Topic : Unit and Dimension,
Kinematics

1. A particle is dropped from the top of a building. When it crosses a point $5 \mathrm{~m}$ below the top, another particles starts to fall from a point $25 \mathrm{~m}$ below the top, both particles reach the bottom of the building simultaneously. The height of the building is :

$\left(g=10 \mathrm{~m} / \mathrm{s}^{2}\right)$

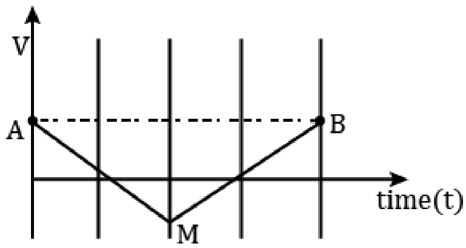
A. $45 \mathrm{~m}$

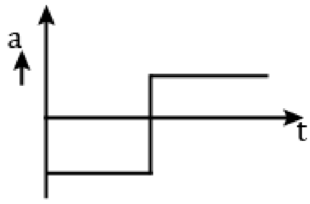
B. $35 \mathrm{~m}$

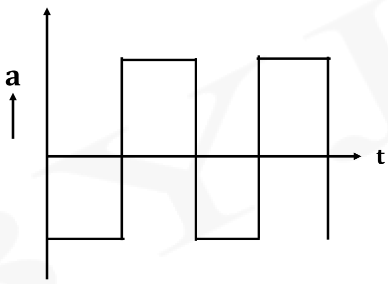
C. $25 \mathrm{~m}$

D. $50 \mathrm{~m}$

2. If the velocity-time graph has the shape AMB, what would be the shape of the corresponding acceleration-time graph?



A. 

B. 

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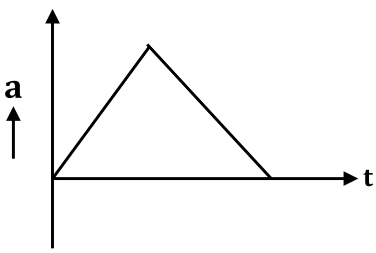
D. 

3. The velocity of a particle is $v = v_0 + gt + Ft^2$. Its position is $x = 0$ at $t = 0$; then its displacement after time $(t = 1 \text{ s})$ is:
(g and F are constants)

A. $v_0 + \frac{g}{2} + F$

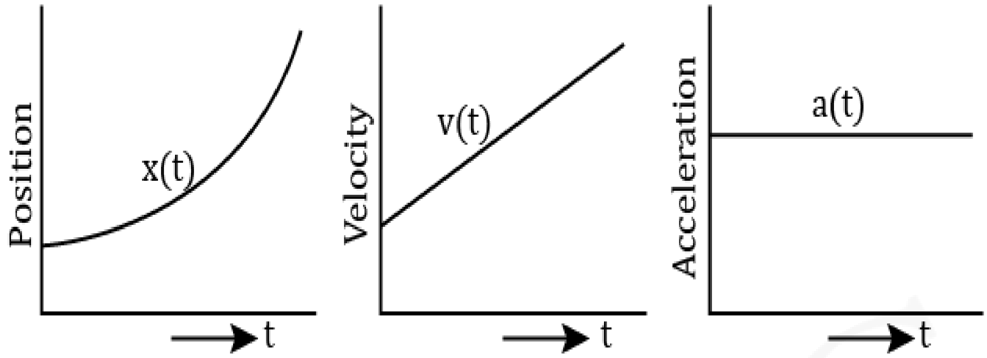
B. $v_0 + 2g + 3F$

C. $v_o + g + F$

D. $v_0 + \frac{g}{2} + \frac{F}{3}$

4. The position, velocity and acceleration of a particle moving with a constant acceleration can be represented by:

A.



