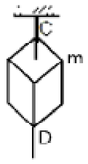
PHYSICS
TOPIC- LAWS OF MOTION AND FRICTION

1. A rider on horse back falls when horse starts running all of a sudden because-
(A) rider is taken back
(B) rider is suddenly afraid of falling
(C) inertia of rest keeps the upper part of body at rest where as lower part of the body moves forward with the horse
(D) None of the above

2. A man getting down a running bus, falls forward because-
(A) due to inertia of rest, road is left behind and man reaches forward
(B) due to inertia of motion upper part of body continues to be in motion in forward direction while feet come to rest as soon as they touch the road
(C) he leans forward as a matter of habbit
(D) of the combined effect of all the three factors stated in (A), (B) and (C)

3. A boy sitting on the top most berth in the compartment of a train which is just going to stop on a railway station, drops an apple aiming at the open hand of his brother sitting vertically below his hands at a distance of about 2 metre. The apple will fall-
(A) precisely on the hand of his brother
(B) slightly away from the hand of his brother in the direction of motion of the train
(C) slightly away from the hand of his brother in the direction opposite to the direction of motion of the train
(D) none of the above

4. A heavy block of mass m is supported by a cord C from the ceiling, and another cord D is attached to the bottom of the block. If a sudden jerk is given to D, then-



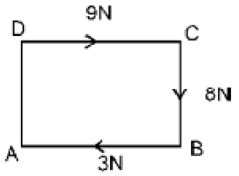
(A) cord C breaks (B) cord D breaks
(C) cord C and D both break (D) none of the cords breaks

5. The **incorrect** statement about Newton's second law of motion is-
(A) it provides a measure of inertia (B) it provides a measure of force
(C) it relates force and acceleration (D) it relates momentum and force

6. The incorrect relation is-

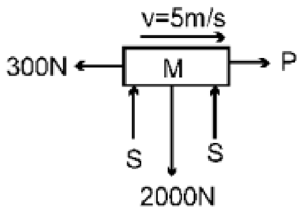
(A) $F = ma$ (B) $F = m\frac{dv}{dt}$ (C) $F = \frac{dp}{dt}$ (D) $F = mv$

7. ABCD is a rectangle forces of 9N, 8N, 3N act along the lines DC, CB and BA, respectively, in the directions indicated by the order of the letters. Then the resultant force is



(A) 8 N (B) 5 N (C) 20 N (D) 10 N

8. The forces acting on an object are shown in the fig. If the body moves horizontally at a constant speed of 5 m/s, then the values of the forces P and S are, respectively-

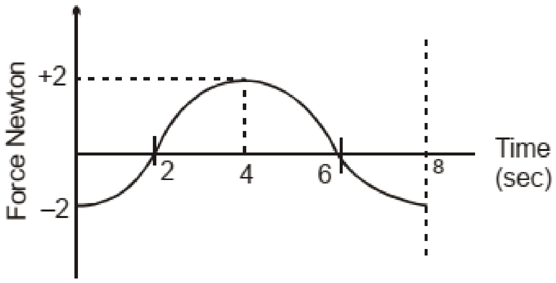


(A) 0 N, 0 N
(B) 300 N, 200 N
(C) 300 N, 1000 N
(D) 2000 N, 300 N

9. When a 1 Newton force acts on a 1 kg body that is able to move freely, the body receives-
(A) A speed of 1 m/sec
(B) An acceleration of 1 m/sec^2
(C) An acceleration of 980 cm/sec^2
(D) An acceleration of 1 cm/sec^2

10. A force of 10 Newton acts on a body of mass 20 kg for 10 seconds. The change produced in momentum is given by-
(A) 5 kg m/sec
(B) 100 kg m/sec
(C) 200 kg m/sec
(D) 2000 kg m/sec

11. A force-time graph for a linear motion is shown in figure where the segments are circular. The linear momentum gained between zero and 8 seconds in -



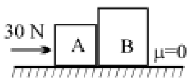
(A) -2π N.s
(B) 0 N.s
(C) 4π N.s
(D) -6π N.s

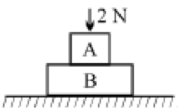
12. A particle moves in the xy plane under the action of a force **F** such that the value of its linear momentum (**P**) at any time t is, $P_x = 2\cos t$, $P_y = 2\sin t$. The angle θ between **P** and **F** at that time t will be -
(A) 0°
(B) 30°
(C) 90°
(D) 180°

