CHAPTER 4

Laws of Motion

1. A lift is moving down with acceleration a. A man in the lift drops a ball inside the lift. The acceleration of the ball as observed by the man in the lift and a man standing stationary on the ground are respectively **[2002]**
(a) g, g (b) $g - a, g - a$
(c) $g - a, g$ (d) a, g

2. When forces F_1, F_2, 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 **[2002]**
(a) F_1/m (b) F_2F_3/mF_1
(c) $(F_2 - F_3)/m$ (d) F_2/m.

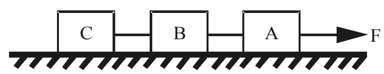
3. The minimum velocity (in ms^{-1}) with which a car driver must traverse a flat curve of radius 150 m and coefficient of friction 0.6 to avoid skidding is
(a) 60 (b) 30 **[2002]**
(c) 15 (d) 25

4. A solid sphere, a hollow sphere and a ring are released from top of an inclined plane (frictionless) so that they slide down the plane. Then maximum acceleration down the plane is for (no rolling) **[2002]**
(a) solid sphere (b) hollow sphere
(c) ring (d) all same.

5. Two forces are such that the sum of their magnitudes is 18 N and their resultant is 12 N which is perpendicular to the smaller force. Then the magnitudes of the forces are **[2002]**
(a) 12 N, 6 N (b) 13 N, 5 N
(c) 10 N, 8 N (d) 16N, 2N.

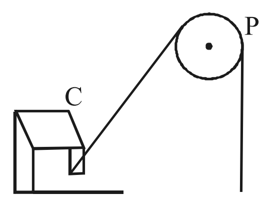
6. A light string passing over a smooth light pulley connects two blocks of masses m_1 and m_2 (vertically). If the acceleration of the system is $g/8$, then the ratio of the masses is **[2002]**
(a) 8 : 1 (b) 9 : 7
(c) 4 : 3 (d) 5 : 3.

7. Three identical blocks of masses m = 2 kg are drawn by a force F = 10. 2 N with an acceleration of 0. 6 ms^{-2} on a frictionless surface, then what is the tension (in N) in the string between the blocks B and C? **[2002]**



(a) 9.2 (b) 3.4
(c) 4 (d) 9.8

8. One end of a massless rope, which passes over a massless and frictionless pulley P is tied to a hook C while the other end is free. Maximum tension that the rope can bear is 360 N. With what value of maximum safe acceleration (in ms^{-2}) can a man of 60 kg climb on the rope? **[2002]**

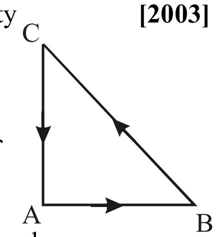


(a) 16 (b) 6
(c) 4 (d) 8

9. A spring balance is attached to the ceiling of a lift. A man hangs his bag on the spring and the spring reads 49 N, when the lift is stationary. If the lift moves downward with an acceleration of $5 m/s^2$, the reading of the spring balance will be **[2003]**
(a) 24 N (b) 74 N
(c) 15 N (d) 49 N

10. Three forces start acting simultaneously on a particle moving with velocity, $\vec{v}$. These forces are represented in magnitude and direction by the three sides of a triangle ABC. The particle

will now move with velocity **[2003]**



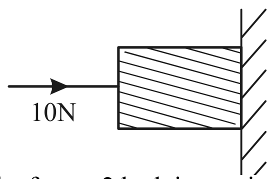
(a) less than $\vec{v}$

(b) greater than $\vec{v}$

(c) $|\vec{v}|$ in the direction of the largest force BC

(d) $\vec{v}$, remaining unchanged

11. 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 **[2003]**



(a) 20 N

(b) 50 N

(c) 100 N

(d) 2 N

12. A marble block of mass 2 kg lying on ice when given a velocity of 6 m/s is stopped by friction in 10 s. Then the coefficient of friction is **[2003]**

(a) 0.02 (b) 0.03

(c) 0.04 (d) 0.06

13. A block of mass M is pulled along a horizontal frictionless surface by a rope of mass m. If a force P is applied at the free end of the rope, the force exerted by the rope on the block is **[2003]**