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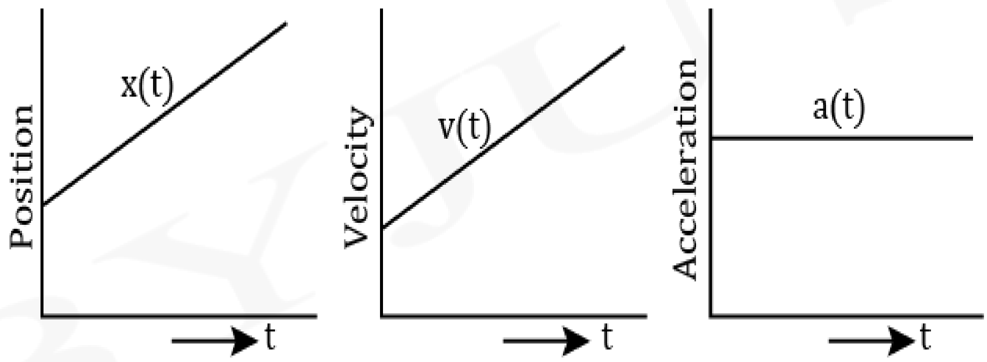
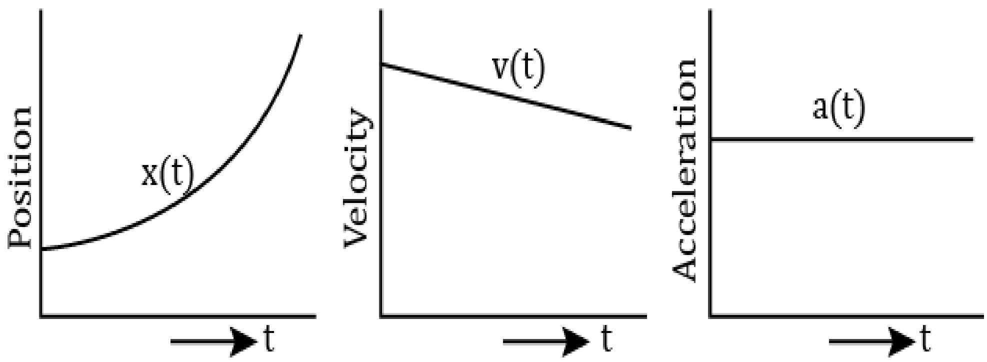
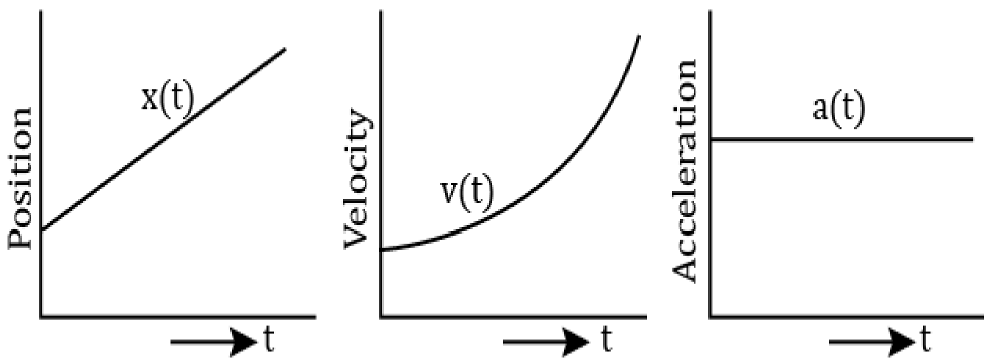


C.



D.



5. Water droplets are coming from an open tap at a particular rate. The spacing between a droplet observed at 4^{th} second after its fall, to the next droplet, is $34.3 \mathrm{~m}$. At what rate the droplets are coming from the tap ? (Take $g=9.8 \mathrm{~m/s}^{2}$)

A. 3 drops/s

B. 2 drops/s

C. 1 drop/s

D. $\frac{1}{7} \text{drops/s}$

6. The trajectory of a projectile in a vertical plane is, $y=\alpha x-\beta x^{2}$, where α, β are constants, x and y are respectively the horizontal and vertical distances of the projectile from the point of projection. The angle of projection and the maximum height attained are respectively given by :

A. $\tan^{-1} \alpha, \ \dfrac{\alpha^{2}}{4 \beta}$

B. $\tan^{-1} \beta, \ \dfrac{\alpha^{2}}{2 \beta}$

C. $\tan^{-1} \alpha, \ \dfrac{\alpha^{2}}{2 \beta}$

D. $\tan^{-1} \beta, \ \dfrac{\alpha^{2}}{4 \beta}$

7. A player kicks a football with an initial speed of $25 \mathrm{~ms}^{-1}$ at an angle of 45° from the ground. What are the maximum height and the time taken by the football to reach at the highest point during motion ? $(\text{Take } g=10 \mathrm{~ms}^{-2})$

A. $h_{max}=10 \mathrm{~m}, \ T=2.5 \mathrm{~s}$

B. $h_{max}=15.625 \mathrm{~m}, \ T=1.77 \mathrm{~s}$

C. $h_{max}=15.625 \mathrm{~m}, \ T=3.54 \mathrm{~s}$

D. $h_{max}=3.54 \mathrm{~m}, \ T=0.125 \mathrm{~s}$

8. A particle starts from the origin at $t=0$ with an initial velocity of $3.0\hat{i}\ \mathrm{m/s}$ and moves in the $x-y$ plane with a constant acceleration $(6.0\hat{i}+4.0\hat{j})\ \mathrm{m/s^2}$. The $x-$coordinate of the particle at the instant when its $y-$coordinate is $32\ \mathrm{m}$ is D meters. The value of D is:

