11. A uniform rope of length l lies on a table. If the coefficient of friction is μ, then the maximum length l_1 of the part of this rope which can overhang from the edge of the table without sliding down is **[DPMT 2001]**

(a) $\frac{l}{\mu}$ (b) $\frac{l}{\mu + l}$

(c) $\frac{\mu l}{1+\mu}$ (d) $\frac{\mu l}{\mu - 1}$

12. Which of the following statements is not true **[CMC Vellore 1989]**

(a) The coefficient of friction between two surfaces increases as the surface in contact are made rough

(b) The force of friction acts in a direction opposite to the applied force

(c) Rolling friction is greater than sliding friction

(d) The coefficient of friction between wood and wood is less than 1

13. A block of 1 kg is stopped against a wall by applying a force F perpendicular to the wall. If $\mu = 0.2$ then minimum value of F will be **[MP PMT 2003]**

(a) 980 N (b) 49 N

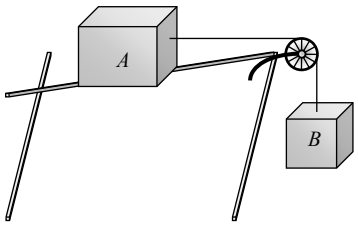
(c) 98 N (d) 490 N

14. A heavy uniform chain lies on a horizontal table-top. If the coefficient of friction between the chain and table surface is 0.25, then the maximum fraction of length of the chain, that can hang over one edge of the table is **[CBSE PMT 1990]**

(a) 20% (b) 25%

(c) 35% (d) 15%

15. The blocks A and B are arranged as shown in the figure. The pulley is frictionless. The mass of A is 10 kg. The coefficient of friction of A with the horizontal surface is 0.20. The minimum mass of B to start the motion will be **[MP PET 1994]**



(a) 2 kg

(b) 0.2 kg

(c) 5 kg

(d) 10 kg

16. Work done by a frictional force is

(a) Negative (b) Positive

(c) Zero (d) All of the above

17. A uniform chain of length L changes partly from a table which is kept in equilibrium by friction. The maximum length that can withstand without slipping is l, then coefficient of friction between the table and the chain is **[EAMCET (Engg.) 1995]**

(a) $\frac{l}{L}$ (b) $\frac{l}{L+l}$

(c) $\frac{l}{L-l}$ (d) $\frac{L}{L+l}$

18. When two surfaces are coated with a lubricant, then they **[AFMC 1998, 99; AIIMS 2001]**

(a) Stick to each other (b) Slide upon each other

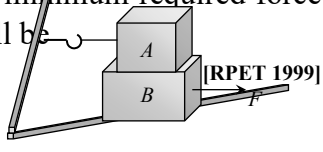
(c) Roll upon each other (d) None of these

19. A 20 kg block is initially at rest on a rough horizontal surface. A horizontal force of 75 N is required to set the block in motion. After it is in motion, a horizontal force of 60 N is required to keep the block moving with constant speed. The coefficient of static friction is **[AMU 1999]**

(a) 0.38 (b) 0.44

(c) 0.52 (d) 0.60

20. A block A with mass 100 kg is resting on another block B of mass 200 kg. As shown in figure a horizontal rope tied to a wall holds it. The coefficient of friction between A and B is 0.2 while coefficient of friction between B and the ground is 0.3. The minimum required force F to start moving B will be **[RPET 1999]**



(a) 900 N

(b) 100 N

(c) 1100 N

(d) 1200 N

21. To avoid slipping while walking on ice, one should take smaller steps because of the

(a) Friction of ice is large

(b) Larger normal reaction

(c) Friction of ice is small

(d) Smaller normal reaction

22. A box is lying on an inclined plane what is the coefficient of static friction if the box starts sliding when an angle of inclination is 60^o **[KCET 2000]**

(a) 1.173 (b) 1.732

(c) 2.732 (d) 1.677

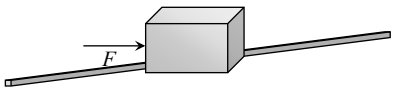
23. A block of mass 2 kg is kept on the floor. The coefficient of static friction is 0.4. If a force F of 2.5 *Newtons* is applied on the block as shown in the figure, the frictional force between the block and the floor will be

