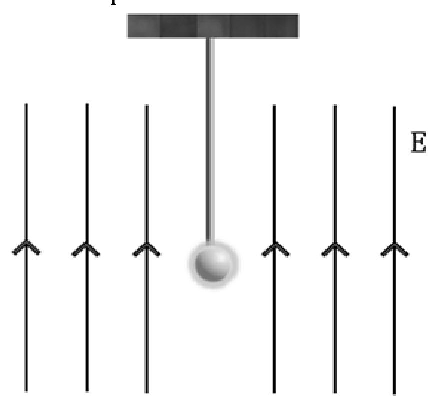
Q.1 An electron of mass m_e, initially at rest, moves through a certain distance in a uniform electric field in time t_1. A proton of mass m_p, which is also initially at rest, takes time t_2 to move through an equal distance in this uniform electric field. Neglecting the effect of gravity, the ratio t_2/t_1 is nearly equal to

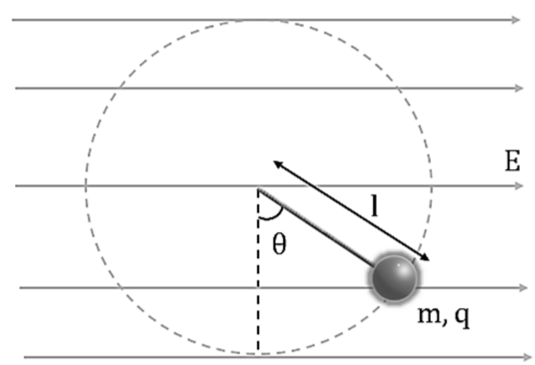
(A) 1 (B) $\left(\frac{m_p}{m_e}\right)^{1/2}$ (C) $\left(\frac{m_e}{m_p}\right)^{1/2}$ (D) $\left(\frac{m_e}{m_p}\right)$

Q.2 A neutral pendulum oscillates in a uniform electric field as shown in the figure. If a positive charge is given to the pendulum, then its time period



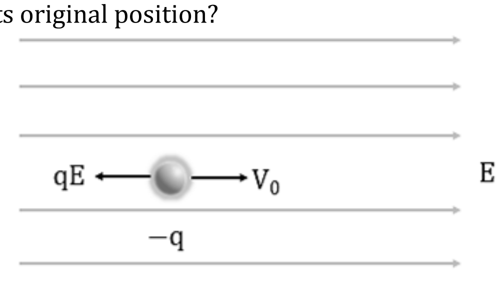
(A) Increases (B) Decreases
(C) remains constant (D) first increases and then decreases

Q.3 A small ball of mass m and charge +q tied with a string of length l, is rotating in a vertical circle under the influence of gravity and a uniform horizontal electric field E, as shown. The tension in the string will be minimum for



(A) $\theta = \tan^{-1}\left(\frac{qE}{mg}\right)$ (B) $\theta = \pi$ (C) $\theta = 0°$ (D) $\theta = \pi + \tan^{-1}\left(\frac{qE}{mg}\right)$

Q.4 An electron $(-e, m)$ is given velocity V_o along a uniform electric field $\vec{E}$. After how much time, electron will return to its original position?



(A) $\frac{2mV_o}{eE}$ (B) $\frac{mV_o}{eE}$ (C) $\frac{eE}{mV_o}$ (D) $\frac{2eE}{mV_o}$

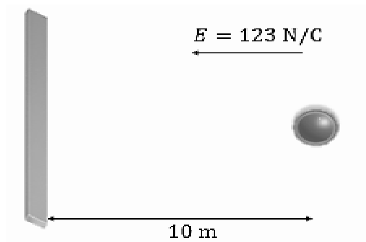
Q.5 A water droplet of mass 10 mg and having a charge of 1.50×10^{-6} C stays suspended in a room. What is the magnitude of electric field and its direction in the room? (Take $g = 10\ ms^{-2}$)

(A) 30 N/C, downwards
(B) 66.7 N/C, upwards
(C) 132 N/C, upwards
(D) 66.7 N/C, downwards

Q.6 A pendulum bob of mass 40 mg and carrying a charge of 2×10^{-8} C is at rest in a horizontal uniform electric field of $2 \times 10^{7}\ Vm^{-1}$. Calculate the tension in the thread of the pendulum and the angle it makes with the vertical.