A. 32

B. 50

C. 60

D. 40

9. A particle of mass m is projected with a speed of u from the ground at an angle $\theta=\frac{\pi}{3}$ w.r.t. horizontal (x-axis). When it has reached its maximum height, it collides completely inelastically with another particle of the same mass and velocity $u\hat{i}$. The horizontal distance covered by the combined mass before reaching the ground is:

A. $\frac{3\sqrt{3}}{8}\frac{u^2}{g}$

B. $\frac{3\sqrt{2}}{4}\frac{u^2}{g}$

C. $\frac{5}{8}\frac{u^2}{g}$

D. $2\sqrt{2}\frac{u^2}{g}$

10. Starting from the origin at time $t=0$, with initial velocity $5\hat{j}\ \mathrm{ms^{-1}}$, the particle moves in the $x-y$ plane with a constant acceleration of $(10\hat{i}+4\hat{j})\ \mathrm{m/s^2}$. At time t, its coordinates are $(20\ \mathrm{m},\ y_0\ \mathrm{m})$. The values of t and y_0 are, respectively:

A. $2\ \mathrm{s}$ and $18\ \mathrm{m}$

B. $4\ \mathrm{s}$ and $52\ \mathrm{m}$

C. $2\ \mathrm{s}$ and $24\ \mathrm{m}$

D. $5\ \mathrm{s}$ and $25\ \mathrm{m}$

11. A butterfly is flying with a velocity $4\sqrt{2}\ \mathrm{m/s}$ in North-East direction. Wind is slowly blowing at $1\ \mathrm{m/s}$ from North to South. The resultant displacement of the butterfly in 3 seconds is :

A. $3\ \mathrm{m}$

B. $20\ \mathrm{m}$

C. $12\sqrt{2}\ \mathrm{m}$

D. $15\ \mathrm{m}$

12. A boy reaches the airport and finds that the escalator is not working. He walks up the stationary escalator in time t_1. If he remains stationary on a moving escalator, then the escalator takes him up in time t_2. The time taken by him to walk up on the moving escalator will be:

A. $\dfrac{t_1 t_2}{t_2 - t_1}$

B. $\dfrac{t_1 + t_2}{2}$

C. $\dfrac{t_1 t_2}{t_2 + t_1}$

D. $t_2 - t_1$

13. Ship A is sailing towards north-east with velocity vector $\vec{v} = 30\hat{i} + 50\hat{j}\ \mathrm{km/hr}$ where $\hat{i}$ points east and $\hat{j}$ north. Ship B is at a distance of $80\ \mathrm{km}$ east and $150\ \mathrm{km}$ north of Ship A and is sailing towards west at $10\ \mathrm{km/hr}$. A will be at minimum distance from B in,

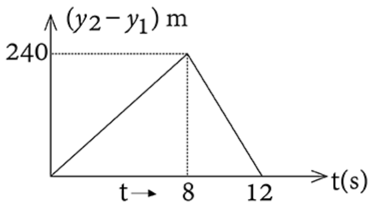
A. $2.2\ \mathrm{hrs}$

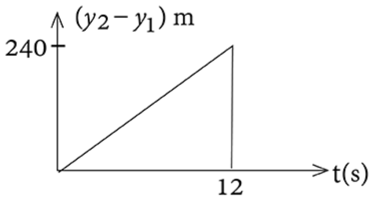
B. $4.2\ \mathrm{hrs}$

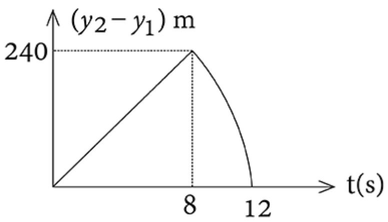
C. $2.6\ \mathrm{hrs}$

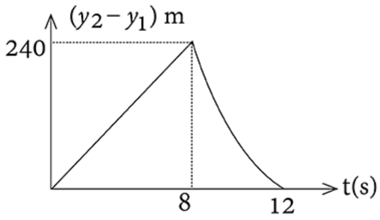
D. $3.2\ \mathrm{hrs}$

14. Two stones are thrown up simultaneously from the edge of a cliff $240\ \mathrm{m}$ high with initial speed $10\ \mathrm{m/s}$ and $40\ \mathrm{m/s}$ respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first? (Assume stones do not rebound after hitting the ground and neglect air resistance, take $g = 10\ \mathrm{m/s^2}$)
(The figures are schematic and not drawn to scale.)

