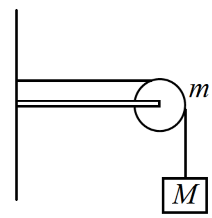
Worksheet

MCQ (Multiple Choice Questions)

Q1. A body of mass $10\,kg$ is being acted on by a force of $3t^2 N$ and an opposing constant force $32N$. The initial speed is $10\,m/s$. The velocity of the body after 5 second is:

(a) $14.5\,m/s$ (b) $6.5\,m/s$ (c) $4.5\,m/s$ (d) $3.5\,m/s$

Q2. A string of negligible mass going over a clamped pulley of mass m supports a block of mass M as shown in the figure. The force on the pulley by the clamp is given by



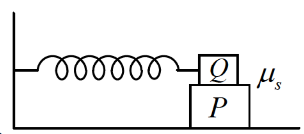
(a) $\sqrt{2}\,Mg$ (b) $\sqrt{2}\,mg$

(c) $\sqrt{(M+m)^2+m^2}\,g$ (d) $\sqrt{(M+m)^2+M^2}\,g$

Q3. What is the maximum value of the force F such that the block shown in the arrangement, does not move? Take $g=10\,m/s^2$.

(a) $20\,N$ (b) $10\,N$ (c) $12\,N$ (d) $15\,N$

Q4. A block P of mass m is placed on a horizontal frictionless plane. A second block of same mass m is placed on it and is connected to a spring of constant k. The two blocks are pulled by distance A. Block Q oscillates without slipping. What is the maximum value of frictional force between the two blocks?



(a) $\frac{kA}{2}$ (b) kA (c) $\mu_s mg$ (d) zero

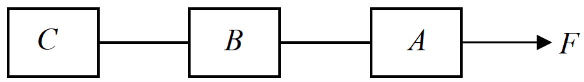
Q5. When forces F_1, F_2 and F_3 are acting on a particle of mass m such that F_2 and F_3 are mutually perpendicular, then the particle remains stationary. If the force F_1 is now removed, then the acceleration of the particle is

(a) $\frac{F_1}{m}$ (b) $\frac{F_2F_3}{mF}$ (c) $\frac{F_2-F_3}{m}$ (d) $\frac{F_2}{m}$

Q6. A smooth block is released at rest on a 45^0 incline and then slides a distance d. If the time taken to slide on rough incline is n times as large as that to slide on a smooth incline, the coefficient of friction is

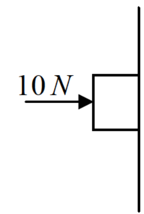
(a) $\frac{n-1}{n}$ (b) $\frac{n-2}{n^2}$ (c) $\frac{n-4}{n^3}$ (d) $\frac{n^2-1}{n^2}$

Q7. Three identical blocks of masses $m = 2\,kg$ each are drawn by a force $10.2\,N$ on a frictionless surface as shown in the figure. What is the tension in the string between the blocks B and C?



(a) 9.2 (b) 8 (c) 3.4 (d) 9.8

Q8. A horizontal force of $10\,N$ is necessary to just hold a block stationary against a wall. The coefficient of friction between the block and the wall is 0.2. The weight of the block is

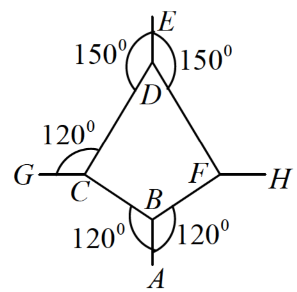


(a) $20\,N$ (b) $50\,N$ (c) $100\,N$ (d) $2\,N$

Q9. The upper half of an inclined plane with inclination θ is perfectly smooth, while the lower half is rough. A body starting from rest at the top will again come to rest at friction for the lower half is given by

(a) $2\tan\theta$ (b) $\tan\theta$ (c) $2\sin\theta$ (d) $2\cos\theta$

Q10. The adjacent figure is a part of a horizontally stretched net. Section AB is stretched with a force of $10\,N$. The tension in the sections BC and BF are



(a) $10\,N,\ 11\,N$

(b) $10\,N,\ 6\,N$

(c) $10\,N,\ 10\,N$

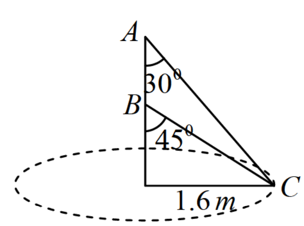
(d) can not be calculated due to insufficient data.

