Centre of Mass

Q.1 A shell fired from a gun at an angle to the horizontal, explodes in midair. The centre of mass of the shell fragments will move.

(A) Vertically down

(B) Horizontally

(C) Along the same parabolic path along which the 'intact' shell was moving

(D) Along the tangent to the parabolic path of the 'intact' shell, at the point of explosion

Q.2 A man of mass 40 kg is standing on a platform of 12 kg kept on a smooth surface. If the man starts running at 6 m/s relative to the platform, the velocity of the platform relative to the ground is

(A) 3 m/s **(B)** 4.6 m/s **(C)** 2 m/s **(D)** 6 m/s

Q.3 Two boys A and B of mass 60 kg and 40 kg are standing on a platform kept on smooth surface. Both start walking towards each other with the same velocity 5 m/s with respect to the platform. Find the velocity of the platform if mass of the platform is 100 kg.

(A) 0.5 m/s **(B)** 2 m/s **(C)** 1m/s **(D)** 5m/s

Q.4 A block moving in air, explodes into two parts. Then just after explosion (neglect change in momentum due to gravity)

Statement 1:- The total momentum of the two parts must be equal to the momentum of the block before explosion.

Statement 2:- If no external force acts on a system, then the linear momentum of the system will be conserved.

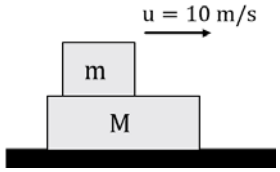
(A) Both Statement 1 and Statement 2 are true and Statement 2 is the correct explanation of Statement 1.

(B) Both Statement 1 and Statement 2 are true and Statement 2 is not the correct explanation of Statement 1.

(C) Statement 1 is true, but statement 2 is false.

(D) Statement 2 is true, but statement 1 is false.

Q.5 The figure given below shows a block of mass m $=$ 10 kg and M $=$ 20 kg. The block of mass m kg is given a velocity of 10 m/s before placing it on the block of mass M at rest on a smooth horizontal surface. The coefficient of friction between the two blocks is $\mu = 0.3$. Then what will be the velocity of COM of the system when the system reaches common speed?



(A) $\frac{5}{3}$ m/s Towards right **(B)** $\frac{10}{3}$ m/s towards right

(C) 5 m/s towards right **(D)** 1. 3 m/s towards right

Q.6 Two men jump from a stationary buggy, one after the other with the same velocity u $=$ 20 m/s relative to the buggy towards left. Masses of the men are same (m $=$ 50 kg) & mass of the buggy is

M = 200 kg. Find the velocity of the buggy after both men jump off. (Assume friction to be negligible)

(A) $\frac{70}{3}$ m/s Towards left **(B)** $\frac{110}{9}$ m/s Towards left

(C) $\frac{22}{3}$ m/s Towards right **(D)** $\frac{220}{9}$ m/s Towards right

Q.7 Two men of the same mass m = 50 kg jump from a stationary buggy of mass M = 50 kg simultaneously, with a velocity of u = 20 m/s towards left. Find the velocity of the buggy after they jump.

(A) 20 m/s Towards left **(B)** $\frac{40}{3}$ m/s Towards right

(C) 10 m/s Towards right **(D)** $\frac{20}{3}$ m/s Towards left

Q.8 When a cannon shell explodes in mid air

(A) Momentum of the system is conserved in all cases.

(B) Momentum of the system is conserved only if the shell was moving horizontally.

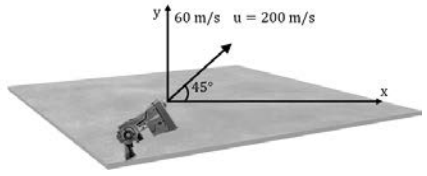
(C) Kinetic energy of the system always remains constant.

(D) Kinetic energy of the system will always increase.

Q.9 A particle of mass m = 4 kg is projected with a speed of u = 10 m/s at an angle of 45° with the horizontal. The particle explodes in midair when it is at the maximum height. One component weighing 1 kg comes to rest after the explosion and the other component of mass 3 kg moves away. Find the distance where the 3 kg mass component strikes the ground from the initial position (projection point). [Take g = 10 m/s^2]

(A) 15 m **(B)** $\frac{35}{3}$ m **(C)** $\frac{20}{3}$ m **(D)** 25 m

Q.10 A 10 kg gun fires a bullet of 100 g with a speed of 200 m/s relative to the barrel of the gun, which is inclined at an angle 45° with the horizontal. The gun is placed over a smooth horizontal surface. Find the recoil speed of the gun (in m/s). (Answer up to two decimal places)



WORK SHEET

Displacement in n^{th} second

Q.1 The ratio of distance covered by a freely falling body (starting from rest) during the 1^{st} and 2^{nd} and 3^{rd} second of its motion is: [Take.g $= 10\ m/s^2$]

