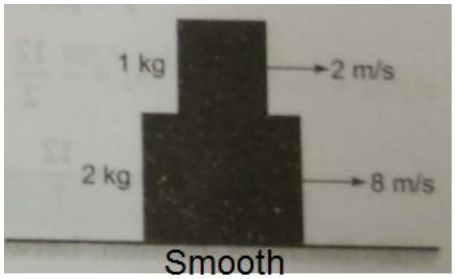
SECTION – II
MULTIPLE CORRECT CHOICE TYPE

This section contains 5 multiple choice questions. Each question has 4 choices A, B, C and D for its answer, out of which ONE OR MORE is/are correct. (+4, –1) 5 x 4 = 20M

5. Coefficient of friction between two blocks shown in figure is $\mu = 0.4$. The blocks are given velocities of 2m/s and 8m/s in the directions shown in the figure. Then :

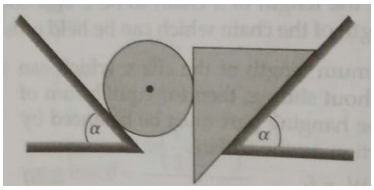


A. The time when relative motion between them will stop is 1sec
B. The common velocities of blocks upto that instant is 6m/sec
C. Displacements of 1 kg and 2 kg blocks upto that instant (g = 10 m/s^2) is 4m, 7m respectively
D. Displacements of 1 kg and 2 kg blocks upto that instant (g = 10 m/s^2) is 7m, 10m respectively

6. A river boat moves relative to water with a velocity which is $\eta = 2.0$ times less than the river flow velocity. At what angle to the stream direction must the boat move to minimize drifting and minimum drift value (b width of the river) respectively cannot be

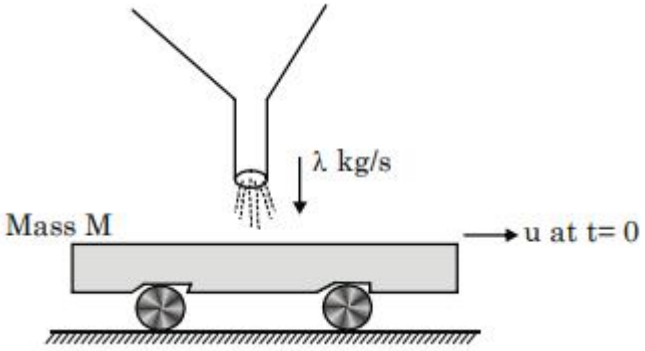
A. $120^0, \frac{b}{\sqrt{3}}$ B. $150^0, \frac{b}{\sqrt{3}}$ C. $120^0, \sqrt{3}b$ D. $45^0, \sqrt{3}b$

7. A cylinder and a prism with a vertical face, touching each other, move along two smooth inclined planes forming the same angle α with the horizontal see figure. The masses of the cylinder and the prism are m_1 and m_2 respectively. Then the force of normal pressure N exerted by the wedge on the cylinder, neglecting the friction between them.



A. $\frac{m_1 m_2}{m_1 + m_2}(g \tan\alpha)$ B. $\frac{2m_1 m_2}{m_1 + m_2}(g \tan\alpha)$ C. $\frac{2m_1 m_2}{m_1 + m_2}(g \cot\alpha)$ D. $\frac{m_1 m_2}{m_1 + m_2}(g \cot\alpha)$

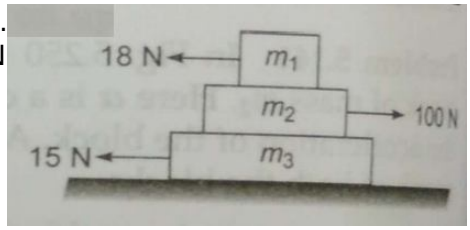
8. A long flat vehicle of mass M with initial speed u pass below a stationary hopper. Sand falls on to the vehicle at a constant rate λ kg/sec (straight at t = 0). Neglect friction on the floor