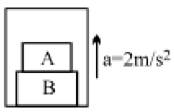
13. The linear momentum P of a body moving in one dimension varies with time according to the equation $P = at^3 + bt$ where a and b are positive constants. The net force acting on the body is
(A) proportional to t^2
(B) a constant
(C) proportional to t
(D) inversely proportional to t

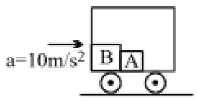
14. A player catches a ball of 200 g moving with a speed of 20 m/s. If the time taken to complete the catch is 0.5 sec, the force exerted on the players hand is -
(A) 8 N
(B) 4 N
(C) 2 N
(D) 0 N

15. In which of the following cases is the contact force between A and B maximum ($m_A = m_B = 1$ kg)

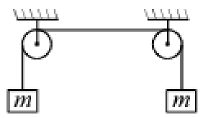
(A)


(B)


(C)


(D)


16. Two identical mass m are connected to a massless string which is hung over two frictionless pulleys as shown in figure. If everything is at rest, what is the tension in the cord?



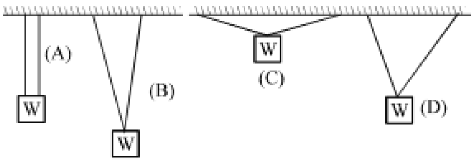
(A) less than mg
(B) exactly mg
(C) more than mg but less than 2mg
(D) exactly 2mg

17. An object will continue accelerating until :
(A) resultant force on it begins to decrease
(B) its velocity changes direction
(C) the resultant force on it is zero
(D) the resultant force is at right angles to its direction of motion

18. Two masses M_1 and M_2 are attached to the ends of a light string which passes over a massless pulley attached to the top of a double inclined smooth plane of angles of inclination α and β. If $M_2 > M_1$ then the acceleration of block M_2 down the inclined will be :

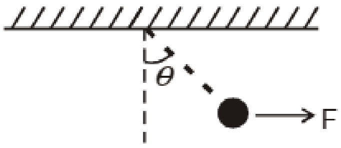
(A) $\frac{M_2 g(\sin\beta)}{M_1 + M_2}$ (B) $\frac{M_1 g(\sin\alpha)}{M_1 + M_2}$ (C) $\left(\frac{M_2 \sin\beta - M_1 \sin\alpha}{M_1 + M_2}\right)g$ (D) zero

19. A weight can be hung in any of the following four ways by string of same type. In which case is the string most likely to break?
(A) A (B) B (C) C (D) D



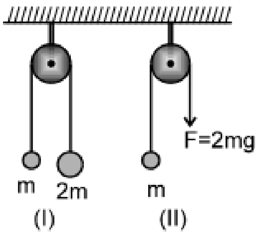
20. A body of mass M is acted upon by a force F and the acceleration produced is a. If three coplaner forces each equal to F and inclined to each other at 120° act on the same body and no other forces are acting. The acceleration produced will be:
(A) $\sqrt{2}$ a (B) a/ $\sqrt{3}$ (C) 3a (D) zero

21. A 1-N pendulum bob is held at an angle θ from the vertical by a 2-N horizontal force ε as shown. The tension in the string supporting the pendulum bob (in newtons) is:



(A) cos θ (B) 2ε cos θ (C) $\sqrt{5}$ (D) 1

22. The pulley arrangements shown in figure are identical the mass of the rope being negligible. In case I, the mass m is lifted by attaching a mass 2m to the other end of the rope. In case II, the mass m is lifted by pulling the other end of the rope with a constant downward force F = 2mg, where g is acceleration due to gravity. The acceleration of mass in case I is:



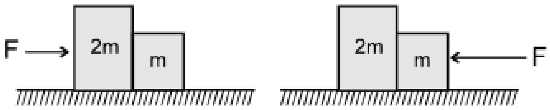
(A) zero (B) more than that in case II
(C) less than that in case II (D) equal to that in case II

23. A ball of mass m is thrown vertically upwards. Assume the force of air resistance has magnitude proportional to the velocity, and direction opposite to the velocity's. At the highest point, the ball's acceleration is
(A) 0 (B) less than g (C) g (D) greater than g

24. A fireman wants to slide down a vertical rope. The rope can bear a tension of $\frac{3}{4}^{th}$ of the weight of the man. With what minimum acceleration should the fireman slide down :