(a) $\frac{Pm}{M+m}$ (b) $\frac{Pm}{M-m}$

(c) P (d) $\frac{PM}{M+m}$

14. A light spring balance hangs from the hook of the other light spring balance and a block of mass M kg hangs from the former one. Then the true statement about the scale reading is **[2003]**

(a) both the scales read M kg each

(b) the scale of the lower one reads M kg and of the upper one zero

(c) the reading of the two scales can be anything but the sum of the reading will be M kg

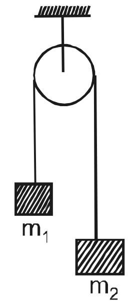
(d) both the scales read $M/2$ kg each

15. A rocket with a lift-off mass 3.5×10^4 kg is blasted upwards with an initial acceleration of 10m/s^2. Then the initial thrust of the blast is **[2003]**

(a) 3.5×10^5 N (b) 7.0×10^5 N

(c) 14.0×10^5 N (d) 1.75×10^5 N

16. Two masses $m_1 = 5\text{g}$ and $m_2 = 4.8$ kg tied to a string are hanging over a light frictionless pulley. What is the acceleration of the masses when left free to move? $(g = 9.8 \text{m/s}^2)$ **[2004]**



(a) 5 m/s^2

(b) 9.8 m/s^2

(c) 0.2 m/s^2

(d) 4.8 m/s^2

17. A block 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 0.8. If the frictional force on the block is 10 N, the mass of the block (in kg) is (take $g = 10 \text{ m/s}^2$) **[2004]**

(a) 1.6 (b) 4.0

(c) 2.0 (d) 2.5

18. A smooth block is released at rest on a 45° incline and then slides a distance 'd'. The time taken to slide is 'n' times as much to slide on rough incline than on a smooth incline. The coefficient of friction is **[2005]**

(a) $\mu_k = \sqrt{1-\frac{1}{n^2}}$ (b) $\mu_k = 1-\frac{1}{n^2}$

(c) $\mu_s = \sqrt{1-\frac{1}{n^2}}$ (d) $\mu_s = 1-\frac{1}{n^2}$

19. A parachutist after bailing out falls 50 m without friction. When parachute opens, it decelerates at 2 m/s^2. He reaches the ground with a speed of 3 m/s. At what height, did he bail out? **[2005]**

(a) 182 m (b) 91 m

(c) 111 m (d) 293 m

20. An annular ring with inner and outer radii R_1 and R_2 is rolling without slipping with a uniform angular speed. The ratio of the forces experienced by the two particles situated on the inner and outer parts of the ring, $\frac{F_1}{F_2}$ is **[2005]**

(a) $\left(\frac{R_1}{R_2}\right)^2$ (b) $\frac{R_2}{R_1}$

(c) $\frac{R_1}{R_2}$ (d) 1

21. The upper half of an inclined plane with inclination ϕ is perfectly smooth while the lower half is rough. A body starting from rest at the top will again come to rest at the bottom if the coefficient of friction for the lower half is given by **[2005]**

(a) $2\cos\phi$ (b) $2\sin\phi$

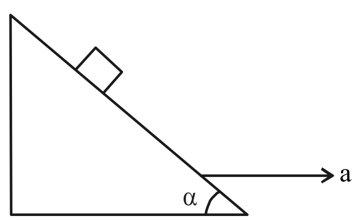
(c) $\tan\phi$ (d) $2\tan\phi$

22. A particle of mass 0.3 kg subject to a force $F = -kx$ with $k = 15$ N/m. What will be its initial acceleration if it is released from a point 20 cm away from the origin ? **[2005]**

(a) 15 m/s^2 (b) 3 m/s^2

(c) 10 m/s^2 (d) 5 m/s^2

23. A block is kept on a frictionless inclined surface with angle of inclination 'α'. The incline is given an acceleration 'a' to keep the block stationary. Then a is equal to **[2005]**



(a) $g \operatorname{cosec}\alpha$ (b) $g/\tan\alpha$

(c) $g\tan\alpha$ (d) g

24. Consider a car moving on a straight road with a speed of 100 m/s. The distance at which car can be stopped is $[\mu_k = 0.5]$ **[2005]**