(a) 2.5 N

(b) 5 N

(c) 7.84 N

(d) 10 N



24. Which one of the following is not used to reduce friction

[Kerala (Engg.) 2001]

(a) Oil (b) Ball bearings

(c) Sand (d) Graphite

25. If a ladder weighing 250N is placed against a smooth vertical wall having coefficient of friction between it and floor is 0.3, then what is the maximum force of friction available at the point of contact between the ladder and the floor **[AIIMS 2002]**

(a) 75 N (b) 50 N

(c) 35 N (d) 25 N

26. A body of mass 2 kg is kept by pressing to a vertical wall by a force of 100 N. The coefficient of friction between wall and body is 0.3. Then the frictional force is equal to

[Orissa JEE 2003]

(a) 6 N (b) 20 N

(c) 600 N (d) 700 N

27. 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 **[BHU 1999; BCECE 2004]**

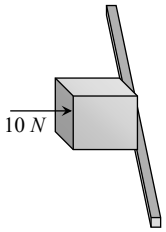
[AIEEE 2003]

(a) 2 N

(b) 20 N

(c) 50 N

(d) 100 N



28. The coefficient of static friction, μ_s, between block A of mass 2 kg 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. $(g = 10\, m/s^2)$

[CBSE PMT 2004]

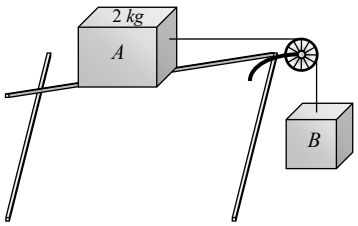
[MP PET 2000]

(a) 2.0 kg

(b) 4.0 kg

(c) 0.2 kg

(d) 0.4 kg



29. If mass of $A = 10\ kg$, coefficient of static friction = 0.2, coefficient of kinetic friction = 0.2. Then mass of B to start motion is

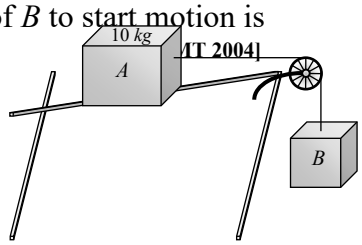
[MT 2004]

(a) 2 kg

(b) 2.2 kg

(c) 4.8 kg

(d) 200 gm



30. A uniform metal chain is placed on a rough table such that one end of chain hangs down over the edge of the table. When one-third of its length hangs over the edge, the chain starts sliding. Then, the coefficient of static friction is

[Kerala PET 2005]

(a) $\frac{3}{4}$ (b) $\frac{1}{4}$

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

31. A lift is moving downwards with an acceleration equal to acceleration due to gravity. A body of mass m kept on the floor of the lift is pulled horizontally. If the coefficient of friction is μ, then the frictional resistance offered by the body is **[DPMT 2004]**

(a) mg (b) μmg

(c) $2\mu mg$ (d) Zero

32. If a ladder weighing 250 N is placed against a smooth vertical wall having coefficient of friction between it and floor is 0.3, then what is the maximum force of friction available at the point of contact between the ladder and the floor **[BHU 2004]**

(a) 75 N (b) 50 N

(c) 35 N (d) 25 N

Kinetic Friction

1. Which one of the following statements is correct

(a) Rolling friction is greater than sliding friction

(b) Rolling friction is less than sliding friction

(c) Rolling friction is equal to sliding friction

(d) Rolling friction and sliding friction are same

2. The maximum speed that can be achieved without skidding by a car on a circular unbanked road of radius R and coefficient of static friction μ, is **[NCERT 1990]**

(a) μRg (b) $Rg\sqrt{\mu}$

(c) $\mu\sqrt{Rg}$ (d) $\sqrt{\mu Rg}$

3. A car is moving along a straight horizontal road with a speed v_0. If the coefficient of friction between the tyres and the road is μ, the shortest distance in which the car can be stopped is **[MP PET 1985; BHU 2002]**

(a) $\frac{v_0^2}{2\mu g}$ (b) $\frac{v_0}{\mu g}$

(c) $\left(\frac{v_0}{\mu g}\right)^2$ (d) $\frac{v_0}{\mu}$

4. A block of mass 5 kg is on a rough horizontal surface and is at rest. Now a force of 24 N is imparted to it with negligible impulse. If the coefficient of kinetic friction is 0.4 and $g = 9.8\ m/s^2$, then the acceleration of the block is