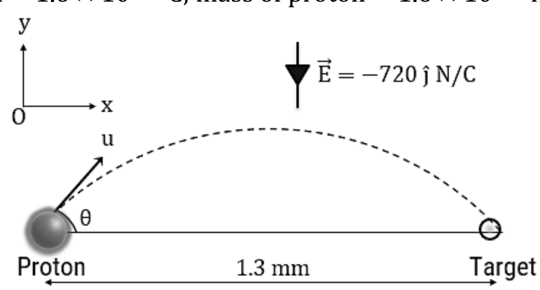
(A) $\theta = 45^o,\ T = \sqrt{32} \times 10^{-1}$ N
(B) $\theta = 45^o,\ T = \sqrt{8} \times 10^{-1}$ N
(C) $\theta = 30^o,\ T = \sqrt{32} \times 10^{-1}$ N
(D) $\theta = 30^o,\ T = \sqrt{8} \times 10^{-1}$ N

Q.7 A proton is released at rest 10 cm from a charged sheet (perpendicular to it) having uniform electric field around it of intensity 123 N/C towards (perpendicular to) the sheet. It will strike the sheet after the time (approximately). [Charge on proton = 1.6×10^{-19}C; mass of proton = 1.6×10^{-27} kg.]



(A) 4 μs
(B) 2μs
(C) $2\sqrt{2}$ μs
(D) $4\sqrt{2}$ μs

Q.8 Protons are projected with an initial speed, $u = 10^4$ m/s into a region where a uniform electric field $\vec{E} = -720\ \hat{j}$ N/C is present, as shown in figure. The protons are to hit a target that lies at a horizontal distance of 1.3 mm from the point where the protons are launched. Find the total time of flight for $\theta = 37°$. [Charge on proton = 1.6×10^{-19} C; mass of proton = 1.6×10^{-27} kg.]



(A) 0.7×10^{-7} s
(B) 1.7×10^{-7} s
(C) 2.7×10^{-7} s
(D) 3.7×10^{-7} s

Q.9 Work done by a Conservative force on a system is equal to

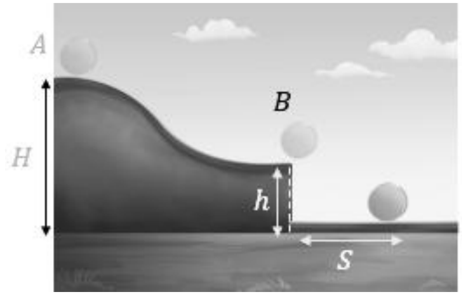
(A) The change in kinetic energy of the system
(B) The negative of the change in potential energy of the system
(C) The change in total mechanical energy of the system
(D) none of the above

Q.10 A force $\vec{F} = -k(y\hat{i} + x\hat{j})$ where k is a positive constant act on a particle moving in the $xy-$plane, starting from the origin, the particle is taken along the positive $x-$axis to the point $(a, 0)$ and then parallel to the $y-$axis to the point (a, a). The total work done by the force $\vec{F}$ on the particle is

(A) $-2ka^2$
(B) $2ka^2$
(C) ka
(D) $-ka^2$

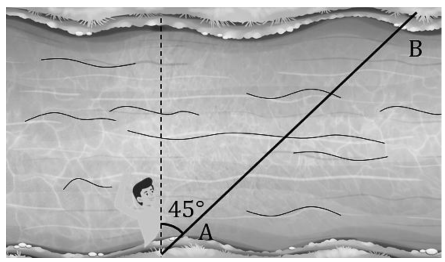
WORK SHEET

Q.1 A small disc A slides down with initial velocity equal to zero from the top of a smooth hill of height H having a horizontal portion. What must be the height of the horizontal portion h to ensure the maximum distance s covered by the disc?