A. Speed as a function of time is $\frac{Mu}{M + \lambda t}$ B. Speed remains unchanged as u with time

C. Mechanical energy loss till time t is $\frac{1}{2}\frac{M\lambda t u^2}{M + \lambda t}$ D. Mechanical energy loss till time t is $\frac{M\lambda t u^2}{M + \lambda t}$

9. Consider three blocks placed one over the other as shown in figure. Let us now pull the blocks with the force of magnitudes 18 N, 100 N and 15 N. Take $m_1 = m_2 = m_3 = 10$ kg. If the coefficients of static and kinetic friction between all contacting surfaces are $\mu_s = 0.3$ and $\mu_k = 0.2$, respectively, find the :



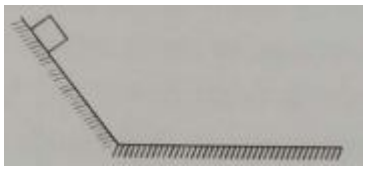
A. Acceleration of the block m_1 , $a_1 = 0.2$ m/s^2
B. Acceleration of the block m_2, $a_2 = 4$m/s^2
C. Frictional force between m_3 and ground is 25N
D. Kinetic friction force between m_2 & m_3 is 20N

SECTION – III

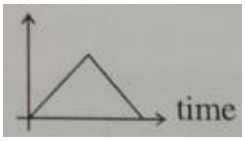
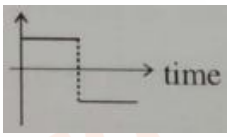
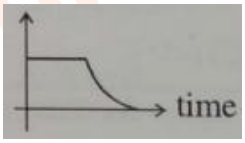
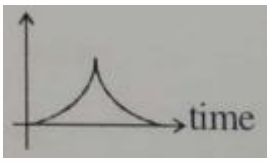
Matrix Match type.

This section contains 2 questions. Each question contains statements given in two columns which have to be matched statements (A, B, C, D) in column I have to be matched with statements (P, Q, R, S) in column II. (+8, 0) 2 x 8 = 16M

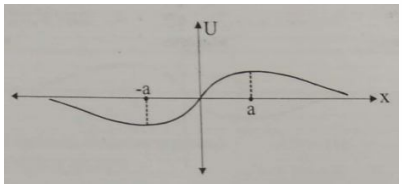
A block slides down a smooth inclined plane & then moves on to a rough horizontal surface. List–I gives quantities related to block. List–II gives corresponding graphs of physical quantities versus time :



10.

Column – I	Column – II
A. Velocity	P. 
B. Acceleration	Q. 
C. Mechanical energy	R. 
D. Kinetic energy	S. 

11. A particle of mass 'm' moves under a conservative force with potential energy $U(x) = \frac{cx}{x^2 + a^2}$ where c & a are positive constants. Assume that initially particle is on mean position (where equilibrium is stable). For the given function potential energy ν/s position graph is shown below.



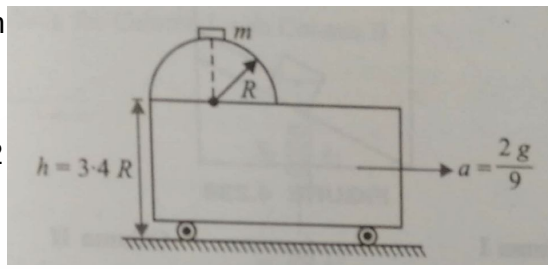
Column – I	Column – II
A. Position of unstable equilibrium is	P. Less than $\sqrt{\frac{c}{ma}}$
B. For the particle to be confined in the region the velocity of particle must be	Q. More than $\sqrt{\frac{c}{ma}}$
C. For particle to reach x = + ∞, velocity of particle must be	R. More than $\sqrt{\frac{2c}{ma}}$
D. For the particle to reach x = – ∞, velocity of particle must be	S. x = + a

SECTION – IV

COMPREHENSION TYPE

This section contains 1 group of questions. Each group has 3 multiple choice questions based on a paragraph. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which ONLY ONE is correct. (+4, –1) 3 x 4 = 12M

A vertical frictionless semicircular track of radius R is fixed on the edge of movable trolley . initially the system is at rest and a mass m is kept at the top of the track. The trolley starts moving to the right with a uniform horizontal acceleration a=2 g /9. The mass slides down the track, eventually losing contact with it and dropping to the floor h below the trolley