Q11. A particle is moving in a vertical circle. The tension in the string when passing through two positions at angles 30^0 and 60^0 from vertical (lowest positions) are T_1 and T_2 respectively. Then

(a) $T_1 = T_2$ (b) $T_2 > T_1$

(c) $T_1 > T_2$ (d) Tension in the string always remains the same.

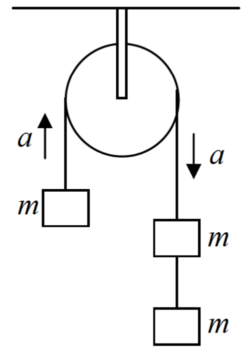
Q12. Two wires AC and BC are tied to a small sphere C of mass $5\,kg$, which revolved at a constant speed v in the horizontal circle of radius $1.6\,m$. Taking $g = 9.8\,m/s^2$, the minimum value of v is



(a) $3.01\,m/s$ (b) $4.01\,m/s$

(c) $3.2\,m/s$ (d) $3.96\,m/s$

Q13. Three equal weights of $3kg$ each are hanging on a string passing over a frictionless pulley as shown in the figure. The tension in the string between the masses II and masses III will be



(a) $5\,N$

(b) $6\,N$

(c) $10\,N$

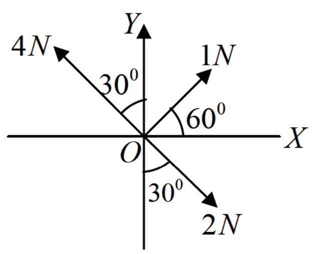
(d) $20\,N$

Q14. A block of mass m is pulled along a horizontal surface by applying a force at an angle θ with the horizontal. If the block travels with a uniform velocity and has a displaced d and the coefficient of friction is μ, then the work done by the applied force is

(a) $\dfrac{\mu mgd}{\cos\theta+\mu\sin\theta}$ (b) $\dfrac{\mu mgd\cos\theta}{\cos\theta+\mu\sin\theta}$

(c) $\dfrac{\mu mgd\sin\theta}{\cos\theta+\mu\sin\theta}$ (d) $\dfrac{\mu mgd\cos\theta}{\cos\theta-\mu\sin\theta}$

Q15. Three forces acting on a body are shown in the figure. To have the resultant force only along the y - direction, the magnitude of minimum additional force needed along OX is



(a) $0.5\,N$

(b) $1.5\,N$

(c) $\dfrac{\sqrt{3}}{4}N$

(d) $\sqrt{3}\,N$

Q16. An object motion is governed by $\vec{v}=(\cos\omega t)\hat{i}+\sin(\omega t)\hat{j}$. What is the speed of the object?

(a) ω (b) 2ω (c) 0 (d) 1

Q17. A particle motion in the $x-y$ plane is governed by its position vector $r=a\sin\omega t\hat{i}+b\cos\omega t\,\hat{j}$ where a,b and ω are positive constants and $a>b$. What is the trajectory of the particle?

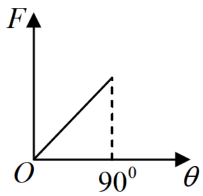
(a) A parabola (b) A hyperbola (c) An ellipse (d) A circle

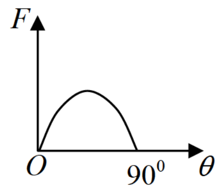
Q18. Consider a particle of mass m, moving on the plane Its position vector is given $\vec{r}=a\cos\omega t\,\hat{i}+b\sin\omega t\,\hat{j}$ where a,b,ω are position constants and $a>b$. What is the direction of force?