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

Q.2 A man wants to reach point B on the opposite bank of a river flowing at a speed u as shown in figure. what minimum speed relative to water should the man have so that he can reach point B?

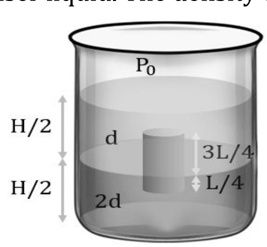


(A)$\sqrt{2}u$ **(B)**$\sqrt{3}u$ **(C)**$\frac{u}{\sqrt{3}}$ **(D)**$\frac{u}{\sqrt{2}}$

Q.3 A solid sphere rests on a horizontal surface. A horizontal impulseJ is applied at height h from center. The sphere starts pure rolling just after the application of the impluse. The ratio $\frac{h}{R}$ will be

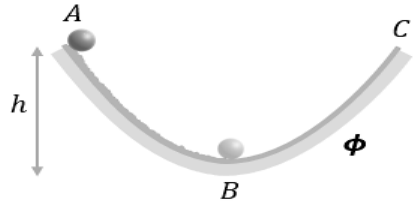
(A)$\frac{1}{2}$ **(B)**$\frac{2}{5}$ **(C)**$\frac{1}{5}$ **(D)**$\frac{2}{3}$

Q.4 A container of a large uniform cross-sectional area A resting on a horizontal surface holds two immiscible, non-viscous and incompressible liquids of densities d and $2d$, each of height $\frac{H}{2}$ as shown in figure. The lower density liquid is open to the atmosphere. A homogenous solid cylinder of length $L(L < \frac{H}{2})$, cross-sectional area $\frac{A}{5}$ is immersed such that it floats with its axis vertical to the liquid-liquid interface with length $\frac{L}{4}$ in the denser liquid. The density of the solid is



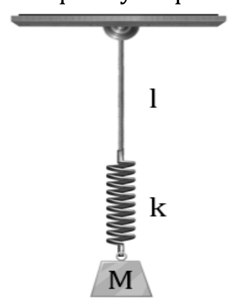
(A)$\frac{3d}{2}$ **(B)**$\frac{4d}{3}$ **(C)**$\frac{5d}{4}$ **(D)**3d

Q.5 A solid ball rolls down a parabolic path ABC from a height h as shown in figure. Portion AB of the path is rough while BC is smooth. How high will the ball climb in BC ?



(A) $\frac{5}{7}$h **(B)** $\frac{7}{5}$h **(C)** $\frac{2}{5}$h **(D)** $\frac{h}{5}$

Q.6 One end of a long metallic wire of length l is tied to the ceiling. The other end is tied to a massless spring of spring constant K. A mass (M) hangs freely from the free end of the spring. The area of cross-section and Young's modulus of the wire are a and Y respectively. If the mass is slightly pulled down and released, it will oscillate with a frequency f equal to



(A) $\frac{1}{2\pi}\sqrt{\frac{Kl}{MYa}}$ **(B)** $\frac{1}{2\pi}\sqrt{\frac{Ya}{Ml}}$ **(C)** $\frac{1}{2\pi}\sqrt{\frac{YaK}{M(Ya+Kl)}}$ **(D)** $\frac{1}{2\pi}\sqrt{\frac{K}{M}}$

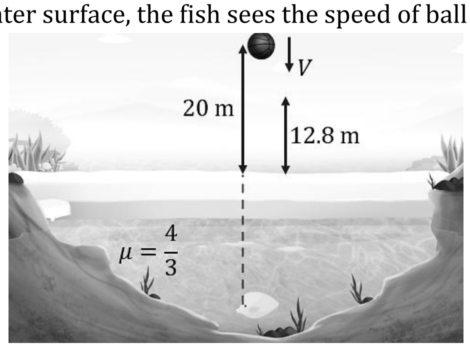
Q.7 The pressure of an ideal gas varies with volume as $P = \alpha V$, where α is a constant. One mole of the gas is allowed to undergo expansion such that its volume becomes m times its initial volume. The work done by the gas in the process is

