Collision

Q.1 In a collision between two balls of masses m_1 and m_2, the balls move at right angles to each other, when

(A) Balls are identical i.e., $m_1 = m_2$ **(B)** One of the balls is at rest

(C) Collision is not only oblique but also elastic **(D)** When all of the above are true

Fuel Consumption

Q.2 A rocket of initial mass 3000 kg is burning fuel at the rate of 30 kg/s. Find the mass of the rocket after 10 s.

(A) 2700 kg **(B)** 3300kg **(C)** 2000kg **(D)** 0kg

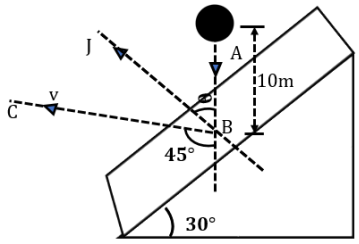
Fuel Consumption

Q.3 Mass of spacecraft varies with time as $m = 5000\, e^{-t}$kg. Find the rate of fuel ejection after 5 s. (Take $e = 2.718$)

(A) 23.7kg/s **(B)** 33.7kg/s **(C)** 337kg/s **(D)** 237kg/s

Impulse

Q.4 The point B lies on a smooth plane inclined at 30^o to the horizontal. A particle of mass $\frac{1}{7}$kg is dropped from a point A which lies 10 m vertically above B.The particle rebounds from the plane in the direction BC with speed v m/s at an angle of 45^o to the plane. Find the impulse exerted by the plane on the particle (in Ns)



(A) $1 + \sqrt{3}$ **(B)** $1 - \sqrt{3}$ **(C)** $2 + \sqrt{3}$ **(D)** $2 - 2\sqrt{3}$

Fuel Consumption

Q.5 A rocket of mass 20 kg has 180 kg fuel. The exhaust velocity of the fuel is 1.6 km/s. Calculate the minimum rate of consumption of fuel so that the rocket may rise from the ground. (Take $g = 9.8$ m/s^2)

(A) 1.225 kg/s **(B)** 1.725 kg/s **(C)** 2.125kg/s **(D)** 2.425kg/s

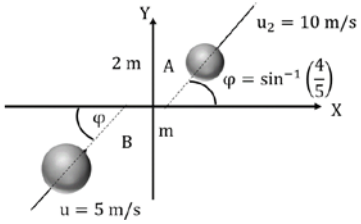
Fuel Consumption

Q.6 In a gravity free space, a spacecraft of mass 10 kg, having 20 kg of fuel is initially at rest. The fuel is ignited and the exhaust velocity is 0.1 km/s. Then, speed gained by the spacecraft when the fuel is fully consumed is

(A) 109 km/s **(B)** 10.9km/s **(C)** 109 m/s **(D)** 1.09km/s

Coefficient of restitution

Q.7 Two smooth spheres made of identical material having masses m and 2m undergo an oblique impact as shown in figure. The initial velocities of the masses are also shown. The impact force is along the line joining their centers/ The coefficient of restitution is $\frac{5}{9}$. The velocities of the masses after the impact are:



(A) $\frac{10}{3}\hat{\imath} + 8\hat{\jmath}, \frac{5}{3}\hat{\imath} + \frac{4}{3}\hat{\jmath}$ **(B)** $\frac{5}{3}\hat{\imath} - 8\hat{\jmath}, \frac{-5}{3}\hat{\imath} + 4\hat{\jmath}$ **(C)** $\frac{10}{3}\hat{\imath} - 8\hat{\jmath}, \frac{-5}{3}\hat{\imath} + 4\hat{\jmath}$ **(D)** None of these

Rate of ejection of gases

Q.8 A cart of total mass 50 kg is at rest on a horizontal road having coefficient of friction 0.1. Gases are ejected from this cart backwards with velocity 20 m/s w.r.t the cart. The rate of ejection of gases is 2 kg/s. The cart will start moving after time: [Take $g = 10\ m/s^2$]

(A) $t = 2s$ **(B)** $t = 3s$ **(C)** $t = 5s$ **(D)** $t = 10s$

Rate of ejection of gases

Q.9 A car at rest on a horizontal surface (with coefficient of friction 0.1) has total mass 50 kg. Gases are ejected from this car backwards with relative velocity 20 m/s. The rate of ejection of gases is 2 kg/s. Total mass of gas is 20 kg. Find the maximum speed of the car (in m/s) (Take $g = 10\ m/s^2$)

(A) 0.2 m/s **(B)** 0.75m/s **(C)** 0.6m/s **(D)** 0.4m/s

Thrust Force

Q.10 In case of a variable mass system, a thrust force of magnitude $\left|V_r \frac{dm}{dt}\right|$ has to be applied on the system, whose mass is changing. Which of the following statements is/are correct?

(A) Direction of thrust force is along V_r if the mass is increasing.

(B) Direction of thrust force is opposite to V_r if the mass is increasing.

(C) Direction of thrust force is opposite to V_r if the mass is decreasing.

(D) Direction of thrust force is along V_r if the mass is decreasing.

WORK SHEET

Motion under gravity

Q.1 A ball is thrown vertically upward with a velocity of 10 m/s from the top of a tower of height of 50 m. Find the time taken by the ball to reach a height 10 m from the ground. (take $g = 10\ m/s^2$)

(A)1 s **(B)**3s **(C)**4s **(D)**5s

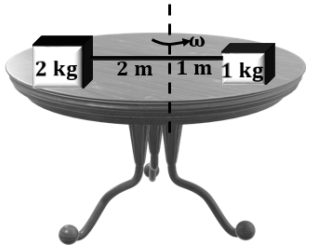
Relative Motion

Q.2 Two trains are moving on parallel tracks in opposite directions at the speeds of 20 m/s and 15 m/s respectively. If both the trains are of equal length 140 m each, then how much time will take to cross each other?

(A)4s **(B)**8s **(C)**16s **(D)**2s

Rotation

Q.3 Two blocks tied with a massless string of length 3 m are placed on a table rotating at an angular speed $\omega = 4$ rad/s. The axis of rotation is 1 m from the bock having 1 kg mass. Assume that the surface below 2 kg block is smooth and that below the 1 kg block is rough. Find the tension (T) in the string and the frictional force (f) acting on the 1 kg block. Take $g = 10\ m/s^2$

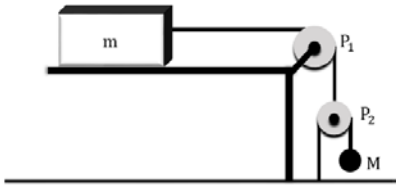


(A)$T = 64N, f = 48N$ **(B)**$T = 48N, f = 64N$

. **(C)**$T = 8N, f = 4N$ **(D)**$T = 4N, f = 8N$

Pulley Mass system

Q.4 In the pulley arrangement shown in figure, pulley P_2 is movable. Assuming the coefficient of friction between the block having mass m and the surface is μ, find the maximum value of M for which m is at rest.

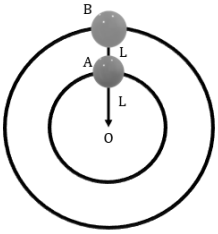


(A)$T = 64N, f = 48N$ **(B)**$T = 48N, f = 64N$

(C)$T = 8N, f = 4N$ **(D)**$T = 4N, f = 8N$

Circular Motion

Q.5 Two particles are joined together by a string of total length 2L as shown in figure. Both the particles are performing uniform circular motion about point O in a horizontal plane. If the speed of the outermost particle is v_0. Then the ratio of tension in string AB and OA will be:

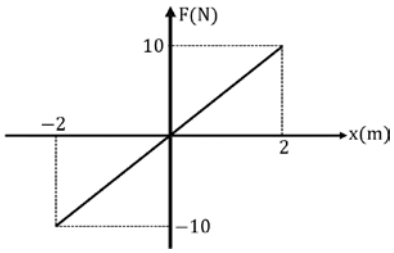


(A)4: 5 **(B)**3: 4 **(C)**5: 3 **(D)**2: 3

Work done

Q.6 A force F acting on a particle varies with the particle varies the position x as shown in figure. The work done by this force in displacing the particle from $x = -2$ m to $x = 0$

(A)$+10$J **(B)**$+20$J **(C)**-20J **(D)**-10J



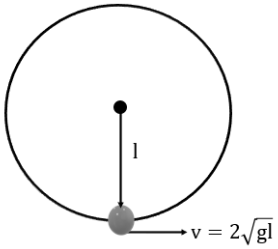
Power

Q.7 An engine pumps up 100 kg of water through a height of 10 m in 5 s. Given that the efficiency of the engine is 60%, what is the power of the engine? (Take g $= 10$ m/s^2)

(A)33 kW **(B)**3.3kW **(C)**0.33kW **(D)**0.033kW

Circular Motion

Q.8 A particle is suspended from a fixed point by a string of length l.It is projected from the equilibrium position with a velocity $v = 2\sqrt{gl}$ shown in the figure below, which of the following statements is true?



(A) The particle reaches point C and undergoes free fall along the diameter CA.

(B) The particle reaches a point between B and C where tension and velocity are both zero and free falls.

(C) The particle reaches a point between B and C, where tension is zero but velocity is not zero, and follows a parabolic path.

(D) The particle never reaches point B and it oscillates between B and C.

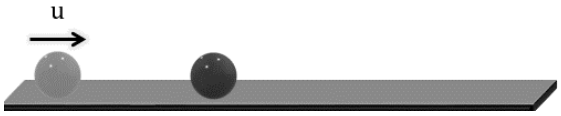
Relative Motion

Q.9 A man of mass M stands at one end of a plank of length L which is at rest on a frictionless horizontal surface. The man walks to the other end of the plank. If mass of the plank is $\frac{M}{3}$, distance that the man moves relative to the ground is

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

Coefficient of restitution

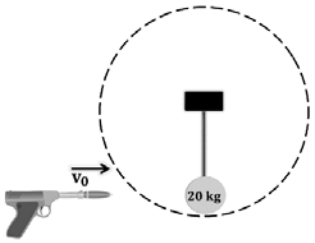
Q.10 A particle loses 25 % of its kinetic energy during head on collision with another identical particle initially at rest. The coefficient of restitution will be