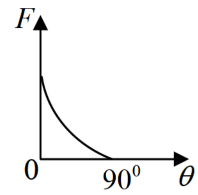
(a) Always towards the origin (b) Always away from the origin

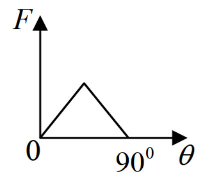
(c) Tangential to its trajectory (d) Unknown

Q19. A block tests on a rough plane, whose inclination θ to the horizontal can be varied. Which of the following graph indicates how the frictional force F between the block and plane varies as θ increased?

(a) 

(b) 

(c) 

(d) 

Q20. If a body of mass $45\ kg$ resting on a rough horizontal surface can be just moved by a force of $10\ kg$ weight acting horizontally, then the coefficient of sliding friction is

(a) 4.5 (b) 0.5 (c) 0.45 (d) 0.22

Q21. A block B is resting on a. horizontal plate in the xy plane and the coefficient of friction between the block and the plate is μ. The plate begins to move in the x-direction and its velocity is $u = bt^2$ being time and b being a constant. At what time will the block start sliding on the plate?

(a) $\frac{\mu b}{g}$ (b) $\frac{\mu g b}{2}$ (c) $\frac{\mu g}{b}$ (d) $\frac{\mu g}{2b}$

Q22. A particle is moving in a plane with a constant radial velocity of $12\, m/s$ and constant angular velocity of $2\, rad/s$. When the particle is at a distance $r = 8\, m$ from the origin, the magnitude of the instantaneous acceleration of the particle in m/s^2 is

(a) $\vec{a} = 16\left(2\hat{r} + 3\hat{\theta}\right)$ (b) $\vec{a} = 16\left(-2\hat{r} + 3\hat{\theta}\right)$

(c) $\vec{a} = 8\left(2\hat{r} + 3\hat{\theta}\right)$ (d) $\vec{a} = 8\left(-2\hat{r} + 3\hat{\theta}\right)$

Q23. If the motion of a particle is described by $x = 5t\cos(8\pi t), y = 5t\sin(8\pi t)$ and $z = 0$, then the trajectory of the particle is

(a) Circular (b) Elliptical (c) Helical (d) Spiral

MSQ (Multiple Select Questions)

Q24. The force exerted by the floor of an elevator on the foot of a person standing there is more than the weight of the person if the lift is

(a) going up and slowing down (b) going up and speeding down

(c) going down and slowing down (d) going down and speeding up

Q25. If the tension in the cable is supporting an elevator is equal to the weight of the elevator, the elevator may be

(a) going up with increasing speed. (b) going down with increasing speed

(c) going up with uniform speed (d) going down with uniform speed

Q26. A block of mass $20\,kg$ is placed gently on an incline plane having an angle of inclination 37^0. The coefficient of friction between the block and the incline is 0.1. Take $g = 10\,m/s^2$, $\sin 37^0 = \frac{3}{5}$ and $\cos 37^0 = \frac{4}{5}$. Then

(a) The frictional force acting on the block is $16\,N$

(b) The normal force acting on the block is $120\,N$

(c) A force of static friction acts on the block

(d) The acceleration of the block is $5.2\,m/s^2$

Q27. A block of mass $2.5\,kg$ is kept on a rough horizontal surface. It is found that the block does not slide if a horizontal force less than $15\,N$ is applied to it. Also it is found that it takes $5\,s$ to slide through the first $10\,m$, if a horizontal force of $15\,N$ is applied and the block is gently pushed to start the motion. If $g = 10\,m/s^2$, then

(a) the coefficient of static friction is 0.50

(b) the coefficient of static friction is 0.60

(c) the coefficient of kinetic friction is 0.52

(d) the coefficient of kinetic friction is 0.40

Q28. A person applies a constant force $\vec{F}$ on a particle of mass m and finds that the particle moves in a circle of radius r with a uniform speed v as seen from an inertial frame of reference

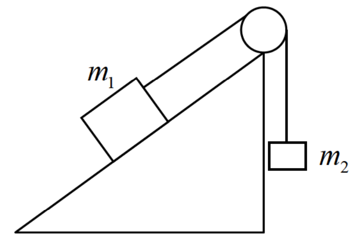
(a) This is not possible

(b) There are other forces on the particle

(c) The resultant of other forces is $\frac{mv^2}{r}$ towards the centre.