(A) $\frac{\alpha V^2}{2}(m^2-1)$ **(B)** $\frac{\alpha}{2}(m^2-1)$ **(C)** $\frac{\alpha^2 V^2}{2}(m^2-1)$ **(D)** $\frac{\alpha V}{2}(m^2-1)$

Q.8 Two tuning forks with natural frequencies 340 Hz each move relative to stationary observer. One fork moves away from the observer while the other moves towards him at the same speed. The observer hears beats of frequency 3 Hz. Find the speed of the tuning fork (velocity of sound in air is 340 m/s).

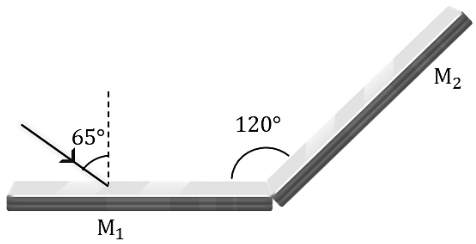
(A) 1.5 m/s **(B)** 3 m/s **(C)** 4.5 m/s **(D)** 6 m/s

Q.9 A ball is dropped from a height of 20m above the surface of water in a lake. The refractive index of water is $\frac{4}{3}$. A fish inside the lake, in the line of fall of the ball, is looking at the ball. At an instant, when the ball is 12.8m above the water surface, the fish sees the speed of ball as



(A) $9 ms^{-1}$ **(B)** $12 ms^{-1}$ **(C)** $16 ms^{-1}$ **(D)** $21.33 ms^{-1}$

Q.10 Find the value of angle of reflection at plane mirror M_2, when a ray of light is incident at M_1 as shown in figure.



(A)45° **(B)**55° **(C)**65° **(D)**75°

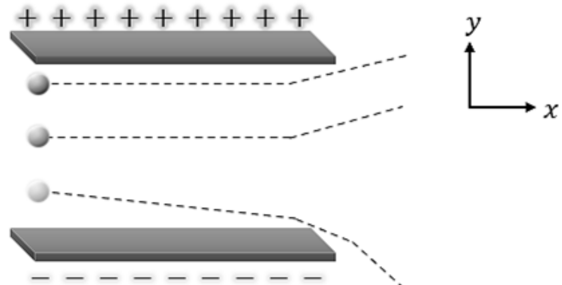
Q.11 An electric field of magnitude 10^5 N/C points due west at certain point. The magnitude of the force that acts on a charge of $+2\ \mu C$ and $-5\ \mu C$ at this point respectively are

(A)0.5 N and 0.2 N **(B)**0.2 N and 0.5 N **(C)**1 N and 0.3 N **(D)**2 N and 0.1 N

Q.12 There is an electric field E in x − direction. If the work done by electric force on moving a charge of 0.2 C through a distance of 2 m along a line making an angle 60° with x − axis is 4 J, then what is the value of E? (Neglect gravity)

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

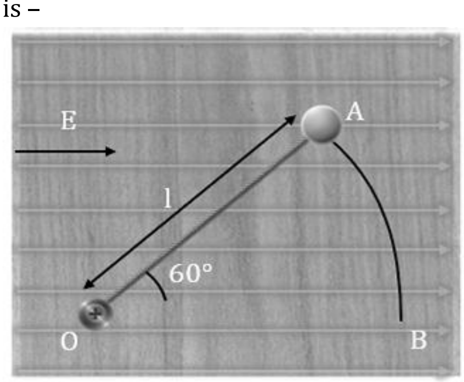
Q.13 Figure shows tracks of three charged particles in a uniform electrostatic field. Which particle has the highest magnitude of charge to mass ratio (Assume gravity to be negligible)?