(a) 1000 m (b) 800 m

(c) 400 m (d) 100 m

25. A ball of mass 0.2 kg is thrown vertically upwards by applying a force by hand. If the hand moves 0.2 m while applying the force and the ball goes upto 2 m height further, find the magnitude of the force. (Consider g = 10 m/s^2). **[2006]**

(a) 4 N (b) 16 N

(c) 20 N (d) 22 N

26. A player caught a cricket ball of mass 150 g moving at a rate of 20 m/s. If the catching process is completed in 0.1s, the force of the blow exerted by the ball on the hand of the player is equal to **[2006]**

(a) 150 N (b) 3 N

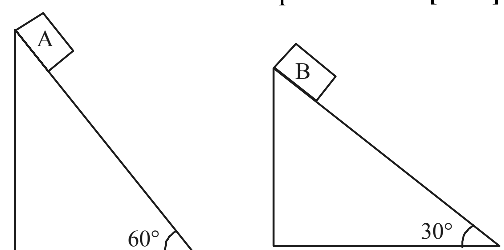
(c) 30 N (d) 300 N

27. A block of mass m is connected to another block of mass M by a spring (massless) of spring constant k. The block are kept on a smooth horizontal plane. Initially the blocks are at rest and the spring is unstretched. Then a constant force F starts acting on the block of mass M to pull it. Find the force of the block of mass m. **[2007]**

(a) $\dfrac{MF}{(m+M)}$ (b) $\dfrac{mF}{M}$

(c) $\dfrac{(M+m)F}{m}$ (d) $\dfrac{mF}{(m+M)}$

28. Two fixed frictionless inclined planes making an angle 30° and 60° with the vertical are shown in the figure. Two blocks A and B are placed on the two planes. What is the relative vertical acceleration of A with respect to B ? **[2010]**



(a) 4.9 ms^{-2} in horizontal direction

(b) 9.8 ms^{-2} in vertical direction

(c) Zero

(d) 4.9 ms^{-2} in vertical direction

29. The minimum force required to start pushing a body up rough (frictional coefficient μ) inclined plane is F_1 while the minimum force needed to prevent it from sliding down is F_2. If the inclined plane makes an angle θ from the horizontal such that $\tan\theta = 2\mu$ then the ratio $\dfrac{F_1}{F_2}$ is **[2011 RS]**

(a) 1 (b) 2

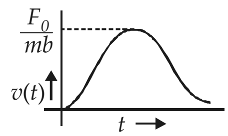
(c) 3 (d) 4

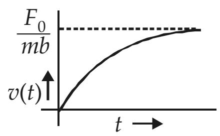
30. If a spring of stiffness 'k' is cut into parts 'A' and 'B' of length $\ell_A : \ell_B = 2:3$, then the stiffness of spring 'A' is given by **[2011 RS]**

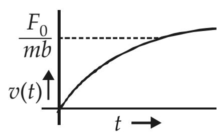
(a) $\dfrac{3k}{5}$ (b) $\dfrac{2k}{5}$

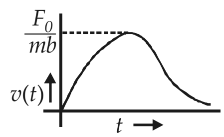
(c) k (d) $\dfrac{5k}{2}$

31. A particle of mass m is at rest at the origin at time $t = 0$. It is subjected to a force $F(t) = F_0 e^{-bt}$ in the x direction. Its speed $v(t)$ is depicted by which of the following curves? **[2012]**

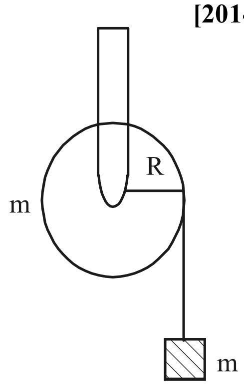
(a) 

(b) 

(c) 

(d) 

32. A mass 'm' is supported by a massless string wound around a uniform hollow cylinder of mass m and radius R. If the string does not slip on the cylinder, with what acceleration will the mass fall or release? **[2014]**