(d) The resultant of other forces varies in magnitude as well as in direction.

Q29. Two bodies of masses m_1 and m_2 are connected by a light string going over a smooth light pulley at the end of a frictionless incline as shown in the figure. The whole system is at rest.



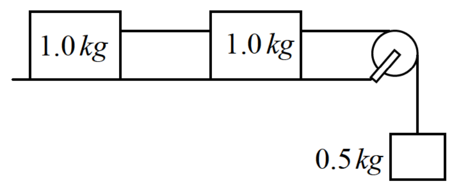
(a) The angle of inline is $\sin^{-1}\left(\frac{m_1}{m_2}\right)$

(b) The angle of inline is $\sin^{-1}\left(\frac{m_2}{m_1}\right)$

(c) The tension in the string is $\sin^{-1}\left(\frac{m_1}{m_2}\right)$

(d) The normal force acting on mass m_1 is $m_1 g\sqrt{1-\left(\frac{m_2}{m_1}\right)^2}$

Q30. A system of three blocks are connected together by means of two inextensible strings. Two blocks lie on a horizontal surface and one of them passes over a smooth pulley as shown in the figure. The coefficient of friction between the blocks and the surface is 0.2. Take $g = 10\,m/s^2$.



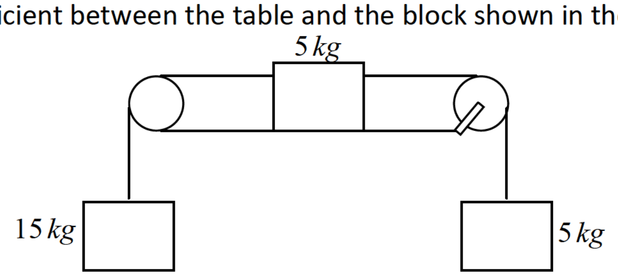
(a) The magnitude of acceleration of the system is $0.4\,m/s^2$

(b) The magnitude of acceleration of the system is $0.8\,m/s^2$

(c) The tension is the string connecting the two $1\ kg$ blocks is $2.4\,N$

(d) The tension in the string attached to $0.5\,kg$ block is $4.8N$

Q31. The friction coefficient between the table and the block shown in the figure is 0.2.



Hence the system can not be in equilibrium. Suppose it moves such that the $15\,kg$ block moves downwards with an acceleration a. In this case, from the free body diagrams.

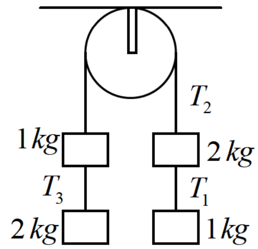
(a) The system remains in equilibrium

(b) The system moves with an acceleration of $\frac{18}{5}m/s^2$

(c) The tension in the left string is $98N$ in the left string.

(d) The tension in the right string is $68\,N$

Q32. In the figure shown all the strings are massless, and friction is absent everywhere. Choose the correct option(s).



(a) $T_1 > T_3$

(b) $T_3 > T_1$

(c) $T_2 > T_1$

(d) $T_2 > T_3$

Q33. A block of mass $10\,kg$ slides down an inclined surface of inclination 30^0. Starting from rest it moves $8\,m$ in the first two seconds. Take $g = 10\,m/s^2$.

(a) The acceleration of the block is $4\,m/s^2$

(b) The coefficient of kinetic friction is 0.1

(c) The kinetic frictional force acting on the block is $50N$

(d) The kinetic frictional force acting on the block is $10N$

Q34. A particle is moving in space with O as the origin. Some possible expression for its position, velocity, acceleration and angular momentum in cylindrical coordinates (ρ, ϕ, z) are given below. Which one of these options is/are correct?