A. 

B. 

C. 

D. 

15. When a car is at rest, its driver sees raindrops falling on it vertically. When driving the car with speed v, he sees that raindrops are coming at an angle 60° from the horizontal. On further increasing the speed of the car to $(1+\beta)v$, this angle changes to 45°. The value of β is close to :

A. 0.50

B. 0.41

C. 0.37

D. 0.73

16. If e is the electric charge of an electron, c is the speed of light in free space, and h is planck's constant, ϵ_0 is permittivity of free space. The dimension of $\frac{e^2}{4\pi\epsilon_0 hc}$ is

A. $[LC^{-1}]$

B. $[M^0L^0T^0]$

C. $[MLT^0]$

D. $[MLT^{-1}]$

17. The work done by a gas molecule in an isolated system is given by,

$$W = \alpha\beta^2 e^{-x^2/\alpha kT}$$

Where x is the displacement, k is the Boltzmann constant, T is the temperature, α and β are constants, then the dimension of β will be :

A. $[M^0LT^0]$

B. $[M^2LT^2]$

C. $[MLT^{-2}]$

D. $[ML^2T^{-2}]$

18. Match List - I with List - II.

List - I	List - II
$a.\ h$ (Planck's Constant)	$i.\ [MLT^{-1}]$
$b.\ E$ (Kinetic Energy)	$ii.\ [ML^2T^{-1}]$
$c.\ V$ (Electric Potential)	$iii.\ [ML^2T^{-2}]$
$d.\ P$ (Linear Momentum)	$iv.\ [ML^2I^{-1}T^{-3}]$

Choose the correct answer from the options given below.

A. $(a) \rightarrow (ii), (b) \rightarrow (iii), (c) \rightarrow (iv), (d) \rightarrow (i)$

B. $(a) \rightarrow (i), (b) \rightarrow (ii), (c) \rightarrow (iv), (d) \rightarrow (iii)$

C. $(a) \rightarrow (iii), (b) \rightarrow (ii), (c) \rightarrow (iv), (d) \rightarrow (i)$

D. $(a) \rightarrow (iii), (b) \rightarrow (iv), (c) \rightarrow (ii), (d) \rightarrow (i)$

19. The pitch of the screw gauge is 1 mm and there are 100 divisions on the circular scale. When nothing is put in between the jaws, the zero of the circular scale lies 8 divisions below the reference line. When a wire is placed between the jaws, the first linear scale division is clearly visible while 72^{nd} division on circular scale coincides with the reference line. The radius of the wire is :

A. 1.64 mm

B. 1.80 mm

C. 0.82 mm

D. 0.90 mm

20. In a typical combustion engine, the work done by a gas molecule is given by,

$$W = \alpha^2 \beta e^{-\beta x^2/kT}$$

Where x is the displacement, k is the Boltzmann constant, T is the temperature, α and β are constants, then the dimension of α will be :

A. $[M^0 L T^0]$

B. $[M^2 L T^0]$

C. $[M L T^{-2}]$

D. $[M L^2 T^{-2}]$

21. If C and V represent capacitance and voltage respectively then what is the dimension of λ where $\lambda = \frac{C}{V}$?

A. $[M^{-2} L^{-4} I^3 T^7]$

B. $[M^{-2} L^{-3} I^2 T^6]$

C. $[M^{-1} L^{-3} I^{-2} T^{-7}]$

D. $[M^{-3} L^{-4} I^3 T^7]$

22. In order to determine the Young`s Modulus of a wire of radius 0.2 cm (measured using a scale of least count $= 0.001 \text{ cm}$) and length 1 m (measured using a scale of least count $= 1 \text{ mm}$), a weight of mass 1 kg (measured using a scale of least count $= 1 \text{ g}$) was hanged to get the elongation of 0.5 cm (measured using a scale of least count 0.001 cm). What will be the fractional error in the value of Young`s Modulus determined by this experiment.

A. 9%

B. 1.4%

C. 0.9%

D. 0.14%

23. The vernier scale used for measurement has a positive zero error of $0.2 \mathrm{~mm}$. If while taking a measurement it was noted that 0 on the vernier scale lies between $8.5 \mathrm{~cm}$ and $8.6 \mathrm{~cm}$, vernier coincidence is 6, then the correct value of measurement is ________cm.