(a) $\frac{2g}{3}$

(b) $\frac{g}{2}$

(c) $\frac{5g}{6}$

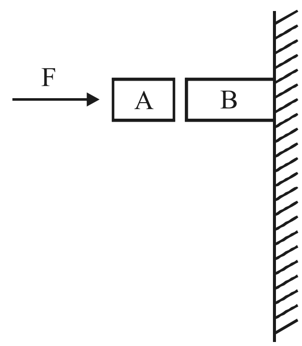
(d) g

33. A block of mass m is placed on a surface with a vertical cross section given by $y = \frac{x^3}{6}$. If the coefficient of friction is 0.5, the maximum height above the ground at which the block can be placed without slipping is: **[2014]**

(a) $\frac{1}{6}$m (b) $\frac{2}{3}$m

(c) $\frac{1}{3}$m (d) $\frac{1}{2}$m

34. 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: **[2015]**



(a) 120 N (b) 150 N

(c) 100 N (d) 80 N

Answer Key

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
(c)	(a)	(b)	(d)	(b)	(b)	(b)	(c)	(a)	(d)	(d)	(d)	(d)	(a)	(b)
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
(c)	(c)	(b)	(d)	(c)	(d)	(c)	(c)	(a)	(d)	(c)	(d)	(d)	(c)	(d)
31	32	33	34											
(c)	(b)	(a)	(a)											

SOLUTIONS

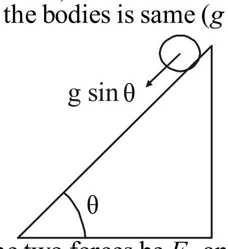
1. (c)
- For the man standing in the left, the acceleration of the ball
  $\vec{a}_{bm} = \vec{a}_b - \vec{a}_m \Rightarrow a_{bm} = g - a$
  Where 'a' is the acceleration of the mass (because the acceleration of the lift is 'a')
- For the man standing on the ground, the acceleration of the ball
  $\vec{a}_{bm} = \vec{a}_b - \vec{a}_m \Rightarrow a_{bm} = g - 0 = g$

2. (a) When F_1, F_2 and F_3 are acting on a particle then the particle remains stationary. This means that the resultant of F_1, F_2 and F_3 is zero. When F_1 is removed, F_2 and F_3 will remain. But the resultant of F_2 and F_3 should be equal and opposite to F_1. i.e. $|F_2 + F_3| = |F_1|$

$$\therefore \quad a = \frac{|F_2 + F_3|}{m} \Rightarrow a = \frac{F_1}{m}$$

3. (b) For negotiating a circular curve on a levelled road, the maximum velocity of the car is
$v_{max} = \sqrt{\mu r g}$
Here $\mu = 0.6$, $r = 150$ m, $g = 9.8$
$\therefore v_{max} = \sqrt{0.6 \times 150 \times 9.8} \simeq 30 \text{m/s}$

4. (d) This is a case of sliding (the plane being frictionless) and therefore the acceleration of all the bodies is same ($g \sin\theta$).

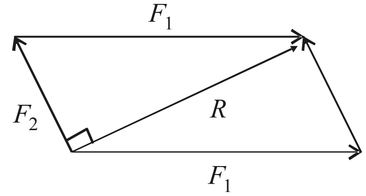


5. (b) Let the two forces be F_1 and F_2 and let $F_2 < F_1$. R is the resultant force.
Given $F_1 + F_2 = 18$ ...(i)
From the figure $F_2^2 + R^2 = F_1^2$

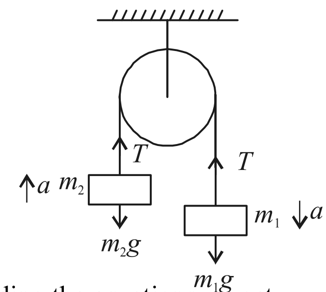
$$F_1^2 - F_2^2 = R^2$$

$\therefore \quad F_1^2 - F_2^2 = 144$ ...(ii)

Only option (b) follows equation (i) and (ii).