(a) Position vector $\vec{r} = \rho\hat{\rho} + z\hat{z}$

(b) Velocity vector $\vec{v} = \frac{d\rho}{dt}\hat{\rho} + \rho\frac{d\varphi}{dt}\hat{\varphi} + \frac{dz}{dt}\hat{z}$

(c) Acceleration $\vec{a} = \left(\ddot{r} - r\dot{\varphi}^2\right)\hat{r} + r\ddot{\varphi} + \left(\ddot{\varphi} + 2\dot{r}\dot{\varphi}\right)\hat{\varphi} + \ddot{z}\hat{z}$

(d) Angular momentum is conserved if $\left(r\ddot{\varphi} + 2\dot{r}\dot{\varphi}\right) = 0$

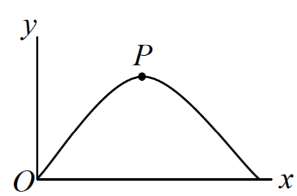
Q35. A projectile is fired from the origin O at an angle of 45^0 from the horizontal. Then which one of the following is/are correct?

(a) If $\vec{r}$ is radius vector from origin O to P then it will make an angle $\tan^{-1}\frac{1}{\sqrt{2}}$ with horizontal

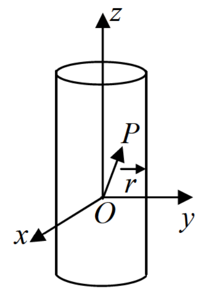
(b) If $\vec{r}$ is radius vector from origin O to P then it will make angle $\tan^{-1}\frac{1}{2}$ with horizontal

(c) The radial component of acceleration at P is $a_r = \frac{-g}{\sqrt{5}}$

(d) The radial component of acceleration at P is $a_r = \frac{-2g}{\sqrt{5}}$



Q36. A particle P of mass m is constrained to move on the surface of cylinder under a force $-k\vec{r}$ as shown in figure (k is the positive constant). Which of the following statements is/are correct? (Neglect friction.)



(a) The force is conservative

(b) The motion along z has frequency $\sqrt{\frac{k}{m}}$.

(c) Angular momentum of the particle about O is conserved .

(d) The total energy is given by $\frac{m}{2}\left(\dot{r}^2+r^2\dot{\theta}^2+z^2\right)+\frac{1}{2}kr^2+\frac{1}{2}kz^2$

Q37. A particle of mass m is moving in a circular orbit given by $x=R\cos\omega t$; $y=R\sin(\omega t)$, as observed in an inertial frame S_1 .Another inertial frame S_2 moves with uniform velocity $\vec{v}=\omega R\hat{i}$ with respect to S_1.S_1 and S_2 are related by Galilean transformation, such that the origins coincide at $t=0$.

Which one of following is correct?

(a) The position vector from S_2 frame is $\left(R-\frac{2\pi v}{\omega}\right)\hat{i}$

(b) The velocity vector from S_2 is $v\hat{i}+R\omega\hat{j}$

(c) The acceleration from both the frame is same at $t=\frac{2\pi}{\omega}$

(d) Angular momentum at $t=\frac{2\pi}{\omega}$ is $m\omega R^2(1-2\pi)\hat{k}$

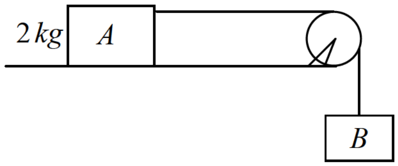
NAT (Numerical Answer Type)

Q38. The force required to accelerate a car of mass $2000\ kg$ from rest to $30\ m/s$ in $12s$, if the frictional force between the tyres and the ground is $0.2\ N/kg$ ___________ N

Q39. A wooden block having a mass of $2\ kg$ is placed on a table. The block just starts to move, when a force of $10\ N$ is applies at 45^0 to the vertical to pull the block. The coefficient of friction between the table and the block, (taking $g=10\ m/s^2$) approximate _________.

Q40. The coefficient of static friction between a box and the flat bed of a track is 0.75. The maximum acceleration, the track can have along the level ground if the box is not to slide is__________ m/s^2

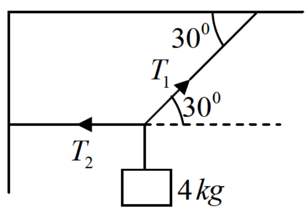
Q41. The coefficient of static friction between block A of mass $2\,kg$ and the table is 0.2. Take $g = 10\,m/s^2$. The maximum mass value of block B, so that the two blocks do not move is______________.