(Least count $= 0.01 \mathrm{~cm}$)

A. $8.36 \mathrm{~cm}$

B. $8.56 \mathrm{~cm}$

C. $8.58 \mathrm{~cm}$

D. $8.54 \mathrm{~cm}$

24. In the experiment of Ohm's law, a potential difference of $5.0 \mathrm{~V}$ is applied across the end of a conductor of length $10.0 \mathrm{~cm}$ and diameter of $5.00 \mathrm{~mm}$. The measured current in the conductor is $2.00 \mathrm{~A}$. The maximum permissible percentage error in the resistivity of the conductor is:

A. 7.5

B. 3.9

C. 8.4

D. 3.0

25. The time period of a simple pendulum is given by $T=2\pi\sqrt{\frac{l}{g}}$. The measured value of the length of pendulum is $10 \mathrm{~cm}$ known to $1 \mathrm{~mm}$ accuracy. The time for 200 oscillations of the pendulum is found to be 100 second using a clock of $1 \mathrm{~s}$ resolution. The percentage accuarcy in the determination of g using this pendulum is x. The value of x to the nearest integer is.

A. 5%

B. 4%

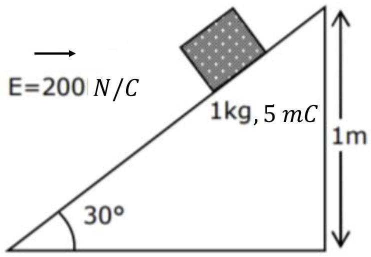
C. 3%

D. 2%

Topic : NLM and Friction

1. A man standing on a spring balance inside a stationary lift measures $60\ \text{kg}$. The weight of that person if the lift descends with a uniform downward acceleration of $1.8\ \text{m/s}^2$ will be _____N.
$[g = 10\ \text{m/s}^2]$

2. An inclined plane making an angle of 30° with the horizontal is placed in a uniform horizontal electric field $200\ \text{N/C}$ as shown in the figure. A body of mass $1\ \text{kg}$ and charge $5\ \text{mC}$ is allowed to slide down from rest from a height of $1\ \text{m}$. If the coefficient of friction is 0.2, find the time taken by the body to reach the bottom.



$$\left[g = 9.8\ \text{m/s}^2;\ \sin 30^\circ = \frac{1}{2};\ \cos 30^\circ = \frac{\sqrt{3}}{2}\right]$$

A. $2.3\ \text{s}$

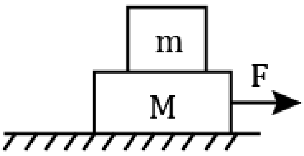
B. $0.46\ \text{s}$

C. $1.3\ \text{s}$

D. $0.92\ \text{s}$

3. Two blocks ($m = 0.5\ \mathrm{kg}$ and $M = 4.5\ \mathrm{kg}$) are arranged on a horizontal frictionless table as shown in the figure. The coefficient of static friction between the two blocks is $3/7$. Then the maximum horizontal force that can be applied on the larger block so that blocks move together is ______N.

(Round off to the nearest integer)
(Take g as $9.8\ \mathrm{ms}^{-2}$)



4. A particle of mass M orginally at rest is subjected to a force whose direction is constant but magnitude varies with time according to the relation

$$F = F_0\left[1 - \left(\frac{t-T}{T}\right)^2\right]$$

where F_0 and T are constants. The force acts only for the time interval $2T$. The velocity v of the particle after time $2T$ is :

A. $\frac{2F_0T}{M}$

B. $\frac{F_0T}{2M}$

C. $\frac{4F_0T}{3M}$

D. $\frac{F_0T}{3M}$

5. A particle is projected with velocity v_o along $x-$axis. A damping force is acting on the particle which is proportional to the square of the distance from the origin, $i.e.\ ma=-\alpha x^2$. The distance at which the particle stops :

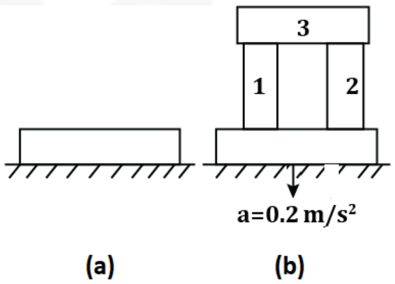
A. $\left(\frac{2mv_o^2}{3\alpha}\right)^{\frac{1}{3}}$

B. $\left(\frac{3mv_o^2}{2\alpha}\right)^{\frac{1}{2}}$

C. $\left(\frac{3mv_o^2}{2\alpha}\right)^{\frac{1}{3}}$

D. $\left(\frac{2mv_o^2}{3\alpha}\right)^{\frac{1}{2}}$

6. A steel block of mass $10\ \mathrm{kg}$ rests on a horizontal floor as shown in the figure (a). When three iron cylinders are placed on it as shown in the figure (b), the block and cylinders go down with an acceleration $0.2\ \mathrm{m/s^2}$. The normal reaction R exerted by the floor, if masses of the iron cylinders are $20\ \mathrm{kg}$ each, is -