(a) $0.26\ m/s^2$ (b) $0.39\ m/s^2$

(c) $0.69\ m/s^2$ (d) $0.88\ m/s^2$

5. A body of mass 2 kg is being dragged with uniform velocity of 2 m/s on a rough horizontal plane. The coefficient of friction between the body and the surface is 0.20. The amount of heat generated in 5 sec is

($J = 4.2\ joule/cal$ and $g = 9.8\ m/s^2$)

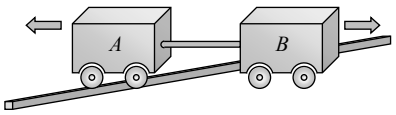
[MH CET (Med.) 2001]

(a) 9.33 cal (b) 10.21 cal

(c) 12.67 cal (d) 13.34 cal

6. Two carts of masses 200 kg and 300 kg on horizontal rails are pushed apart. Suppose the coefficient of friction between the carts and the rails are same. If the 200 kg cart travels a distance of 36 m and stops, then the distance travelled by the cart weighing 300 kg is

[CPMT 1989; DPMT 2002]



(a) 32 m (b) 24 m

(c) 16 m (d) 12 m

7. A body B lies on a smooth horizontal table and another body A is placed on B. The coefficient of friction between A and B is μ. What acceleration given to B will cause slipping to occur between A and B

(a) μg (b) g/μ

(c) μ/g (d) $\sqrt{\mu g}$

8. A 60 kg body is pushed with just enough force to start it moving across a floor and the same force continues to act afterwards. The coefficient of static friction and sliding friction are 0.5 and 0.4 respectively. The acceleration of the body is

(a) $6\ m/s^2$ (b) $4.9\ m/s^2$

(c) $3.92\ m/s^2$ (d) $1\ m/s^2$

9. A car turns a corner on a slippery road at a constant speed of $10\ m/s$. If the coefficient of friction is 0.5, the minimum radius of the arc in meter in which the car turns is

(a) 20 (b) 10

(c) 5 (d) 4

10. A motorcyclist of mass m is to negotiate a curve of radius r with a speed v. The minimum value of the coefficient of friction so that this negotiation may take place safely, is

[Haryana CEE 1996]

(a) v^2rg (b) $\frac{v^2}{gr}$

(c) $\frac{gr}{v^2}$ (d) $\frac{g}{v^2r}$

11. On a rough horizontal surface, a body of mass 2 kg is given a velocity of 10 m/s. If the coefficient of friction is 0.2 and $g = 10\ m/s^2$, the body will stop after covering a distance of

[MP PMT 1999]

(a) 10 m (b) 25 m

(c) 50 m (d) 250 m

12. A block of mass 50 kg can slide on a rough horizontal surface. The coefficient of friction between the block and the surface is 0.6. The least force of pull acting at an angle of 30° to the upward drawn vertical which causes the block to just slide is **[ISM Dhanbad 1994]**

(a) 29.43 N (b) 219.6 N

(c) 21.96 N (d) 294.3 N

13. A body of 10 kg is acted by a force of 129.4 N if $g = 9.8\ m/\sec^2$. The acceleration of the block is $10\ m/s^2$. What is the coefficient of kinetic friction **[EAMCET 1994]**

(a) 0.03 (b) 0.01

(c) 0.30 (d) 0.25

14. Assuming the coefficient of friction between the road and tyres of a car to be 0.5, the maximum speed with which the car can move round a curve of 40.0 m radius without slipping, if the road is unbanked, should be **[AMU 1995]**

(a) 25 m/s (b) 19 m/s

(c) 14 m/s (d) 11 m/s

15. Consider a car moving along a straight horizontal road with a speed of 72 km/h. If the coefficient of kinetic friction between the tyres and the road is 0.5, the shortest distance in which the car can be stopped is $[g = 10\ ms^{-2}]$

[CBSE PMT 1992]

