(A) $8q_2$ **(B)** $6q_2$ **(C)** $8q_1$ **(D)** $6q_1$

Q.10 Three-point charges 1 C, 2 C and 3 C are placed at the corners of an equilateral triangle of side 100 cm. Find the work done to move these charges to corners of similar triangle of side 50 cm.

(A) 10^{11} J **(B)** 10^{10} J **(C)** 10^{12} J **(D)** 10^{13} J

WORK SHEET

Q.1 A uniform ladder of length 5 m and mass 100 kg is in equilibrium between a vertical smooth wall and a rough horizontal surface as shown below. Find the minimum friction coefficient between floor and ladder for this equilibrium.



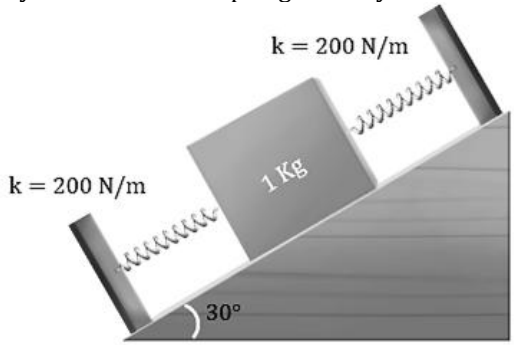
(A) $\frac{1}{2}$ **(B)** $\frac{3}{4}$ **(C)** $\frac{1}{3}$ **(D)** $\frac{2}{3}$

Q.2 A man of mass m climbs a rope of length L suspended below a balloon of mass M. The balloon is stationary with respect to the ground. If the man begins to climb up the rope at a speed v_{rel} (relative to the rope), in what direction and with what speed (relative to the ground) will the balloon move?

(A) Downwards, $\frac{m\,v_{rel}}{m+M}$ **(B)** Upwards, $\frac{m\,v_{rel}}{m+M}$

(C) Downwards, $\frac{m\,v_{rel}}{M}$ **(D)** Downwards, $\frac{(M+m)\,v_{rel}}{M}$

Q.3 Find the natural frequency of oscillation of spring block system shown.



(A) $\frac{7}{\pi}$ Hz **(B)** $\frac{7}{\pi}$ Hz **(C)** $\frac{3}{\pi}$ Hz **(D)** $\frac{5}{\pi}$ Hz

Q.4 n identical cubes each of mass m and side l are on a horizontal surface. Then the minimum amount of work done to arrange them one over another in a vertical stack is

(A) nmgl **(B)** $\frac{mgl\ n^2}{2}$ **(C)** $\frac{mgl\ n(n-1)}{2}$ **(D)** $\frac{mgl\ n(n+1)}{2}$

Q.5 A rubber cord of a catapult has a cross sectional area 1 mm^2 and total unstretched length 10 cm . It is stretched to 12 cm and then released to project a stone of mass 5 gm . Taking Young's Modulus Y for rubber as 5×10^8 N/m^2, the velocity of projection is

(A) 10 m/s **(B)** 15 m/s **(C)** 20 m/s **(D)** 25 m/s

Q.6 When the temperature of a thin copper coin is raised by 80° C , its diameter increases by 0.2 percent. The coefficient of linear expansion (α) and percentage rise in the area of the coin will be:

(A) $\alpha = 0.80 \times 10^{-4}/°C$, percentage rise in the area of coin is 0.6 percent

(B) $\alpha = 0.25 \times 10^{-4}/°C$, percentage rise in the area of coin is 0.4 percent

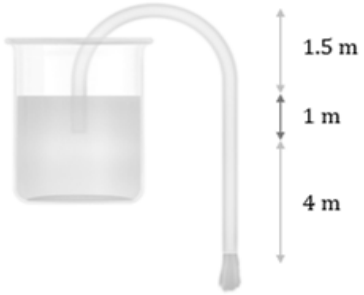
(C) $\alpha = 1.25 \times 10^{-4}/°C$, percentage rise in the area of coin is 0.2 percent

(D) $\alpha = 0.50 \times 10^{-4}/°C$, percentage rise in the area of coin is 0.80 percent

Q.7 A hollow pipe of length 0.8 m is closed at one end. At its open end a 0.5 m long uniform string (fixed at both ends) is vibrating in its second harmonic and it resonates with the fundamental frequency of the pipe. If the tension in the wire is 50 N and the speed of sound is 320 ms^{-1}, the mass of the string is

(A) 5g **(B)** 10g **(C)** 20g **(D)** 40g

Q.8 A siphon tube is discharging a liquid of specific gravity 0.9 from a reservoir as shown in the figure. The velocity of the liquid coming out through the siphon is(Take $g = 10\ m/s^2$)

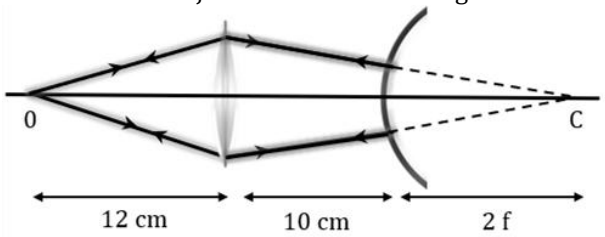


(A) 7 m/s **(B)** 8 m/s **(C)** 9 m/s **(D)** 10 m/s

Q.9 A concave lens of focal length 20 cmplaced in contact with a plane mirror acts as a