(A)1 **(B)**2

(C)3 **(D)**All particles have same charge to mass ratio

Q.14 A particle of mass m and charge q is fastened to one end of a string of length l. The other end of the string is fixed to the point O. The whole system lies on a frictionless horizontal plane. Initially, the mass is at rest at A. A uniform electric field in the direction shown is then switched on. The speed of the particle when it reaches B is –



(A)$\sqrt{\frac{2qEl}{m}}$ **(B)**$\sqrt{\frac{qEl}{m}}$ **(C)**$\sqrt{\frac{3qEl}{m}}$ **(D)**$\sqrt{\frac{5qEl}{m}}$

Q.15 A pendulum bob of mass m carrying a charge q is at rest with its string making an angle θ with the vertical in a uniform horizontal electric field E. The tension in the string is

(A) $\frac{mg}{\sin\theta}$ **(B)** mg **(C)** $\frac{qE}{\sin\theta}$ **(D)** $\frac{qE}{\cos\theta}$

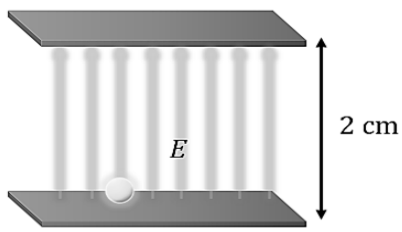
Q.16 At some instant the velocity component of an electron moving between two charged parallel plates are $u_x = 1.5 \times 10^5$ m/s and $u_y = 3 \times 10^6$ m/s. Suppose that the electric field between the plates is given by $\vec{E} = 120\hat{j}$ N/C. What will be the velocity of the electron as its x −coordinate changes by 2 cm? (Neglect gravity)

(A) $(1.5\hat{i} + 2\hat{j}) \times 10^5$ m/s **(B)** $(2\hat{i} + 1.5\hat{j}) \times 10^5$ m/s
(C) $(1.5\hat{i} - 2\hat{j}) \times 10^5$ m/s **(D)** $(2\hat{i} - 1.5\hat{j}) \times 10^5$ m/s

Q.17 A block of mass 1 kg containing a net positive charge 10^{-10} C is placed on a smooth horizontal table which terminates in a vertical wall as shown in figure. The distance of the block from the wall is 2 m. A horizontal electric field 10^{10} N/C towards right is switched on. Assuming elastic collision (if any), find the time period of the resulting oscillatory motion.

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

Q.18 An electric field of magnitude 1000 N/C is produced between two parallel plates having a separation of 2.0 cm as shown in figure. With what minimum speed should an electron be projected from the lower plate in the direction of the field so that it may just reach the upper plate? (Assume gravity free space) (Charge on electron is -1.6×10^{-19} C and mass of electron is 9.1×10^{-31} kg)



(A) 1.7×10^6 m/s **(B)** 2.7×10^6 m/s **(C)** 3.7×10^6 m/s **(D)** 4.7×10^6 m/s

Q.19 An object is displaced from position vector $\vec{r_1} = (2\hat{i} + 3\hat{j})$ m to $\vec{r_2} = (4\hat{i} + 6\hat{j})$ m under a force $\vec{F} = (3x^2\hat{i} + 2y\hat{j})$ N. Find the work done.

(A) 83J **(B)** 38J **(C)** –83J **(D)** –38J

Q.20 A carpenter is applying a force $\vec{F} = -1.5xy^2\hat{j}$ on a hammer, whose magnitude depends on the position of the tool. The displacement of the tool from the origin to the point (2,2) m. Find the workdone on the hammer, if the displacement is along the straight line $y = x$.

(A) 16 J **(B)** 6 J **(C)** 0 J **(D)** 12 J

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(B)	(A)	(D)	(A)	(B)	(A)	(A)	(B)	(B)	(D)

WORK SHEET

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