6. (b) **For mass m_1**
$m_1 g - T = m_1 a$
For mass m_2
$T - m_2 g = m_2 a$



Adding the equations we get

$$a = \frac{(m_1 - m_2)g}{m_1 + m_2}$$

Here $a = \dfrac{g}{8}$

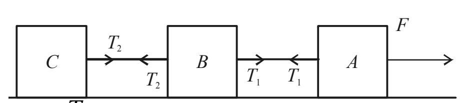
$$\therefore \quad \frac{1}{8} = \frac{\frac{m_1}{m_2} - 1}{\frac{m_1}{m_2} + 1} \quad \Rightarrow \frac{m_1}{m_2} + 1 = 8\frac{m_1}{m_2} - 8$$

$$\Rightarrow \frac{m_1}{m_2} = \frac{9}{7}$$

7. (b) $F = (m + m + m) \times a$

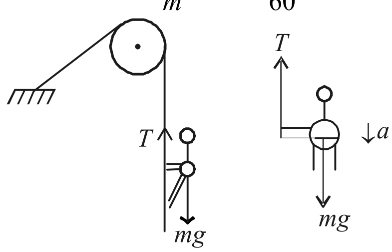
$$\therefore a = \frac{10.2}{6} \text{m/s}^2$$

$$\therefore \quad T_2 = ma = 2 \times \frac{10.2}{6} = 3.4\text{N}$$

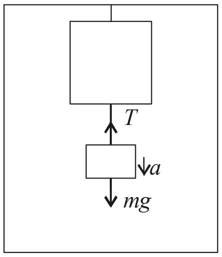


8. (c) $mg - T = ma$

$$\therefore \quad a = g - \frac{T}{m} = 10 - \frac{360}{60} = 4m/s^2$$



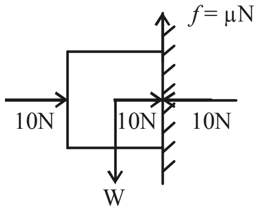
9. **(a)** For the bag accelerating down
$mg - T = ma$



$\therefore \; T = m(g-a) = \frac{49}{10}(10-5) = 24.5\,\text{N}$

10. **(d)** As shown in the figure, the three forces are represented by the sides of a triangle taken in the same order. Therefore the resultant force is zero. $\vec{F}_{net} = m\vec{a}$.
Therefore, acceleration is also zero i.e., velocity remains unchanged.

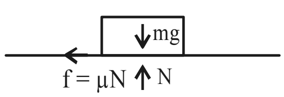
11. **(d)** For the block to remain stationary with the wall
$f = W$



$\mu N = W$
$0.2 \times 10 = W \Rightarrow W = 2N$

12. **(d)** $u = 6$ m/s, $v = 0$, $t = 10s$, $a = ?$
$v = u + at \Rightarrow 0 = 6 + a \times 10$

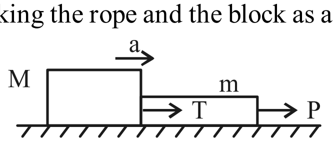
$\Rightarrow \quad a = \frac{-6}{10} = -0.6\,\text{m/s}^2$



The retardation is due to the frictional force
$\therefore \quad f = ma \Rightarrow \mu N = ma \Rightarrow \mu mg = ma$

$\Rightarrow \mu = \frac{a}{g} = \frac{0.6}{10} = 0.06$

13. **(d)** Taking the rope and the block as a system



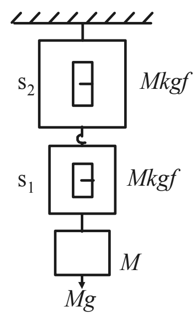
we get $P = (m+M)\,a$

$\therefore \; a = \frac{P}{m+M}$

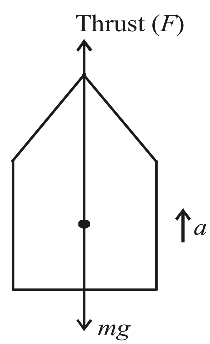
Taking the block as a system,
we get $T = Ma$

$\therefore \; T = \frac{MP}{m+M}$

14. **(a)** The Earth pulls the block by a force Mg. The block in turn exerts a force Mg on the spring of spring balance S_1 which therefore shows a reading of M kgf.
The spring S_1 is massless. Therefore, it exerts a force of Mg on the spring of spring balance S_2 which shows the reading of M kgf.