(A) $\frac{g}{3}$ (B) $\frac{g}{6}$ (C) $\frac{g}{4}$ (D) $\frac{g}{2}$

25. Two blocks are in contact on a frictionless table. One has mass m and the other 2m. A force F is applied on 2m as shown in the figure. Now the same force F is applied from the right on m. In the two cases respectively, the ratio of force of contact between the two blocks will be :

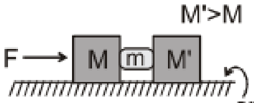


(A) 1 : 1 (B) 1 : 2 (C) 2 : 1 (D) 1 : 3

26. Two forces of 6N and 3N are acting on the two blocks of 2kg and 1kg kept on frictionless floor. What is the force exerted on 2kg block by 1kg block?

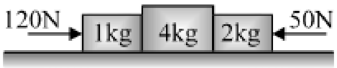
(A) 1N
(B) 2N
(C) 4N
(D) 5N

27. A constant force F is applied in horizontal direction as shown. Contact force between M and m is N and between m and M' is N' then



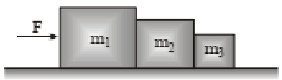
(A) N = N' (B) N > N' (C) N' > N (D) cannot be determined

28. Three blocks of mass 1 kg, 4 kg and 2 kg are placed on a smooth horizontal plane as shown in the figure. The contact force between 1 kg block and 4 kg block is :



(A) 100 N (B) 120 N (C) 50 N (D) 110 N

29. Three blocks of masses m_1, m_2 and m_3 kg are placed in contact with each other on a frictionless table. A force F is applied on the heaviest mass m_1; the acceleration of m_3 will be :

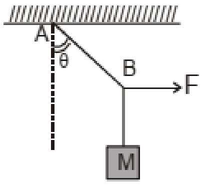


(A) $\frac{F}{m_1}$ (B) $\frac{F}{m_1+m_2}$ (C) $\frac{F}{m_2+m_3}$ (D) $\frac{F}{m_1+m_2+m_3}$

30. A rope of mass 5 kg is moving vertically in vertical position with an upwards force of 100 N acting at the upper end and a downwards force of 70 N acting at the lower end. The tension at midpoint of the rope is

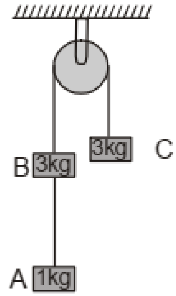
(A) 100 N (B) 85 N (C) 75 N (D) 105 N

31. A mass M is suspended by a rope from a rigid support at A as shown in figure. Another rope is tied at the end B, and it is pulled horizontally with a force F. If the rope AB makes an angle θ with the vertical in equilibrium, then the tension in the string AB is :



(A) F sin θ (B) F/sin θ (C) F cos θ (D) F/cos θ

32. In the system shown in the figure, the acceleration of the 1 kg mass and the tension in the string connecting between A and B is :



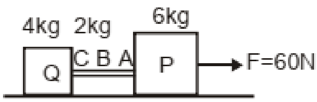
(A) $\frac{g}{4}$ downwards , $\frac{8g}{7}$

(B) $\frac{g}{4}$ upwards, $\frac{g}{7}$

(C) $\frac{g}{7}$ downwards , $\frac{6}{7}g$

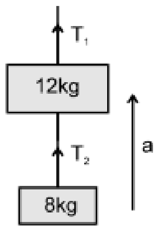
(D) $\frac{g}{2}$ upwards , g

33. Two bodies of mass 6kg and 4 kg are kept on a smooth plane tied with a string of mass 2kg. If a constant force of 60 N is applied on the body of 6 kg then tension in string at point A, B & C respectively will be -



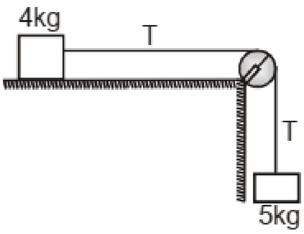
(A) 30N, 25N, 20N (B) 25N, 30N, 20N (C) 20N, 30N, 25N (D) 30N, 20N, 25N

34. A body of mass 8 kg is hanging from another body of mass 12 kg. The combination is being pulled by a string with an acceleration of 2.2 m s^{-2}. The tension T_1 and T_2 will be respectively :(use g = 9.8m/s^2)



(A) 200 N, 80 N
(B) 220 N, 90 N
(C) 240 N, 96 N
(D) 260 N, 96 N

35. Two bodies of 5 kg and 4 kg are tied to a string as shown in the figure. If the table and pulley both are smooth, acceleration of 5 kg body will be equal to-