(a) 30 m (b) 40 m

(c) 72 m (d) 20 m

16. A 500 kg horse pulls a cart of mass 1500 kg along a level road with an acceleration of $1\ ms^{-2}$. If the coefficient of sliding friction is 0.2, then the force exerted by the horse in forward direction is **[SCRA 1998]**

(a) 3000 N (b) 4000 N

(c) 5000 N (d) 6000 N

17. The maximum speed of a car on a road turn of radius 30m; if the coefficient of friction between the tyres and the road is 0.4; will be

(a) 9.84 m/s (b) 10.84 m/s

(c) 7.84 m/s (d) 5.84 m/s

18. A block of mass 50 kg slides over a horizontal distance of 1 m. If the coefficient of friction between their surfaces is 0.2, then work done against friction is

[BHU 2001; CBSE PMT 1999, 2000; AIIMS 2000]

(a) 98 J (b) 72J

(c) 56 J (d) 34 J

19. On the horizontal surface of a truck ($\mu = 0.6$), a block of mass 1 kg is placed. If the truck is accelerating at the rate of $5m/sec^2$ then frictional force on the block will be

[CBSE PMT 2001]

(a) 5 N (b) 6 N

(c) 5.88 N (d) 8 N

20. A vehicle of mass m is moving on a rough horizontal road with momentum P. If the coefficient of friction between the tyres and the road be μ, then the stopping distance is

[CBSE PMT 2001]

(a) $\frac{P}{2\mu mg}$ (b) $\frac{P^2}{2\mu mg}$

(c) $\frac{P}{2\mu m^2 g}$ (d) $\frac{P^2}{2\mu m^2 g}$

21. A body of weight 64 N is pushed with just enough force to start it moving across a horizontal floor and the same force continues to act afterwards. If the coefficients of static and dynamic friction are 0.6 and 0.4 respectively, the acceleration of the body will be (Acceleration due to gravity = g)

[EAMCET 2001]

(a) $\frac{g}{6.4}$ (b) 0.64 g

(c) $\frac{g}{32}$ (d) 0.2 g

22. When a body is moving on a surface, the force of friction is called **[MP PET 2002]**

(a) Static friction (b) Dynamic friction

(c) Limiting friction (d) Rolling friction

23. A block of mass 10 kg is placed on a rough horizontal surface having coefficient of friction $\mu = 0.5$. If a horizontal force of 100 N is acting on it, then acceleration of the block will be

(a) 0.5 m/s^2 (b) 5 m/s^2

(c) 10 m/s^2 (d) 15 m/s^2

24. It is easier to roll a barrel than pull it along the road. This statement is **[BVP 2003]**

(a) False (b) True

(c) Uncertain (d) Not possible

25. 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

(a) 0.01 (b) 0.02

(c) 0.03 (d) 0.06

26. A horizontal force of 129.4 N is applied on a 10 kg block which rests on a horizontal surface. If the coefficient of friction is 0.3, the acceleration should be

(a) $9.8\ m/s^2$ (b) $10\ m/s^2$

(c) $12.6\ m/s^2$ (d) $19.6\ m/s^2$

27. A 60 kg weight is dragged on a horizontal surface by a rope upto 2 *metres*. If coefficient of friction is $\mu = 0.5$, the angle of rope with the surface is 60° and $g = 9.8\ m/\sec^2$, then work done is **[MP PET 1995]**

(a) 294 *joules* (b) 315 *joules*

(c) 588 *joules* (d) 197 *joules*

28. A car having a mass of 1000 kg is moving at a speed of 30 *metres*/*sec*. Brakes are applied to bring the car to rest. If the frictional force between the tyres and the road surface is 5000 *newtons*, the car will come to rest in **[MP PMT 1995]**

(a) 5 *seconds* (b) 10 *seconds*

(c) 12 *seconds* (d) 6 *seconds*

29. If μ_s, μ_k and μ_r are coefficients of static friction, sliding friction and rolling friction, then **[EAMCET (Engg.) 1995]**

(a) $\mu_s < \mu_k < \mu_r$ (b) $\mu_k < \mu_r < \mu_s$

(c) $\mu_r < \mu_k < \mu_s$ (d) $\mu_r = \mu_k = \mu_s$

30. A body of mass 5kg rests on a rough horizontal surface of coefficient of friction 0.2. The body is pulled through a distance of 10m by a horizontal force of 25 N. The kinetic energy acquired by it is (g = 10 ms^2) **[AIIMS 2002]**