15. **(b)** As shown in the figure $F - mg = ma$

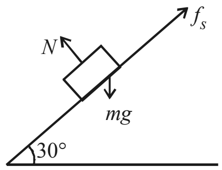


$\therefore \; F = m(g+a) = 3.5 \times 10^4\,(10+10)$
$= 7 \times 10^5\,\text{N}$

16. **(c)** Acceleration $a = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) g$

$= \frac{(5-4.8)\times 9.8}{(5+4.8)}\,\text{m/s}^2 = 0.2\ \text{m/s}^2$

17. (c)

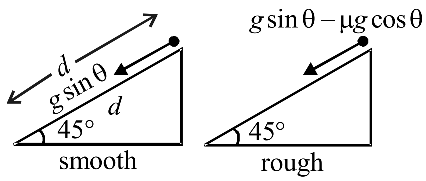


mg $\sin\theta = f_s$ (for body to be at rest)

$\Rightarrow m \times 10 \times \sin 30° = 10$

$\Rightarrow m \times 5 = 10 \Rightarrow m = 2.0$ kg

18. (b)



When surface is smooth

When surface is rough

$$d = \frac{1}{2}(g\sin\theta)t_1^2,$$

$$d = \frac{1}{2}(g\sin\theta - \mu g\cos\theta)t_2^2$$

$$t_1 = \sqrt{\frac{2d}{g\sin\theta}},\quad t_2 = \sqrt{\frac{2d}{g\sin\theta - \mu g\cos\theta}}$$

According to question, $t_2 = nt_1$

$$n\sqrt{\frac{2d}{g\sin\theta}} = \sqrt{\frac{2d}{g\sin\theta - \mu g\cos\theta}}$$

μ, as applicable here, is coefficient of kinetic friction as the block moves over the inclined plane.

$$n = \frac{1}{\sqrt{1-\mu_k}}$$

$$\left(\because \cos 45° = \sin 45° = \frac{1}{\sqrt{2}}\right)$$

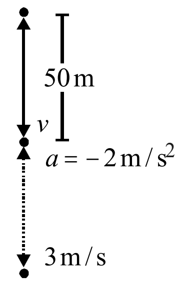
$$n^2 = \frac{1}{1-\mu_k} \text{ or } 1-\mu_k = \frac{1}{n^2}$$

$$\text{or } \mu_k = 1 - \frac{1}{n^2}$$

19. (d) Initial velocity of parachute after bailing out,

$$u = \sqrt{2gh}$$

$$u = \sqrt{2 \times 9.8 \times 50} = 14\sqrt{5}$$



The velocity at ground,

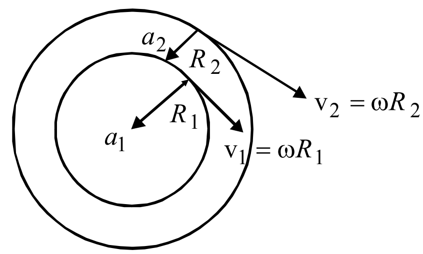
$v = 3$m/s

$$S = \frac{v^2 - u^2}{2 \times 2} = \frac{3^2 - 980}{4} \approx 243 \text{ m}$$

Initially he has fallen 50 m.

$\therefore$ Total height from where he bailed out $= 243 + 50 = 293$ m

20. (c)



$$a_1 = \frac{v_1^2}{R_1} = \frac{\omega^2 R_1^2}{R_1} = \omega^2 R_1$$

$$a_2 = \frac{v_2^2}{R_2} = \omega^2 R_2$$

Taking particle masses equal

$$\frac{F_1}{F_2} = \frac{ma_1}{ma_2} = \frac{a_1}{a_2} = \frac{R_1}{R_2}$$

ALTERNATE SOLUTION

The force experienced by any particle is only along radial direction.

Force experienced by the particle, $F = m\omega^2 R$

$$\therefore \frac{F_1}{F_2} = \frac{R_1}{R_2}$$

21. (d) Acceleration of block while sliding down upper half

$= g\sin\phi$;

retardation of block while sliding down lower half

$= -(g\sin\phi - \mu g\cos\phi)$

For the block to come to rest at the bottom, acceleration in I half = retardation in II half.