A. $716\ \mathrm{N}$

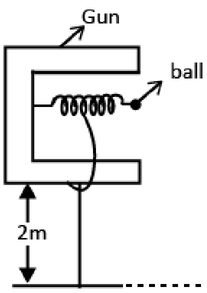
B. $686\ \mathrm{N}$

C. $714\ \mathrm{N}$

D. $684\ \mathrm{N}$

7. In a spring gun having spring constant $100 \mathrm{~N/m}$, a small ball B of mass $100 \mathrm{~g}$ is put in its barrel (as shown in the figure) by compressing the spring through $0.05 \mathrm{~m}$. There should be a box placed at a distance d on the ground so that the ball falls in it. If the ball leaves the gun horizontally at a height of $2 \mathrm{~m}$ above the ground. The value of d in meter is _______.

Take $g = 10 \mathrm{~m/s}^2$



8. A body of mass m is launched up on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of friction between the body and plane is $\frac{\sqrt{x}}{5}$ if the time of ascent is half of the time of descent. The value of x is ______.

9. Two bodies, a ring and a solid cylinder of same material are rolling down without slipping an inclined plane. The radii of the bodies are same. The ratio of velocity of the centre of mass at the bottom of the inclined plane of the ring to that of the cylinder is $\frac{\sqrt{x}}{2}$. Then, the value of x is _____.

10. A force $\overrightarrow{F} = (40\hat{i} + 10\hat{j})\ \mathrm{N}$ acts on a body of mass $5\ \mathrm{kg}$. If the body starts from rest, its position vector $\overrightarrow{r}$ at time $t = 10\ \mathrm{s}$, will be :

A. $(100\hat{i} + 400\hat{j})\ \mathrm{m}$

B. $(100\hat{i} + 100\hat{j})\ \mathrm{m}$

C. $(400\hat{i} + 100\hat{j})\ \mathrm{m}$

D. $(400\hat{i} + 400\hat{j})\ \mathrm{m}$

11. The initial mass of a rocket is $1000\ \mathrm{kg}$. Calculate at what rate the fuel should be burnt so that the rocket is given an acceleration of $20\ \mathrm{ms}^{-2}$. the gases come out at a relative speed of $500\ \mathrm{ms}^{-1}$ with respect to the rocket : [use $g = 10\ \mathrm{ms}^{-2}$]

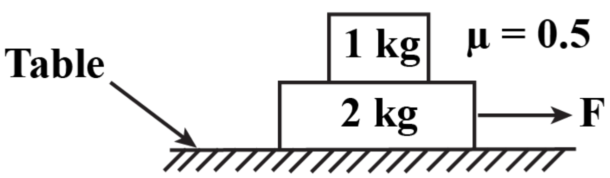
A. $60\ \mathrm{kg\ s}^{-1}$

B. $6.0 \times 10^2\ \mathrm{kg\ s}^{-1}$

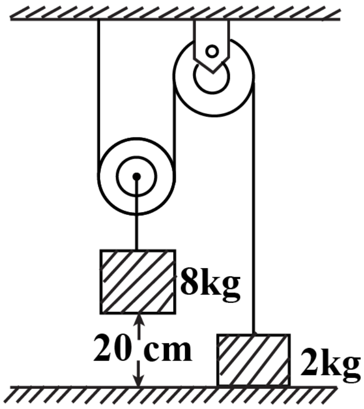
C. $500\ \mathrm{kg\ s}^{-1}$

D. $10\ \mathrm{kg\ s}^{-1}$

12. The coefficient of static friction between the two blocks is 0.5 and the table is smooth. The maximum horizontal force that can be applied to move the blocks together is _____N.
$(\text{Take } g = 10\ \mathrm{ms}^{-2})$



13. The boxes of masses $2\ \mathrm{kg}$ and $8\ \mathrm{kg}$ are connected by a massless string passing over smooth pulleys. Calculate the time taken by box of mass $8\ \mathrm{kg}$ to strike the ground starting from rest.
(Use $g = 10\ \mathrm{m/s^2}$) :



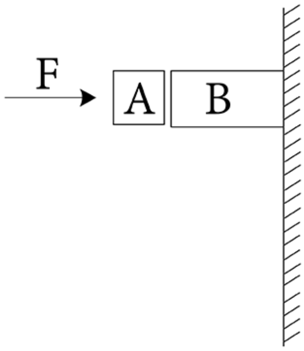
A. $0.2\ \mathrm{s}$

B. $0.34\ \mathrm{s}$

C. $0.25\ \mathrm{s}$

D. $0.4\ \mathrm{s}$

14. Given in the figure are two blocks A and B of weight $20\ N$ and $100\ N$, respectively. These are being pressed against a wall by a force F as shown. If the coefficient of friction between the blocks is 0.1 and between block B and the wall is 0.15, the frictional force applied by the wall on block B is