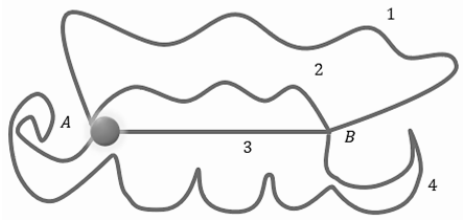
(A) Convex mirror of focal length 10 cm **(B)** Concave mirror of focal length 40 cm
(C) Concave mirror of focal length 60 cm **(D)** Concave mirror of focal length 10 cm

Q.10 A point object is placed at a distance 12 cmfrom a convex lens of focal length 10 cm. On the other side of the lens, a convex mirror is placed at a distance of 10 cmfrom the lens such that the image formed by the combination coincides with the object itself. The focal length of the convex mirror is



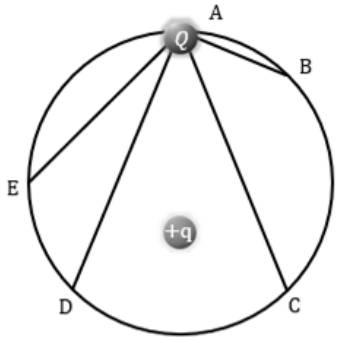
(A) 20 cm **(B)** 25 cm **(C)** 30 cm **(D)** 35 cm

Q.11 A charge q is moved from point A to point B in a uniform electric field along 4 paths as shown below. The work done to move the charge along the paths is W_1, W_2, W_3 and W_4 respectively. Choose the correct statement.



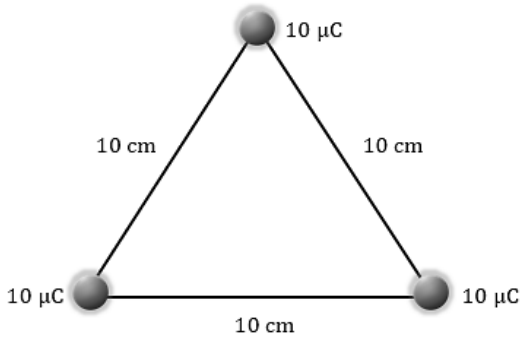
(A) $W_4 > W_1 > W_2 > W_3$ **(B)** $W_4 < W_1 < W_2 < W_3$
(C) $W_4 = W_1 = W_2 = W_3$ **(D)** $W_4 < W_1 = W_2 < W_3$

Q.12 In the electric field of a fixed-point charge q, a certain charge is carried from point A to B, C, D and E as shown in the figure. Then the work done:



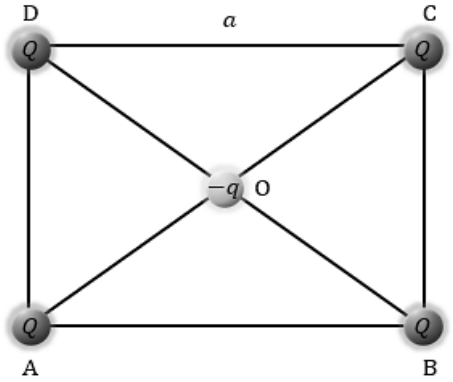
(A) Is least along the path AB **(B)** Is least along the path AD
(C) Is zero along all the paths **(D)** Is least along the path AE

Q.13 Three particles, each having a charge of 10 μCare placed at the vertices of an equilateral triangle of side 10 cm . Find the work done by a person in pulling them apart to infinite separation.



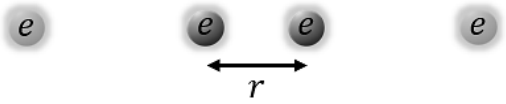
(A)0 J **(B)**27 J **(C)**-54 J **(D)**-27 J

Q.14 Four charges each of magnitude q are placed at four corners of a square of side a. The work done in carrying a charge $-q$ from its centre to infinity will be



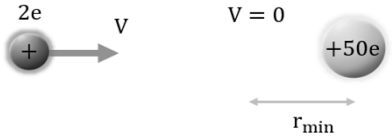
(A)zero **(B)**$\frac{2\sqrt{2}q^2}{\pi\epsilon_0 a}$ **(C)**$\frac{\sqrt{2}q^2}{\pi\epsilon_0 a}$ **(D)**$\frac{q^2}{2\pi\epsilon_0 a}$

Q.15 Two electrons, each moving with a velocity of 10^6 m/stowards each other. The closest distance of approach between them is (Charge on an electron, $e = -1.6 \times 10^{-19}$ Cand mass of an electron, $m_e = 9.1 \times 10^{-31}$ kg)



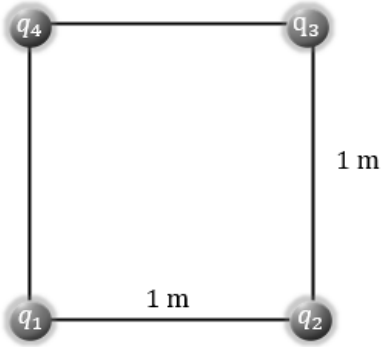
(A)2.5×10^{-10} m **(B)**4.5×10^{-10} m **(C)**3.5×10^{-10} m **(D)**5.5×10^{-10} m

Q.16 An $\alpha -$ particle with kinetic energy 10 MeVis heading towards a stationary nucleus of atomic number 50. Calculate the distance of closest approach. Initially they were far apart.