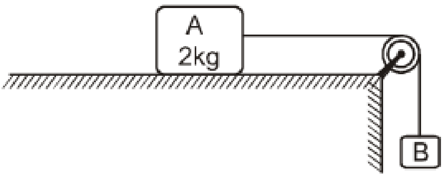
(A) g (B) g/9 (C) 4g/9 (D) 5g/9

36. On the horizontal surface of a truck, a block of mass 1kg is placed (μ = 0.6) and truck is moving with acceleration 5 m/sec^2, then frictional force on block will be -
(1) 5 N (2) 6 N (3) 5.88 N (4) 8 N

37. A 10 kg box is placed on surface. Coefficient of friction between surface and box is $\mu = 0.5$. If horizontal force 100 N is applied acceleration of box will be ($g = 10\ m/sec^2$) -

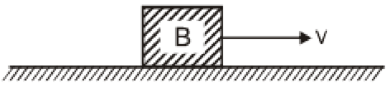
(1) $2.5\ m/s^2$ (2) $5\ m/s^2$ (3) $7.5\ m/s^2$ (4) none

38. The coefficient of static friction, μ_s, between block A of mass 2kg and the table as shown in the figure, is 0.2. What would be the maximum mass value of block B so that the two blocks do not move ? The string and the pulley are assumed to be smooth and massless : ($g = 10\ m/s^2$)



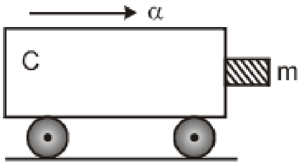
(1) 2.0 kg (2) 4.0 kg (3) 0.2 kg (4) 0.4 kg

39. A block B is pushed momentarily along a horizontal surface with an initial velocity v. If μ is the coefficient of sliding friction between B and the surface, block B will come to rest after a time :



(1) $\frac{v}{g\mu}$ (2) $\frac{g\mu}{v}$ (3) $\frac{g}{v}$ (4) $\frac{v}{g}$

40. A block of mass m is in contact with the cart C as shown in the figure.



The coefficient of static friction between the block and the cart is μ. The acceleration α of the cart that will prevent the block from falling satisfies

(1) $\alpha > \frac{mg}{\mu}$ (2) $\alpha > \frac{g}{\mu m}$ (3) $\alpha \geq \frac{g}{\mu}$ (4) $\alpha < \frac{g}{\mu}$

41. A gramophone record is revolving with an angular velocity ω. A coin is placed at a distance r from the centre of the record. The static coefficient of friction is μ. The coin will revolve with the record if

(1) $r = \mu g \omega^2$ (2) $r = \frac{\omega^2}{\mu g}$ (3) $r \leq \frac{\mu g}{\omega^2}$ (4) $r \geq \frac{\mu g}{\omega^2}$

42. A conveyor belt is moving at a constant speed of 2m/s. A box is gently dropped on it. The coefficient of friction between them is $\mu = 0.5$. The distance that the box will move relative to belt before coming to rest on it taking $g = 10\ ms^{-2}$, is :

(1) 1.2 m (2) 0.6 m (3) zero (4) 0.4 m

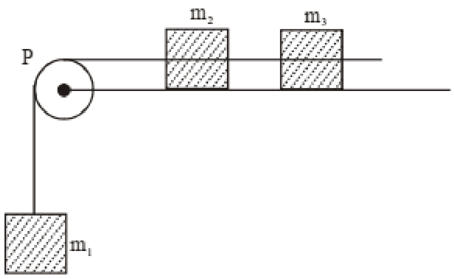
43. A car of mass m is moving on a level circular track of radius R. If μ_s represents the static friction between the road and tyres of the car, the maximum speed of the car in circular motion is given by :

(1) $\sqrt{\mu_s mRg}$ (2) $\sqrt{Rg/\mu_s}$ (3) $\sqrt{mRg/\mu_s}$ (4) $\sqrt{\mu_s Rg}$

44. The upper half of an inclined plane of inclination θ is perfectly smooth while lower half is rough. A block starting from rest at the top of the plane will again come to rest at the top of the plane will again come to rest at the bottom, if the coefficient of friction between the block and lower half of the plane is given by :