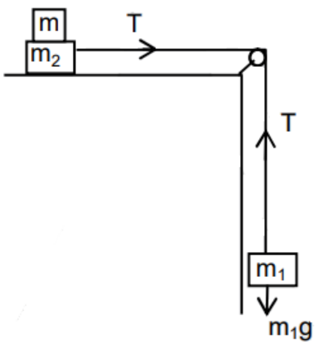
A. $100\ N$

B. $80\ N$

C. $120\ N$

D. $150\ N$

15. Two masses $m_1 = 5\ \mathrm{kg}$ and $m_2 = 10\ \mathrm{kg}$ connected by an inextensible string over a frictionless pulley are moving as shown in the figure. The coefficient of friction of horizontal surface is 0.15. The minimum weight m that should be put on top of $\mathrm{m_2}$ to stop the motion is



A. 43.3 kg

B. 10.3 kg

C. 18.3 kg

D. 23.3 kg

16. An insect is at the bottom of a hemispherical ditch of radius $1\ \mathrm{m}$. It crawls up the ditch but start slipping after it is at height h from the bottom. If the coefficient of friction between the ground and the insect is 0.75, then h is : ($g = 10\ \mathrm{ms}^{-2}$)

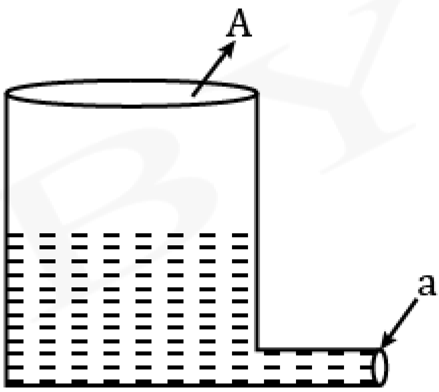
A. $0.20\ \mathrm{m}$

B. $0.45\ \mathrm{m}$

C. $0.60\ \mathrm{m}$

D. $0.80\ \mathrm{m}$

17. A light cylindrical vessel is kept on a horizontal surface. Area of base is A. A hole of cross-sectional area $'a'$ is made just at its bottom side. The minimum coefficient of friction necessary to prevent sliding the vessel due to the impact force of the emerging liquid is $(a << A)$:



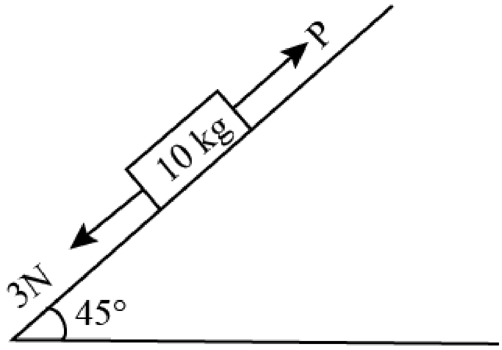
A. $\frac{A}{2a}$

B. None of these

C. $\frac{2a}{A}$

D. $\frac{a}{A}$

18. A block of mass $10 \mathrm{~kg}$ is kept on a rough inclined plane as shown in the figure. A force of $3 \mathrm{~N}$ is applied on the block. The coefficient of static friction between the plane and the block is 0.6. What should be the minimum value of force P, such that the block does not move downward?
(take $g=10 \mathrm{~ms}^{-2}$)



A. $32 \mathrm{~N}$

B. $18 \mathrm{~N}$

C. $23 \mathrm{~N}$

D. $25 \mathrm{~N}$

19. Statement I: It is easier to pull a heavy object than to push it on a level ground.

Statement II: The magnitude of frictional force depends on the nature of the two surfaces in contact.

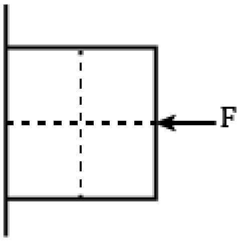
A. Both Statements are true and Statement II is the correct explanation for Statement I.

B. Both Statements are true and Statement II is not the correct explanation for Statement I.

C. Statement I is true and Statement II is false.

D. Statement I is false and Statement II is true.

20. A block of mass m is at rest under the action of force F against a wall as shown in figure. Which of the following statement is incorrect ?