12. The angle θ with vertical , at which it losses contact with the trolley is

A. 37^0 B. 53^0 C. $\cos^{-1}\left(\frac{2}{3}\right)$ D. $\frac{\pi}{2}-\cos^{-1}\left(\frac{2}{3}\right)$

13. The speed of mass with respect to trolley when it losses contact with it is

A. $\sqrt{gR}$ B. $\sqrt{2gR}$ C. $\sqrt{2gR/3}$ D. $\sqrt{gR/3}$

14. The time taken by the mass to drop on the floor , after losing contact is

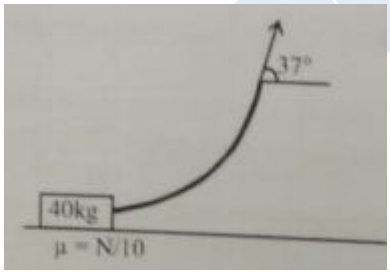
A. $\sqrt{2R/3g}$ B. $\sqrt{6R/g}$ C. $\sqrt{3R/2g}$ D. $2\sqrt{3R/g}$

SECTION – V

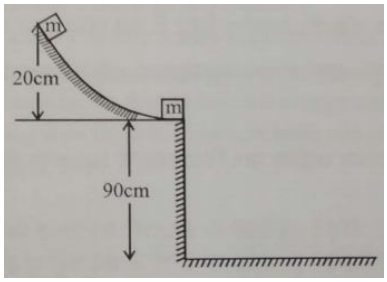
INTEGER ANSWER TYPE

This section contains 5 questions. The answer to each of the questions is a single-digit integer, ranging from 0 to 9. The appropriate bubbles below the respective question numbers in the ORS have to be darkened. (+4, –1) 5 x 4 = 20M

15. A mass 40 kg is kept on a rough as shown. A person tries to pull this mass by attaching a uniform string of mass 6 kg. The mass 40 kg is about to move when the person pulls the top end of string at an angle 37^0 with horizontal while tangent at lower end of string is horizontal. If coefficient of friction between mass and ground is $\frac{N}{10}$; , find N.

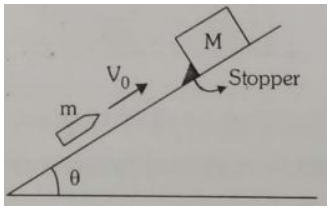


16. In a physics lab, a small cube slides down a frictionless incline as shown in figure, it strikes elastically and horizontally with another cube that is only one–half of its mass. If the incline is 20cm high and the table is 90 cm off the floor, big and small cubes strikes the ground at a distance x & y meter respectively from the table. Then y/x equal to

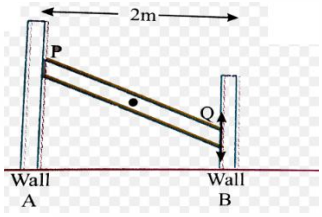


17. A tuning fork of known frequency is held at the open end of a long tube which is dipped into water. The tuning fork of frequency 165 Hz resonates for the first time when air columns have length $l_1 = 50 \pm 0.5$ cm and for second time when air columns have length $l_2 = 150 \pm 0.1$ cm. If the speed of sound in air is $[330 \pm \alpha\ (0.99)]$ m/s then the value of α is

18. A block of mass M is kept at rest on a long smooth inclined plane by a stopper. A bullet of mass m travelling at velocity v_0 parallel to inclined plane collides with block at = 0 and gets embedded. The time elapsed since t = 0 when block hits the stopper is 2/n sec. Find n.
(Given m = 5 kg, M = 10 kg, $v_0 = 5\ ms^{-1}$, g = 10 ms^{-2}, $\theta = 30^0$)



19. Two vertical walls are separated by a distance of 2m. Wall A is smooth while wall B is rough with a coefficient of friction 0.5. A uniform rod is placed between them as shown. The length (in m) of longest rod that can be placed between walls is $\frac{\sqrt{17}}{n}$ *then* $n =$ ————



THE–END