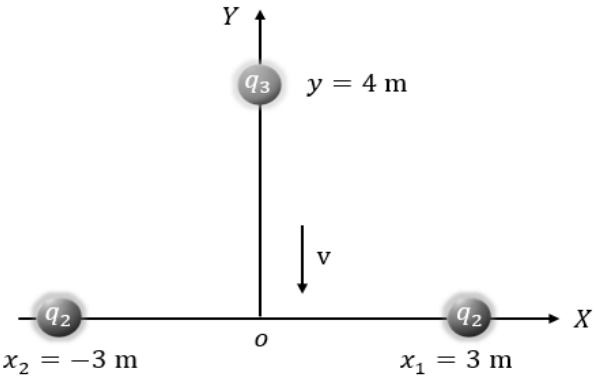
(A)28.8×10^{-15} m **(B)**14.4×10^{-12} m **(C)**14.4×10^{-15} m **(D)**28.8×10^{-15} m

Q.17 Four charges $q_1 = 1$ μC, $q_2 = 2$ μC, $q_3 = -3$ μCand $q_4 = 4$ μCare kept on the vertices of a square of side 1 m. Find the electric potential energy stored in this system of charges.



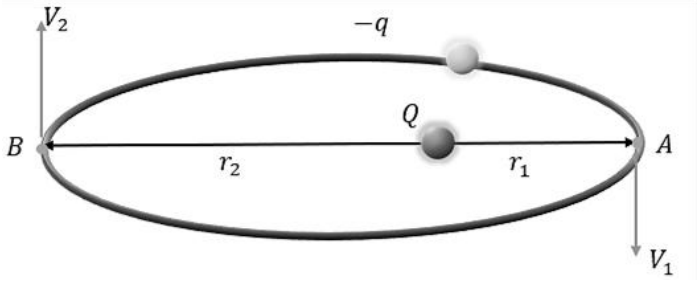
(A) 3.6×10^{-2} J **(B)** -7.62×10^{-2} J **(C)** 7.62×10^{-2} J **(D)** -3.6×10^{-2} J

Q.18 Two-point charges $q_1 = q_2 = +2$ μCare fixed at $x_1 = +3$ mand$x_2 = -3$ m as shown in the figure. A third particle of mass 1 g and charge $q_3 = -4$ μCis released from rest at $y = 4$ m. Find the speed of the third particle as it reaches the origin.



(A) 5.4 m/s **(B)** 6.2 m/s **(C)** 7.6 m/s **(D)** 8.8 m/s

Q.19 A point charge (−q) revolves around a fixed charge (+Q) in an elliptical orbit. The minimum and maximum distance of −q from +Q are r_1 and r_2 respectively. The mass of particle −q is m and assume no gravitational effects. Find the velocities v_1 and v_2 of −q at positions when it is at r_1 and r_2 distance from Q.



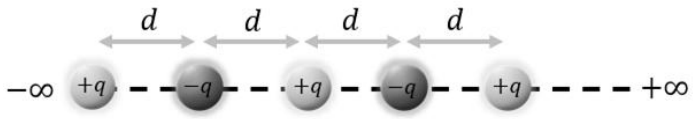
(A) $v_1 = \sqrt{\frac{Qqr_2}{2\pi\varepsilon_0 mr_1(r_1+r_2)}}$; $v_2 = \sqrt{\frac{Qqr_1}{2\pi\varepsilon_0 mr_2(r_1+r_2)}}$

(B) $v_1 = \sqrt{\frac{Qqr_1}{(r_1+r_2)}}$; $v_2 = \sqrt{\frac{KQr_2}{(r_1+r_2)}}$

(C) $v_1 = \sqrt{\frac{Qqr_1}{2\pi\varepsilon_0 mr_2(r_1+r_2)}}$; $v_2 = \sqrt{\frac{Qqr_2}{2\pi\varepsilon_0 mr_1(r_1+r_2)}}$

(D) $v_1 = \sqrt{\frac{Qqr_2}{mr_1^2}}$; $v_2 = \sqrt{\frac{Qqr_1}{mr_2^2}}$

Q.20 The potential energy of the infinite system of charges as shown in figure will be[Consider series expansion of $\ln 2 = (1 - \frac{1}{2} + \frac{1}{3} - \frac{1}{4} \ldots)$]



(A) $\frac{kq^2}{d}$ ln2 **(B)** $\frac{-kq^2}{d}$ ln2 **(C)** $\frac{-2kq^2}{d}$ ln2 **(D)** zero

ANSWER KEY

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