(A) 3: 6: 9 **(B)** 1: 3: 5 **(C)** 2: 3: 5 **(D)** 1: 3: 7

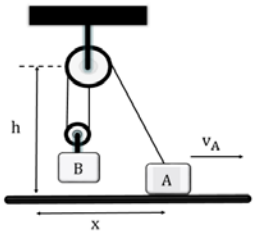
Projectile Motion

Q.2 A particle is projected with a velocity v so that it range on a horizontal plane is twice the greatest height attainable. Consider $g = 10\ m/s^2$ as acceleration due to gravity. Then, its range will be:

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

Constrained Motion

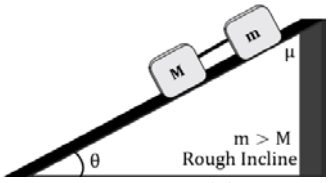
Q.3 If block A is moving horizontally with velocity v_A, then find the velocity of block B at the instant shown in figure.



(A) $\frac{hv_A}{2\sqrt{x^2+h^2}}$ **(B)** $\frac{xv_A}{\sqrt{x^2+h^2}}$ **(C)** $\frac{xv_A}{2\sqrt{x^2+h^2}}$ **(D)** $\frac{hv_A}{\sqrt{x^2+h^2}}$

Friction on Inclined plane

Q.4 In the figure given below, two blocks of mass m and M are connected through a light inextensible rope. Then, find the tension in the connecting rope. Consider coefficient of static friction between the inclined surface and the blocks to be μ.

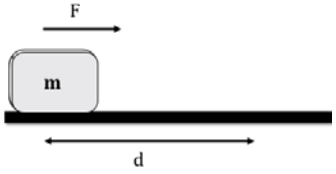


(A) $(M + m)g\sin\theta$ **(B)** $(M + m)g\sin\theta - \mu mg\cos\theta$

(C) Zero **(D)** $(M + m)g\cos\theta$

Circular Motion

Q.5 The angular velocity of a particle moving on a circular path of radius 50 cm is increased in 5 min from 100 rpm to 400 rpm. Find the magnitude of tangential acceleration of the particle.



(A) $60 ms^{-2}$ **(B)** $\frac{\pi}{30} ms^{-2}$ **(C)** $\frac{\pi}{15} ms^{-2}$ **(D)** $\frac{\pi}{60} ms^{-2}$

Work Energy Theorem

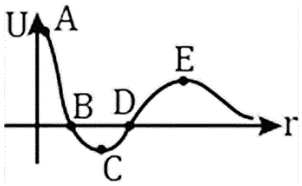
Q.6 A body of mass m starts from rest and is moving in one dimension under the action of a force F such the force F is directly proportional to t. Then, kinetic energy acquired by the body in travelling a certain distance d along a straight line will be:

(A) Directly proportional to t^2 **(B)** Independent of t

(C) Directly proportional to t^4 **(D)** Directly proportional to t

Potential Energy

Q.7 The given plot shows the variation of potential energy U due to the interaction between two particles. Particles are separated by a distance r. Identify the correct statement out of the given statements:

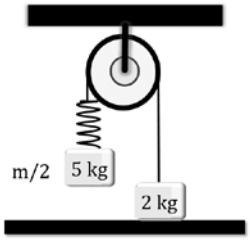


1. BandD are equilibrium points.
2. Cis a point of stable equilibrium
3. The force of interaction between the two particles is attractive between points Band C, and repulsive between points D and E on the curve.
4. The force of interaction between the particles is repulsive between points Aand C.

(A)1and3 **(B)**1 and 4 **(C)**2 and 4 **(D)**2 and 3

Energy Conservation

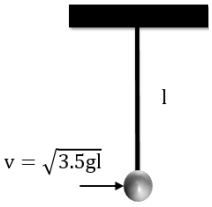
Q.8 The system shown in the figure is released from rest with the mass 2 kg in contact with the ground. The pulley and spring are massless, and friction is absent everywhere. Then, find the speed of the 5 kg block when the 2 kg block leaves contact with the ground (force constant of the spring)k = 40 N/m and g = 10 m/s^2)



(A)$\sqrt{2}$ m/s **(B)**$2\sqrt{2}$ m/s **(C)**2 m/s **(D)**$2\sqrt{3}$ m/s

Vertical Circular Motion

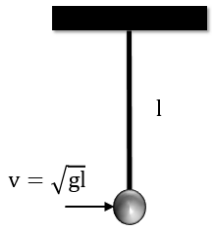
Q.9 The bob of a pendulum initially at rest is given a sharp hit to impart a horizontal velocity of $\sqrt{3.5\,gl}$ m/s, where l is the length of the pendulum in metres. Find the height (in meters) at which tension in the string becomes zero. Take g = 10 m/s^2



(A)l **(B)**$\frac{3l}{2}$ **(C)**2l **(D)**Never be zero

Tangential Acceleration

Q.10 The bob of a pendulum at rest is given hit to impact a horizontal velocity $\sqrt{gl}$ m/s where l is the length of the pendulum. Find the tangential acceleration at the point where velocity of bob is zero.