[EAMCET (Med.) 2000]

(a) 330 J (b) 150 J

(c) 100 J (d) 50 J

31. A motorcycle is travelling on a curved track of radius 500m. If the coefficient of friction between road and tyres is 0.5, the speed avoiding skidding will be **[MH CET (Med.) 2001]**

(a) 50 m/s **[AMIEE 2003]** (b) 75 m/s

(c) 25 m/s (d) 35 m/s

32. A fireman of mass 60 kg slides down a pole. He is pressing the pole with a force of 600 N. The coefficient of friction between the hands and the pole is 0.5, with what acceleration will the fireman slide down (g = 10 m/s^2) **[Pb. PMT 2002]**

(a) 1 m/s^2 (b) 2.5 m/s^2

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

33. A block of mass $M = 5\,kg$ is resting on a rough horizontal surface for which the coefficient of

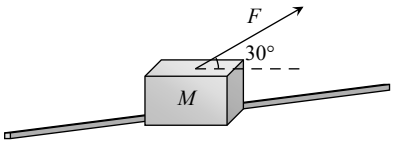
friction is 0.2. When a force $F = 40\ N$ is applied, the acceleration of the block will be $(g = 10\ m/s^2)$ **[MP PMT 2004]**

(a) $5.73\ m/\sec^2$

(b) $8.0\ m/\sec^2$

(c) $3.17\ m/\sec^2$

(d) $10.0\ m/\sec^2$



34. A body is moving along a rough horizontal surface with an initial velocity $6\ m/s$. If the body comes to rest after travelling 9 m, then the coefficient of sliding friction will be **[BCECE 2004]**

(a) 0.4 (b) 0.2

(c) 0.6 (d) 0.8

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

(a) 100 m (b) 400 m

(c) 800 m (d) 1000 m

36. A cylinder of 10 *kg* is sliding in a plane with an initial velocity of 10 *m/s*. If the coefficient of friction between the surface and cylinder is 0.5 then before stopping, it will cover. $(g = 10\ m/s^2)$

(a) 2.5 m (b) 5 m

(c) 7.5 m (d) 10 m

Motion on Inclined Surface

1. When a body is lying on a rough inclined plane and does not move, the force of friction

(a) is equal to μR (b) is less than μR

(c) is greater than μR (d) is equal to R

2. When a body is placed on a rough plane inclined at an angle θ to the horizontal, its acceleration is

(a) $g(\sin\theta - \cos\theta)$ (b) $g(\sin\theta - \mu\cos\theta)$

(c) $g(\mu\sin\theta 1 - \cos\theta)$ (d) $g\mu(\sin\theta - \cos\theta)$

3. A block is at rest on an inclined plane making an angle α with the horizontal. As the angle α of the incline is increased, the block starts slipping when the angle of inclination becomes θ. The coefficient of static friction between the block and the surface of the inclined plane is or

A body starts sliding down at an angle θ to horizontal. Then coefficient of friction is equal to **[CBSE PMT 1993]**

(a) $\sin\theta$ (b) $\cos\theta$

(c) $\tan\theta$ (d) Independent of θ

4. A given object takes n times as much time to slide down a 45° rough incline as it takes to slide down a perfectly smooth 45° incline. The coefficient of kinetic friction between the object and the incline is given by **[RPET 1999; AMU 2000]**

(a) $\left(1 - \frac{1}{n^2}\right)$ (b) $\frac{1}{1 - n^2}$

(c) $\sqrt{\left(1 - \frac{1}{n^2}\right)}$ (d) $\sqrt{\frac{1}{1 - n^2}}$

5. The force required just to move a body up an inclined plane is double the force required just to prevent the body sliding down. If the coefficient of friction is 0.25, the angle of inclination of the plane is

(a) 36.8° **[PB PMT 2004]** (b) 45°

(c) 30° (d) 42.6°

6. Starting from rest, a body slides down a 45° inclined plane in twice the time it takes to slide down the same distance in the absence of friction. The coefficient of friction between the body and the inclined plane is **[CBSE PMT 1990]**