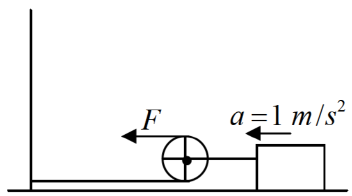
Q42. A block of mass $8\,kg$ is placed on a smooth wedge of inclination 30^0. The whole system is accelerated horizontally so that the block does not slip on the wedge. If we take $g = 10\,m/s^2$, the force exerted by the wedge on the block will be __________ N.

Q43. A person of mass $60\,kg$ is inside a lift of mass $940\,kg$ and presses the button on control panel. The lift starts moving upwards with an acceleration $1.0\,m/s^2$. If $g = 10\,m/s^2$, the tension in the supporting cable is ___________ N.

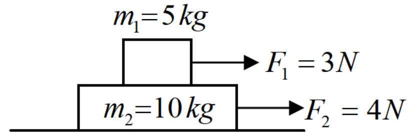
Q44. A block of mass $4\,kg$ hangs as shown in the figure. If we take $g = 9.8\,m/s^2$, value of T_2 is__________.



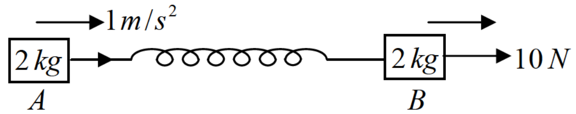
Q45. A block of mass $200\,kg$ is set into motion on a frictionless horizontal surface with the help of a frictionless pulley and rope system as shown in figure. The horizontal force F that should be applied to produce in the block an acceleration of $1\,m/s^2$ is________ N.



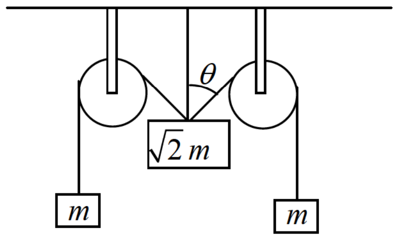
Q46. Two blocks of masses $5\,kg$ and $10\,kg$ are acted on by forces of $3\,N$ and $4\,N$ respectively as shown in the figure. Assuming there is no sliding between the blocks and the ground is smooth, the static friction between the blocks is ________



Q47. Two bodies A and B each of mass $2\,kg$ are connected by a massless spring. A force of $10\,N$ acts on mass B as shown in the figure. At the instant shown body A has acceleration of $1\,m/s^2$, the acceleration of B is _______ m/s^2.



Q48. The pulleys and strings shown in the figure are smooth and of negligible mass. For the system to remain in equilibrium the value of θ is ___________ degree.



Q49. A horizontal force of $20\,N$ is applied to a block of mass $40\,kg$ resting on a rough horizontal table. If the block does not move on the table, the frictional force from the table on the block is __________ N. (Take $g = 10\,m/s^2$)

Q50. A block slides down an incline at angle 30^0 with an acceleration $\frac{g}{4}$. The kinetic friction coefficient is _________.

Q51. A particle of mass m is moving in $x-y$ plane. At any given time t, its position vector is given by $\vec{r}(t) = 3\cos\omega t\,\hat{i} + 4\sin\omega t\,\hat{j}$ where ω is a constant. If the angular momentum of the particle is $\alpha m\omega\hat{k}$ then value of α is__________

Q52. In planar polar co-ordinates, an object's position at time t is given as $(r,\theta) = \left(\cos t\, m, \sqrt{8}\,t \text{ rad}\right)$. The magnitude of its acceleration in m/s^2 at $t = 0$ (up to two decimal points) is___________

Q53. An observer is located on a horizontal, circular turntable which rotates about a vertical axis passing through its center, with a uniform angular speed of $2\,\text{rad/sec}$. A mass of 10 grams is sliding without friction on the turntable. At an instant when the mass is at a distance of $8\,cm$ from the axis it is observed to move towards the center with a speed of $6\,cm/\text{sec}$. The net force on the mass, as seen by the observer at that instant, is $\alpha \times 10^{-4}\,N$ then α is___________