(A) $5\sqrt{3}\ m/s^2$ **(B)** $5\ m/s^2$ **(C)** $\frac{5}{\sqrt{3}}\ m/s^2$ **(D)** $10\ m/s^2$

Linear Momentum

Q.11 What does the principle of conservation of linear momentum state?

(A) The linear momentum of a system cannot be changed.

(B) The linear momentum of a system cannot remain constant.

(C) The linear momentum of a system can be changed onlyif internal forces act on it.

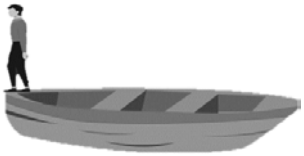
(D) The linear momentum of a system can be changedonly if external forces act on it.

Conservation of Linear Momentum

Q.12 A man of mass 60 kg is standing on a platform of mass 140 kg kept on a smooth horizontal surface. The man starts moving on the platform with a velocity 2m/s relative to the platform. Find the recoil velocity of the platform.

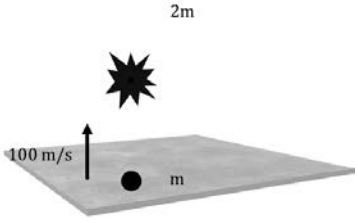
(A) 1 m/s **(B)** 0.5 m/s **(C)** 0.6 m/s **(D)** 2 m/s

Q.13 A boy of mass 20 kg on an initially stationary boat gets off the boat by jumping to the left in an exactly horizontal direction. Immediately after the jump, the boat of mass 40 kg is observed to be moving to the right at speed 2 m/s. How much work did the boy do during the jump?



(A) 240 J **(B)** 0 J **(C)** 120 J **(D)** 60 J

Q.14 A body is projected from the ground with an upward velocity of 100 m/s. The body explodes into two fragments of mass m and 2m just after it was projected. If the lighter part comes to rest instantly, find the maximum height attained by the other part. [Take $g = 10\ m/s^2$]



(A) 1125 m **(B)** 1500 m **(C)** 100 m **(D)** 1250 m

Conservation of Momentum

Q.15 A cannon shell moving along a straight line, explodes into two parts. Just after the explosion, one part moves with momentum 100 Ns making an angle 30° with the original line of motion. The minimum momentum of the other part of the shell after the explosion is (Neglect gravity)

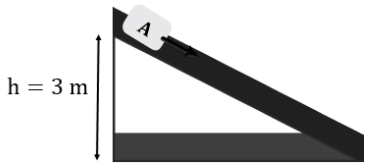
(A) 0 Ns **(B)** 100 Ns **(C)** 75 Ns **(D)** 50 Ns

Q.16 Two men jump simultaneously from one buggy to another on the same track, towards left direction with a relative velocity u. Initially, both the buggies are stationary. Find the final velocities (in m/s) of the buggies after they jump. Given: masses of the men $= 50$ kg each, mass of buggy $= 200$ kg and relative velocity of jumping u $=$ 10 m/s w.r.t buggy.

(A) $\frac{10}{3}, \frac{20}{9}$ **(B)** $\frac{50}{3}, \frac{25}{9}$ **(C)** $\frac{25}{13}, \frac{25}{18}$ **(D)** $\frac{25}{3}, \frac{25}{9}$

Q.17 A body of mass 2 kg is sliding on a smooth inclined plane as shown. Mass of the movable wedge is 4 kg. Find the velocity of the wedge just before the body reaches the ground.

(A) 4 m/s **(B)** 2m/s **(C)** 6m/s **(D)** 10m/s



Work Energy Theorem

Q.18 A block of mass 2 kg is projected with a velocity 6 m/s so that it climbs onto a smooth wedge of mass1 kg. If the block does not leave the wedge, find the maximum height attained by the block. Take g $=$ 10 m/s^2

(A)0.3 m **(B)**0.6 m **(C)**1.2 m **(D)**0.4 m

Conservation of Momentum

Q.19 A bomb at rest explodes into three equal fragments. Two fragments fly off at right angles with velocity 12 m/sand 9 m/s. If the explosion process occurs in 0.1 s, find out the average force acting on the third particle, if total mass of the bomb is 12 kg.

(A)600 N **(B)**60 N **(C)**15 N **(D)**1200N

Q.20 If the external forces acting on a system have zero resultant, the center of mass

(A) Must not move **(B)**Must not accelerate **(C)**May move **(D)**May accelerate

ANSWER KEY

Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(C)	(B)	(A)	(A)	(B)	(C)	(B)	(A)	(B)	1.4m/s
WORK SHEET										
Q.	1	2	3	4	5	6	7	8	9	10
Sol.	(B)	(A)	(C)	(C)	(D)	(C)	(C)	(B)	(B)	(A)
Q.	11	12	13	14	15	16	17	18	19	20
Sol.	(D)	(C)	(A)	(A)	(D)	(A)	(B)	(B)	(A)	(C)