(a) 0.33 (b) 0.25

(c) 0.75 (d) 0.80

7. The coefficient of friction between a body and the surface of an inclined plane at 45° is 0.5. If $g = 9.8\ m/s^2$, the acceleration of the body downwards in m/s^2 is **[EAMCET 1994]**

(a) $\frac{4.9}{\sqrt{2}}$ (b) $4.9\sqrt{2}$

(c) $19.6\sqrt{2}$ (d) 4.9

8. A box is placed on an inclined plane and has to be pushed down. The angle of inclination is **[EAMCET 1994]**

(a) Equal to angle of friction

(b) More than angle of friction

(c) Equal to angle of repose

(d) Less than angle of repose

9. A force of 750 N is applied to a block of mass 102 kg to prevent it from sliding on a plane with an inclination angle 30° with the horizontal. If the coefficients of static friction and kinetic friction between the block and the plane are 0.4 and 0.3 respectively, then the frictional force acting on the block is **[SCRA 1994]**

(a) 750 N (b) 500 N

(c) 345 N (d) 250 N

10. A block is lying on an inclined plane which makes 60° with the horizontal. If coefficient of friction between block and plane is 0.25 and $g = 10\ m/s^2$, then acceleration of the block when it moves along the plane will be **[RPET 1997]**

(a) $2.50\ m/s^2$ (b) $5.00\ m/s^2$

(c) $7.4\ m/s^2$ (d) $8.66\ m/s^2$

11. A body of mass 100 g is sliding from an inclined plane of inclination 30°. What is the frictional force experienced if $\mu = 1.7$ **[BHU 1998]**

(a) $1.7 \times \sqrt{2} \times \frac{1}{\sqrt{3}}\ N$ (b) $1.7 \times \sqrt{3} \times \frac{1}{2}\ N$

(c) $1.7 \times \sqrt{3}\ N$ (d) $1.7 \times \sqrt{2} \times \frac{1}{3}\ N$

12. A body takes just twice the time as long to slide down a plane inclined at 30° to the horizontal as if the plane were frictionless. The coefficient of friction between the body and the plane is

(a) $\frac{\sqrt{3}}{4}$ (b) $\sqrt{3}$

(c) $\frac{4}{3}$ (d) $\frac{3}{4}$

13. A brick of mass 2 kg begins to slide down on a plane inclined at an angle of 45° with the horizontal. The force of friction will be

(a) 19.6 sin 45° (b) 19.6 cos 45°

(c) 9.8 sin 45° (d) 9.8 cos 45°

14. The upper half of an inclined plane of inclination θ is perfectly smooth while the lower half is rough. A body starting from the rest at top comes back to rest at the bottom if the coefficient of friction for the lower half is given by **[Pb. PMT 2000]**

(a) $\mu = \sin\theta$ (b) $\mu = \cot\theta$

(c) $\mu = 2\cos\theta$ (d) $\mu = 2\tan\theta$

15. A body is sliding down an inclined plane having coefficient of friction 0.5. If the normal reaction is twice that of the resultant downward force along the incline, the angle between the inclined plane and the horizontal is **[EAMCET (Engg.) 2000]**

(a) 15° (b) 30°

(c) 45° (d) 60°

16. A body of mass 10 kg is lying on a rough plane inclined at an angle of 30° to the horizontal and the coefficient of friction is 0.5. the minimum force required to pull the body up the plane is

(a) 914 N (b) 91.4 N

(c) 9.14 N (d) 0.914 N

17. A block of mass 1 kg slides down on a rough inclined plane of inclination 60° starting from its top. If the coefficient of kinetic friction is 0.5 and length of the plane is 1 m, then work done against friction is (Take $g = 9.8\ m/s^2$) **[AFMC 2000; KCET 2001]**

(a) 9.82 J (b) 4.94 J

(c) 2.45J (d) 1.96 J

18. A block of mass 10 kg is placed on an inclined plane. When the angle of inclination is 30°, the block just begins to slide down the plane. The force of static friction is **[JIPMER 1999]** **[Kerala (Engg.) 2001]**

(a) 10 $kg\ wt$ (b) 89 $kg\ w$

(c) 49 $kg\ wt$ (d) 5 $kg\ wt$

19. A body of 5 kg weight kept on a rough inclined plane of angle 30° starts sliding with a constant velocity. