Impulsive vs non-impulsive Forces

Q.1 Find out the correct statement from the options given below:

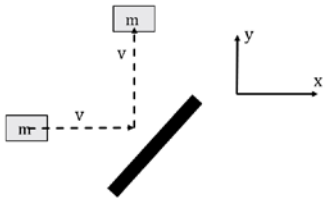
(A) Impulse is a scalar quantity **(B)** Dimensions of impulse are $[ML\,T^{-2}]$

(C) Impulse is a property of particles **(D)** Gravitational force is always non-impulsive

Q.2 A ball of mass 2 kg, travelling with a velocity $2\hat{\imath} + 3\hat{\jmath} + 4\hat{k}$ m/s receives an impulse of $4\hat{\imath} + 2\hat{\jmath}$ N − s. what is the velocity of the ball immediately after the impulse is imparted?

(A) $4\hat{\imath} + 4\hat{\jmath} + 4\hat{k}$ m/s **(B)** $2\hat{\imath} + 2\hat{\jmath} + 2\hat{k}$ m/s **(C)** $6\hat{\imath} + 5\hat{\jmath} + 4\hat{k}$ m/s **(D)** $6\hat{\imath} + 5\hat{\jmath}$ m/s

Q.3 A block of mass m kg strikes an obstacle and moves at an angle of 90° to its original direction. If its speed does not change, find the impulse acting on the block.

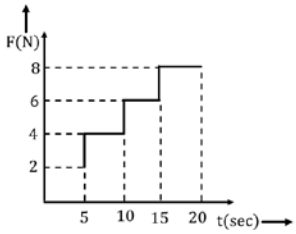


(A) mv **(B)** $\sqrt{2}$mv **(C)** 2 mv **(D)** 0

Q.4 Two identical blocks A and B, connected through a massless string are placed on a frictionless horizontal surface. A bullet having mass 2 times that of a single block, moving with velocity u strikes block B from behind as shown in the figure. If the bullet comes to rest after striking the block, find the impulse on block A due to tension in the string.

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

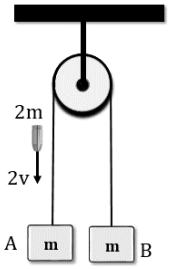
Q.5 A particle of mass 5 kg is initially at rest. A force starts acting on it along a fixed direction. The magnitude of the force changes with time as shown in the figure. Find the velocity of the particle at the end of 20 s.



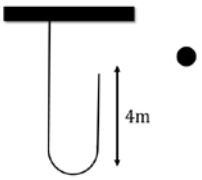
(A) 10 m/s **(B)** 50 m/s **(C)** 100 m/s **(D)** 20 m/s

Q.6 Two blocks A and B of mass m each are connected by a light inextensible string going over a smooth light pulley. Initially, the system is at rest. A bullet of mass 2m strikes the block A and sticks to it. If the bullet strikes the block with a speed 2v, find the speed with which the block A moves, immediately after the collision.

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

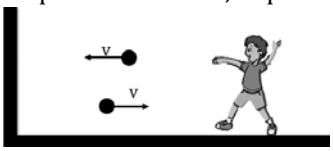


Q.7 A ball of mass 1 kg is attached to an inextensible string. The ball is released from the position shown in figure. Find the magnitude of impulse imparted by the string to the ball immediately after the string becomes taut. Take $g = 10\ m/s^2$.



(A) $4\sqrt{40}N - s$ **(B)** $4\sqrt{10}N - s$ **(C)** $4\sqrt{20}N - s$ **(D)** $4\sqrt{5}N - S$

Q.8 A man throws a ball of mass m on a vertical wall with speed v.If the ball bounces back with the same speed, find out the magnitude of impulse on the ball, imparted by normal reaction from the wall.



(A) mv **(B)** $\sqrt{2}$mv **(C)** 2 mv **(D)** 0

Q.9 A robber fires 100 bullets of mass 100 gm each from a machine gun, each at a speed of 500 m/s.If the first 40 bullets are fired in 10 s, what is the average force exerted on the machine gun by the robber during this period?

(A) 250 N **(B)** 50 N **(C)** 2000N **(D)** 200N

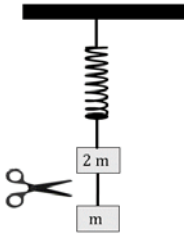
Q.10 A time varying force is represented as $F = 2t$ N. Find out the impulse imparted by this force during the first second.

(A) $\frac{1}{2}N \cdot s$ **(B)** $1N \cdot s$ **(C)** $2N \cdot s$ **(D)** $4N \cdot s$

WORK SHEET

Acceleration

Q.1 A block of mass m kg is suspended by a string attached with a 2m kg mass block. The 2m mass block is suspended by a spring as shown in the figure. The system is initially at equilibrium and rest. The spring and string are massless. Now the string is cut. The accelerations of mass 2m and m just after the string is cut will be.

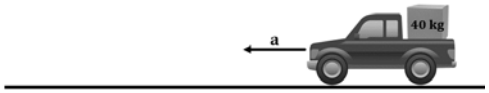


(A) $\frac{g}{2}$ Upwards, g downwards **(B)** g Downwards, $\frac{g}{2}$ upwards

(C) g Downwards, 2g downwards **(D)** 2g Upwards, g downwards

Distance

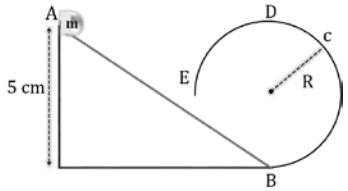
Q.2 As shown in the figure, a truck has its rear side open and a box of 40 kg mass is placed 5 m away from the open end. The coefficient of friction between the box and the surface below it is 0.15. On a straight road, the truck starts from rest and accelerates with $2m/s^2$. Find the distance (in metres) travelled by the truck by the time the box falls from the truck. (Ignore the size of the box) [Take $g = 10\ m/s^2$]



(A) 10 m **(B)** 5m **(C)** 20m **(D)** 15m

Vertical Circular Motion

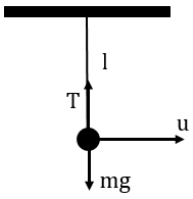
Q.3 A frictionless track ABCDE ends in a circular loop of radius R. A body slides down the track from point A which is at height $h = 5$ cm. Find the maximum value of R for which the body completes the loop successfully.



(A) 2 cm **(B)** 4cm **(C)** 2.5cm **(D)** 5

Tension in the string

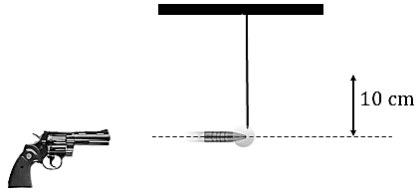
Q.4 A small body of mass $m = 10$ kg hangs at one end of a string of length l, the other end of which is fixed. It is given horizontal velocity u at its lowest position. The string just becomes slack, when it covers an angle 120° with the initial position. Find the tension in the string at the point of projection. Take $g = 10\ m/s^2$.



(A) 900 N **(B)** 50 N **(C)** 5 N **(D)** 450N

Speed

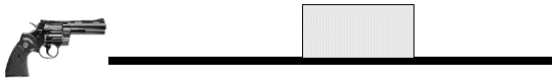
Q.5 A bullet of mass 20 g strikes a pendulum of mass 5 kg. The center of mass of the pendulum rises a vertical distance of 10 cm. If the bullet gets embedded into the pendulum, calculate the initial speed of the bullet.



(A)354.97 m/s **(B)**340.97 m/s **(C)**250.41 m/s **(D)**251 m/s

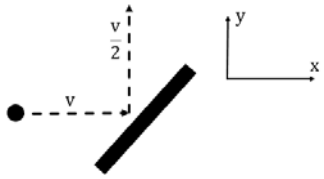
Impulse

Q.6 A bullet moving with speed 100 m/s strikes a block and get embedded into it. If mass of the block is nine times that of the bullet, find the impulse imparted by the bullet to the block (in N s), given mass of the bullet is m kg.



(A)100 m **(B)**90 m **(C)**10 m **(D)**110 m

Q.7 A ball moving with speed v in x direction changes its direction and speed. Its speed reduces to $\frac{v}{2}$ in $y-$ direction. Find out the magnitude of the impulse on the ball while the ball changes its direction. [Given mass of the ball is m]

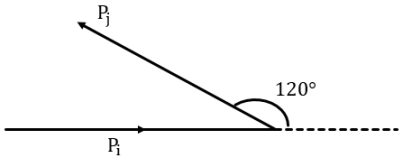


(A)$2\sqrt{5}mv$ **(B)**$\sqrt{5}mv$ **(C)**$\frac{\sqrt{5}}{2}mv$ **(D)**$\frac{\sqrt{5}}{4}mv$

Q.8 A block is moving under the influence of a constant force F = 3600 N.The force acts on the ball for the duration of 0.004 h. The average impulse imparted by the force is

(A)14400 N s **(B)**51840 N s **(C)**0.004 N s **(D)**2844 N s

Q.9 A body having momentum P is moving in positive x direction. If the direction of velocity is changed by angle 120° from the original direction, find the magnitude of the impulse on the body when it changes its direction.



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

Force

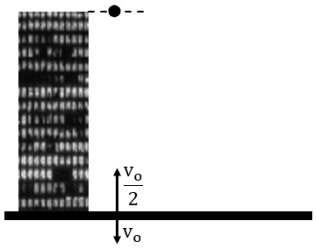
Q.10 A bowler bowled a ball of mass 2 kg at a speed of 162 km/h. the batsman played a defensive shot and the ball came to rest after striking the bat. If the contact between the ball and the bat is for 0.015 s, find the magnitude of the impulsive force applied by the bat on the ball.

(A)3000 N **(B)**4500 N **(C)**1500 N **(D)**6000 N

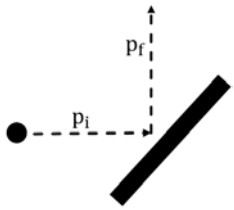
Impulse

Q.11 A ball of mass 2 kg is dropped from a height of 20 m.After striking the ground, the ball bounces back with half of its striking speed. Find the impulse imparted by the normal reaction from the ground. Take $g = 10\ m/s^2$.

(A) $40N - S$ **(B)** $80N - S$ **(C)** $0N - S$ **(D)** $60N - S$



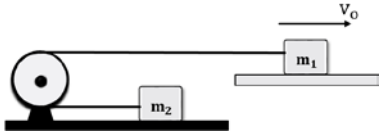
Q.12 A particles of mass 2 kg moving with a velocity of 3 m/s is acted upon by a force which changes its direction of motion by an angle of 90° without changing its speed. What is the magnitude of impulse experienced by the particle?



(A) $6N - s$ **(B)** $2N - s$ **(C)** $3\sqrt{2}N - s$ **(D)** $6\sqrt{2}N - s$

Velocity

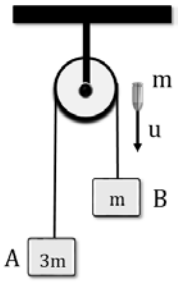
Q.13 Two blocks of masses m_1 and m_2 are connected by a light inextensible string which passes over a fixed pulley. Initially, mass m_1 moves with a velocity v_0 when the string is not taut. Neglect friction at all contact surfaces. Find the velocity of the blocks just after the string is taut, if $m_1 = 2\ kg, m_2 = 3\ kg$ and $v_0 = 5\ m/s$



(A) $2\ m/s$ **(B)** $3\ m/s$ **(C)** $5m/s$ **(D)** $0m/s$

Impulse

Q.14 A system of two blocks A and B are connected by an inextensible massless string as shown in figure. The pulley is massless and frictionless. Initially, the system is at rest. A bullet of mass m moving with a velocity u as shown in the figure hits block B and gets embedded into it. Then find out the impulse imparted by tension force to the block of mass 3m. Neglect the effect of gravity.

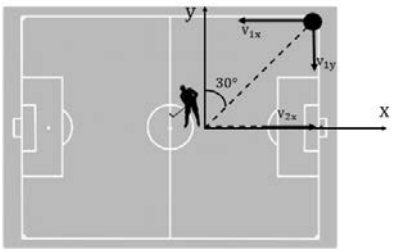


(A) $\frac{5}{4}mu$ **(B)** $\frac{4}{5}mu$ **(C)** $\frac{2}{5}mu$ **(D)** $\frac{3}{5}mu$

Force

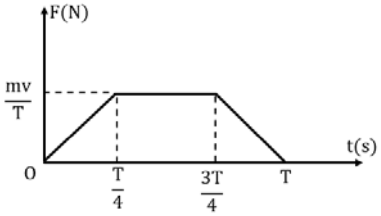
Q.15 A hockey player receives a corner shot at a speed of 15 m/s at an angle 30° with y − axis and then kicks the ball along x − axis with speed 30 m/s.If the mass of the ball is 150 gm and it remains in contact with the hockey stick for 0.01 s, then find the force exerted on the ball along x − axis.

(A) 281 N **(B)** 187 N **(C)** 562.5N **(D)** 375 N



Speed

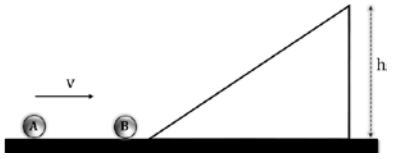
Q.16 A ball of mass m is initially at rest. A variable force starts acting on it in a fixed direction, whose magnitude changes with time. The force − time graph is shown in the figure. Find the speed of the ball at the end of the time t = T seconds.



(A) $\frac{3}{5}$v m/s **(B)** $\frac{3}{4}$v m/s **(C)** $\frac{4}{3}$v m/s **(D)** $\frac{2}{3}$v m/s

Velocity

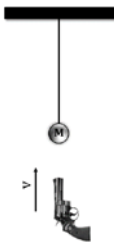
Q.17 Two identical balls A and B of equal masses, are lying on a smooth surface as shown in figure. Ball A hits ball B [which is initially at rest] and sticks to it. What should the minimum velocity of ball A, so that both balls reach the highest point of inclined place? Ignore the impact at the corner of the inclined surface.



(A) $v = \sqrt{2gh}$ m/s **(B)** $v = \sqrt{4gh}$ m/s **(C)** $v = \sqrt{8gh}$ m/s **(D)** $v = \sqrt{5gh}$ m/s

Speed

Q.18 A bullet of mass 50 gm is fired from below onto a bob of mass 450 gm of a long simple pendulum as shown in the figure. The bullet remains inside the bob and the bob rises through a height of 1.8 m vertically upwards. Find the speed of the bullet.



(A) 60 m/s **(B)** 80m/s **(C)** 40 m/s **(D)** 20 m/s

Velocity

Q.19 A bullet of mass 0.01 kg is fired from a gun weighing 2 kg. Calculate the velocity with which the gun recoils if 10 bullets are fired at the same time with a speed of 250 m/s. Consider +ve x axis along the direction of firing.

(A) -12.5 m/s **(B)** -1.25 m/s **(C)** 12.5 m/s **(D)** 1.25 m/s

Momentum

Q.20 A ball of mass m $= 1$ kg has an initial velocity 10 m/s.A variable force $F = 20t + 30t^2$ N is applied on the ball for 1 second. Find the final momentum of the ball.

(A) 30 N s **(B)** 20 N s **(C)** 10 N s **(D)** 15 N s

ANSWER KEY

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