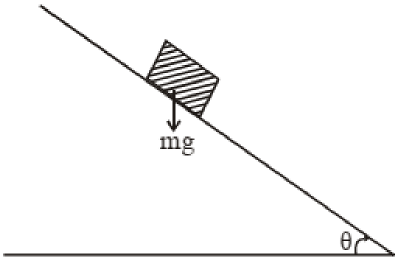
(1) $\mu = \frac{2}{\tan\theta}$ (2) $\mu = 2\tan\theta$ (3) $\mu = \tan\theta$ (4) $\mu = \frac{1}{\tan\theta}$

45. A system consists of three masses m_1, m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (the coefficient of friction = ¼). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is : (Assume $m_1 = m_2 = m_3 = m$)



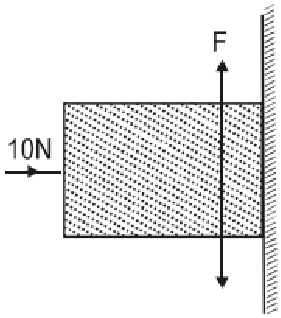
(1) $\frac{g(1-g\mu)}{9}$ (2) $\frac{2g\mu}{3}$ (c) $\frac{g(1-2\mu)}{3}$ (d) $\frac{g(1-2\mu)}{2}$

46. A plank with a box on it at one end is gradually raised about the other end. As the angle of inclination with the horizontal reaches 30º the box starts to slip and slides 4.0 m down the plank in 4.0 s. The coefficients of static and kinetic friction between the box and the plank will be, respectively :



(1) 0.6 & 0.5 (2) 0.5 & 0.6 (3) 0.4 & 0.3 (4) 0.6 & 0.6

47. 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 :



(1) 20 N (2) 50 N (3) 100 N (4) 2 N

48. A marble block of mass 2 kg lying on ice when given a velocity of 6 m/s is stopped by friction in 10s. Then the coefficient of friction is :
(1) 0.02 (2) 0.03 (3) 0.06 (4) 0.01

49. A block rests on a rough inclined plane making an angle of 30º 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 $g = 10\ m/s^2$) :
(1) 2.0 (2) 4.0 (3) 1.6 (4) 2.5

50. A smooth block is released at rest on a 45º 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-

(1) $\mu_s = 1-\frac{1}{n^2}$ (2) $\mu_s = \sqrt{1-\frac{1}{n^2}}$ (3) $\mu_k = 1-\frac{1}{n^2}$ (4) $\mu_k = \sqrt{1-\frac{1}{n^2}}$

ANSWER- KEY

1.	C	2.	B	3.	B	4.	B	5.	A	6.	D	7.	D
8.	C	9.	B	10.	B	11.	B	12.	A	13.	A	14.	A
15.	A	16.	B	17.	C	18.	C	19.	C	20.	D	21.	C
22.	C	23.	C	24.	C	25.	B	26.	C	27.	B	28.	D
29.	D	30.	B	31.	B	32.	C	33.	A	34.	C	35.	D
36.	A	37.	B	38.	D	39.	A	40.	C	41.	C	42.	D
43.	D	44.	B	45.	C	46.	A	47.	D	48.	C	49.	A
50.	C												

36. A

$f_{max} = 0.6 \times 1 \times g = 6N$

$f_{max} > 5$ so $f = 5$ N

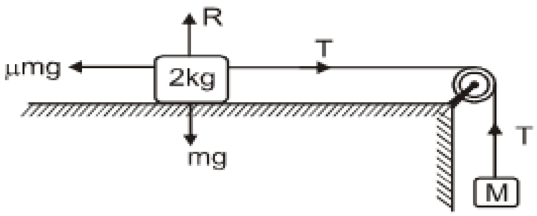
37. B

$$a = \frac{100 - \mu mg}{m}$$

$$a = \frac{100 - \frac{1}{2} \times 10 \times 10}{10} = 5 \text{ m/s}^2$$

38. D

Key Idea : The tension in the string is equal to static frictional force between block A and the surface. Let the mass of the block B is M.