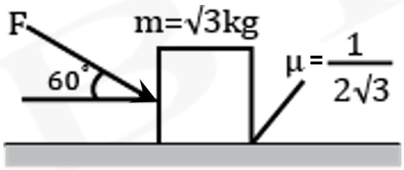
A. $f = mg$ (where f is the frictional force)

B. $F = N$ (where N is the normal force)

C. F will not produce torque

D. N will not produce torque

21. What is the maximum value of the force F such that the block shown in the arrangement, does not move?



A. $20\ \text{N}$

B. $10\ \text{N}$

C. $12\ \text{N}$

D. $15\ \text{N}$

22. A block of mass $2\ \text{kg}$ rests on a rough inclined plane making an angle of 30° with the horizontal. The coefficient of static friction between the block and the plane is 0.7. The frictional force on the block is :

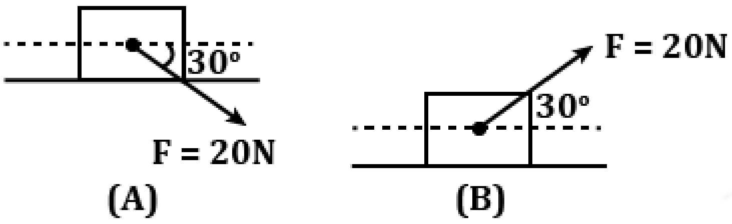
A. $9.8\ \text{N}$

B. $0.7 \times 9.8 \times \sqrt{3}\ \text{N}$

C. $9.8 \times \sqrt{3}\ \text{N}$

D. $0.7 \times 9.8\ \text{N}$

23. A block of mass $5 \mathrm{~kg}$ is (i) pushed in case (A) and (ii) pulled in case (B), by a force $F=20 \mathrm{~N}$, making an angle of 30° with the horizontal, as shown in the figures. The coefficient of friction between the block and the floor is $\mu=0.2$. The difference between the accelerations of the block, in case (B) and case (A) will be
(Take, $g=10 \mathrm{~ms}^{-2}$)



A. $0.4 \mathrm{~ms}^{-2}$

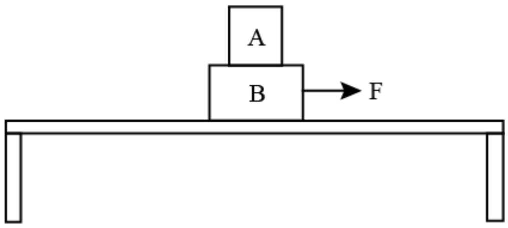
B. $3.2 \mathrm{~ms}^{-2}$

C. $0.8 \mathrm{~ms}^{-2}$

D. $0 \mathrm{~ms}^{-2}$

24. Two blocks A and B of masses $m_A=1 \mathrm{~kg}$ and $m_B=3 \mathrm{~kg}$ are kept on the table as shown in figure. The coefficient of friction between A and B is 0.2 and between B and the surface of the table is also 0.2. The maximum force F that can be applied on B horizontally, so that the block A does not slide over the block B is

[Take, $g=10 \mathrm{~m} / \mathrm{s}^2$]



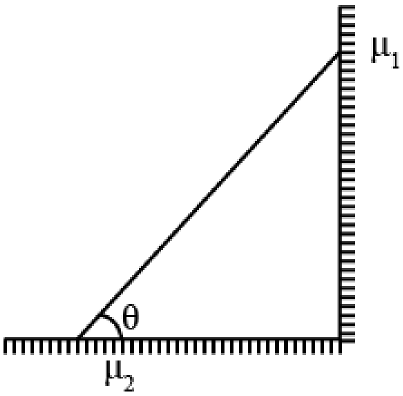
A. $12 \mathrm{~N}$

B. $16 \mathrm{~N}$

C. $8 \mathrm{~N}$

D. $40 \mathrm{~N}$

25. In the figure, a ladder of mass m is shown leaning against a wall. It is static equilibrium making an angle θ with the horizontal floor. The coefficient of friction between the wall and the ladder is μ_1 and that between the floor and the ladder is μ_2. The normal reaction of the wall on the ladder is N_1 and that of the floor is N_2. If the ladder is about to slip, then



A. $\mu_1 = 0,\ \mu_2 \neq 0$ and $N_2\ \tan\theta = \dfrac{mg}{2}$

B. $\mu_1 \neq 0,\ \mu_2 = 0$ and $N_1\ \tan\theta = \dfrac{mg}{2}$

C. $\mu_1 \neq 0,\ \mu_2 \neq 0$ and $N_2 = \dfrac{mg}{1+\mu_1\mu_2}$

D. $\mu_1 = 0,\ \mu_2 \neq 0$ and $N_1 \tan\theta = \dfrac{mg}{2}$