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

Collision

Q.11 A ball of mass 20 kg is suspended from a massless string of length 5 m as shown in figure. A bullet of mass 5 kg moving with velocity v_0 m/s collides with the ball and sticks to it. Find the minimum value of v_0 so that the combined mass completes the vertical circular motion. [Take g $= 10$ m/s^2]



(A)100 m/s **(B)**15m/s **(C)**79m/s **(D)**47.4m/s

Fuel Consumption

Q.12 A rocket of mass 120 kg has 280 kg fuel. The relative exhaust velocity of the fuel is 1.8 km/s and the rate of consumption of the fuel is 2 kg/s. Calculate the ultimate vertical speed gained by the rocket. (Take $g = 9.8\ m/s^2$)

(A)3.54 km/s **(B)**1.79km/s **(C)**0.795km/s **(D)**0km/s

Collision

Q.13 A ball of mass m is suspended by a massless string of length $l = 10$ m from a fixed point as shown in the figure below. A ball of mass 2 m strikes at an angle $\theta = 45^o$ from the horizontal and sticks to it. If the system deflects by angle $\phi = \frac{\pi}{2}$, then the velocity of the system just after the collision and the velocity of 2 m particle before collision are, respectively (in m/s)

(A)$10\sqrt{2}, 30$ **(B)**$10, 30\sqrt{2}$ **(C)**10,30 **(D)**$10\sqrt{2}, 30\sqrt{2}$

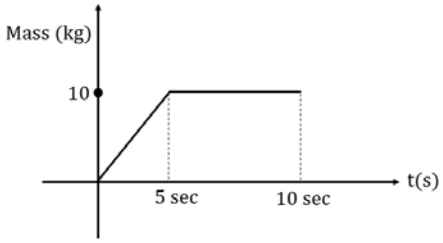
Fuel Consumption

Q.14 A spacecraft engine ejects mass at a rate of 30 kg/s with exhaust velocity of 3000 m/s. What is the thrust of the engine in vacuum?

(A)90,000 N **(B)**9000N **(C)**9,00,000N **(D)**900N

Fuel Consumption

Q.15 A graph of mass ejected vs time is shown in the figure below [Given $\ln\left(\frac{50}{49}\right) = 0.02$]. Find the velocity of the rocket after 5 s, if initial launch velocity is 200 m/s and velocity of ejected fuel w.r.t the rocket is 20 m/s. [takeg $= 10\ m/s^2$ and initial mass of the rocket is 500 kg]



(A)20.4 m/s **(B)**150.4m/s **(C)**30.4m/s **(D)**15.6m/s

Fuel Consumption

Q.16 A rocket with an initial mass $m = 2000$ kg is launched vertically upwards. The rocket burn fuel at the rate of 20 kg/s. The burnt material is ejected vertically downwards with a speed of 4000 m/s relative to the rocket. If burning stops after 30 seconds, find the maximum velocity of the rocket. (Take $g = 10\ m/s^2$)

(A) 0 m/s **(B)** 4515.9m/s **(C)** 1126.7m/s **(D)** 300m/s

Fuel Consumption

Q.17 Scientists of ISRO want to achieve a velocity of rocket 100 m/s after time t = 5 sec. Velocity of ejected burnt fuel is 20 m/s w.r.t the rocket. What should be the rate of consumption of fuel (approximately) so that the rocket will achieve the velocity of 100 m/s? Initial mass of rocket is 2000kg [Take g = 10 m/ s^2]

(A)300 kg/s **(B)**400kg/s **(C)**100kg/s **(D)**200kg/s

Fuel Consumption

Q.18 PSLV decides to send a rocket to the moon for which it required a velocity of 1232.6 m/s after 1 min. The rocket burns fuel at the rate of 10 kg/s. The burnt matter is ejected vertically downwards with a speed of 2000 m/s relative to the rocket. Calculate the initial mass of rocket. [Take g = 10 m/s^2]

(A)400 kg **(B)**100kg **(C)**500kg **(D)**200kg

Fuel Consumption

Q.19 A rocket with an initial mass of M = 2000 kg is launched vertically upwards form rest, under gravity. The rocket burns fuel at the rate of 20 kg/s. The burnt matter is ejected vertically downwards with a speed of 4000 m/s relative to the rocket. Velocity of the rocket after 60 secis 2000 m/s. Find the mass of rocket gas ejected in 60 sec. [Take g = 10 m/s^2]

(A)420.62 kg **(B)**955.86kg **(C)**590.62kg **(D)**500.92kg

Elastic Collision

Q.20 A ball A collides elastically with another identical ball B with velocity 10 m/s at an angle of 30^{o} with the line joining their centers C_1 and C_2. Select the correct alternative(s).

(A) Velocity of ball A after collision is 5 m/s.

(B) Velocity of ball B after collision is $5\sqrt{3}$ m/s.

(C) Both the balls move at right angles after collision.

(D) Kinetic energy will not be conserved here, because collision is not head on.

ANSWER KEY

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