In equilibrium

$T = \ Mg = 0$

$\Rightarrow$ $T = Mg$ ....(i)

If blocks do not move then

$T = f_s$

where f_s = frictional force = $\mu_s R = \mu_s mg$

$\therefore$ $T = \mu_s mg$ ....(ii)

Thus, from Eqs. (i) and (ii), we have

$Mg = \mu_s mg$

or $M = \mu_s m$

Given : $\mu_s = 0.2$, $m = 2$ kg

$\therefore$ $M = 0.2 \times 2 = 0.4$ kg

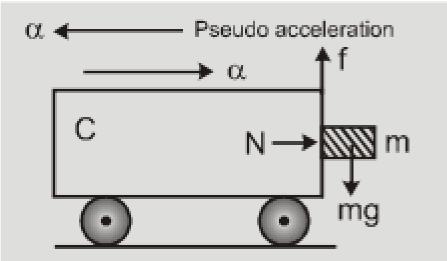
39. A

Block B will come to rest, if force applied to it will vanish due to frictional force acting between block B and surface, i.e, foce applied = frictional force

i.e., $\mu mg = ma$

or $\mu mg = m\left(\frac{v}{t}\right)$ or $t = \frac{v}{\mu g}$

40. C



Pseudo force or fictitious force, $F_{fic} = m\alpha$

Force of friction, $f = \mu N = \mu m\alpha$,

The block of mass m will not fall as long as

$f \geq mg$

$\mu m\alpha \geq mg$

$\alpha \geq \frac{g}{\mu}$

41. C

The coin will revolve with the record, if Force of friction ≥ Centrifugal force

$\mu mg \geq mr\omega^2$

or $\frac{\mu g}{\omega^2} \geq r$

$\mu mg \geq m\omega^2 r$

$\frac{\mu g}{\omega^2} \geq r$

42. D

$a = \mu g = 5$

$v^2 = u^2 + 2as$

$0 = 2^2 + 2 \times (5)s$

$s = -\frac{2}{5}$ w.r.t. belt

or distance = 0.4 m

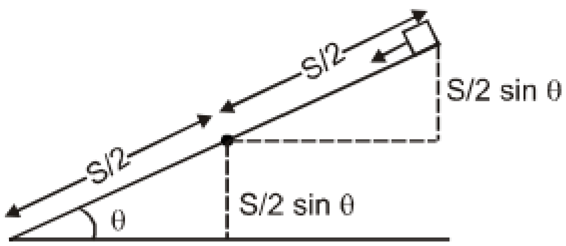
43. D

For smooth driving maximum speed of car v then

$$\frac{mv^2}{R} = \mu_s mg$$

$$v = \sqrt{\mu_s Rg}$$

44. B



$w_{all} = \Delta K = 0$

$$mg\sin\theta\frac{S}{2} + mg\sin\theta\frac{S}{2} - \mu mg\cos\theta\frac{S}{2} = 0$$

$2\sin\theta = \mu\cos\theta$

$\mu = 2\tan\theta$

45. C

46. A

47. D

Force, $F = \mu R = Mg$

weight of block $= \mu R = 0.2 \times 10 = 2N$

48. C

$F = ma$

$\therefore \quad \mu mg = ma$

$\Rightarrow \quad \mu = \frac{a}{g}$

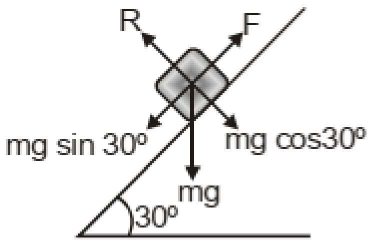
Now, $v = u + at$ or $0 = 6 + 10a$

or $\frac{0.6}{10} = a = -0.6$

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

49. A

Let the mass of block be m.
Frictional force in rest position
F = mg sin 30º



$10 = m \times 10 \times \frac{1}{2}$

$\therefore \quad m = \frac{2 \times 10}{10} = 2$ kg

50. C

When friction is absent

$a_1 = g \sin \theta$

$\therefore \quad s_1 = \frac{1}{2} a_1 t_1^2$ .... (i)

When friction is present

$a_2 = g \sin \theta - \mu g \cos \theta$

$\therefore \quad s_2 = \frac{1}{2} a_2 t_2^2$ .... (ii)

From Eq. (i) and (ii)

$$\frac{1}{2} a_1 t_1^2 = \frac{1}{2} a_2 t_2^2$$

or $\quad a_1 t_1^2 = a_2 (nt_1)^2 \quad (\because t_2 = nt_1)$

or $\quad a_1 = n^2 a_2$

or $\quad \frac{a_2}{a_1} = \frac{g \sin\theta - \mu g \cos\theta}{g \sin\theta} = \frac{1}{n^2}$

or $\quad \frac{g \sin 45^\circ - \mu g \cos 45^\circ}{g \sin 45^\circ} = \frac{1}{n^2}$

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

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