$g\sin\phi = -(g\sin\phi - \mu g\cos\phi)$

$\Rightarrow \mu = 2\tan\phi$

ALTERNATE SOLUTION

According to work-energy theorem, $W = \Delta K = 0$

(Since initial and final speeds are zero)

$\therefore$ Workdone by friction + Work done by gravity = 0

i.e., $-(\mu\, mg\cos\phi)\dfrac{\ell}{2} + mg\ell\sin\phi = 0$

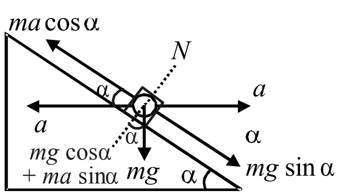
or $\dfrac{\mu}{2}\cos\phi = \sin\phi$ or $\mu = 2\tan\phi$

22. (c) Mass $(m) = 0.3$ kg $\Rightarrow F = m.a = -15\,x$

$$a = -\frac{15}{0.3}x = \frac{-150}{3}x = -50x$$

$$a = -50 \times 0.2 = 10\,\text{m/s}^2$$

23. (c) From free body diagram,



For block to remain stationary,

$$mg\sin\alpha = ma\cos\alpha \Rightarrow a = g\tan\alpha$$

24. (a) $v^2 - u^2 = 2as$ or

$0^2 - u^2 = 2(-\mu_k g)s$

$$-100^2 = 2 \times -\frac{1}{2} \times 10 \times s$$

s = 1000 m

25. (d) Let the velocity of the ball just when it leaves the hand is u then applying,

$v^2 - u^2 = 2as$ for upward journey

$\Rightarrow -u^2 = 2(-10)\times 2 \Rightarrow u^2 = 40$

Again applying $v^2 - u^2 = 2as$ for the upward journey of the ball, when the ball is in the hands of the thrower,

$v^2 - u^2 = 2as$

$\Rightarrow 40 - 0 = 2\,(a)\,0.2 \Rightarrow a = 100\ \text{m/s}^2$

$\therefore F = ma = 0.2 \times 100 = 20\ N$

$\Rightarrow N - mg = 20 \Rightarrow N = 20 + 2 = 22N$

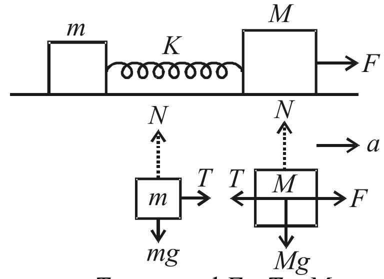
ALTERNATE SOLUTION

$W_{hand} + W_{gravity} = \Delta K$

$\Rightarrow F(0.2) + (0.2)(10)(2.2) = 0 \Rightarrow F = 22\ N$

26. (c) $F = \dfrac{m(v-u)}{t} = \dfrac{0.15(0-20)}{0.1} = 30\,N$

27. (d) Writing free body-diagrams for m & M,



we get $T = ma$ and $F - T = Ma$

where T is force due to spring

$\Rightarrow F - ma = Ma$ or, $F = Ma + ma$

$\therefore a = \dfrac{F}{M+m}$.

Now, force acting on the block of mass m is

$$ma = m\left(\frac{F}{M+m}\right) = \frac{mF}{m+M}.$$

28. (d) $mg\sin\theta = ma$

$\therefore a = g\sin\theta$

where a is along the inclined plane

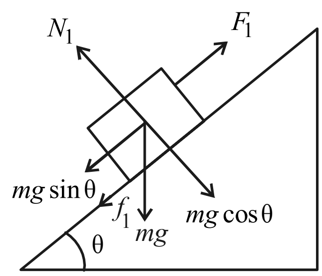
$\therefore$ vertical component of acceleration is $g\sin^2\theta$

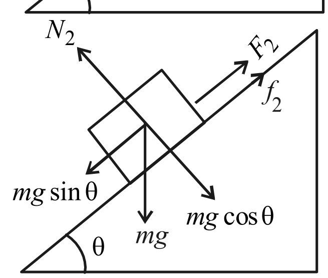
$\therefore$ relative vertical acceleration of A with respect to B is

$$g(\sin^2 60 - \sin^2 30] = \frac{g}{2} = 4.9\ \text{m/s}^2$$

in vertical direction

29. (c)





For the upward motion of the body

$mg\sin\theta + f_1 = F_1$

or, $F_1 = mg\sin\theta + \mu mg\cos\theta$

For the downward motion of the body,

$mg\sin\theta - f_2 = F_2$

or $F_2 = mg\sin\theta - \mu mg\cos\theta$

$$\therefore \frac{F_1}{F_2} = \frac{\sin\theta + \mu\cos\theta}{\sin\theta - \mu\cos\theta}$$

$$\Rightarrow \frac{\tan\theta + \mu}{\tan\theta - \mu} = \frac{2\mu + \mu}{2\mu - \mu} = \frac{3\mu}{\mu} = 3$$

30. **(d)** Here, $\ell_A = \frac{2\ell}{5},\ \ell_B = \left(\frac{3\ell}{5}\right)$

$k\ell = k_A\ell_A = k_B\ell_B$

$k\ell = k_A\left(\frac{2\ell}{5}\right)$

$k_A = \frac{5k}{2}$

31. **(c)** Given that $F(t) = F_0 e^{-bt}$

$$\Rightarrow m\frac{dv}{dt} = F_0 e^{-bt}$$

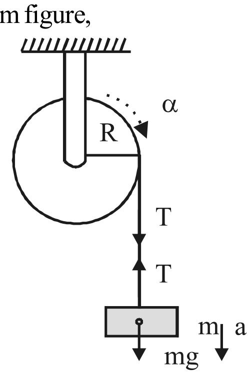
$$\frac{dv}{dt} = \frac{F_0}{m}e^{-bt}$$

$$\int_0^v dv = \frac{F_0}{m}\int_0^t e^{-bt}dt$$

$$v = \frac{F_0}{m}\left[\frac{e^{-bt}}{-b}\right]_0^t = \frac{F_0}{mb}\left[-\left(e^{-bt} - e^{-0}\right)\right]$$

$$\Rightarrow v = \frac{F_0}{mb}\left[1 - e^{-bt}\right]$$

32. **(b)** From figure,



Acceleration $a = R\alpha$ ...(i)

and $mg - T = ma$ ...(ii)

From equation (i) and (ii)

$$T \times R = mR^2\alpha = mR^2\left(\frac{a}{R}\right)$$

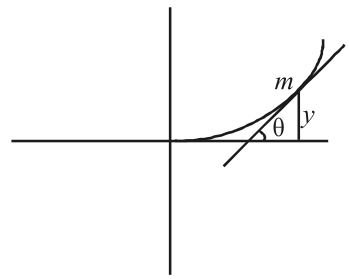
or $T = ma$

$\Rightarrow mg - ma = ma$

$\Rightarrow a = \frac{g}{2}$

33. **(a)** At limiting equilibrium,

$\mu = \tan\theta$



$\tan\theta = \mu = \frac{dy}{dx} = \frac{x^2}{2}$ (from question)

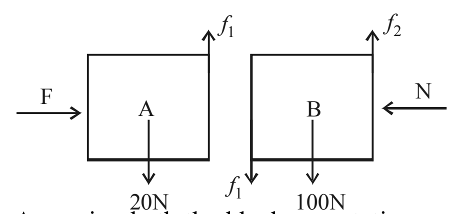
$\because$ Coefficient of friction $\mu = 0.5$

$\therefore\ 0.5 = \frac{x^2}{2}$

$\Rightarrow x = \pm 1$

Now, $y = \frac{x^3}{6} = \frac{1}{6}m$

34. **(a)**

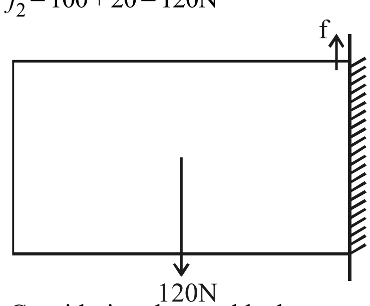


Assuming both the blocks are stationary

N = F

$f_1 = 20\,N$

$f_2 = 100 + 20 = 120N$



Considering the two blocks as one system and due to equilibrium f = 120N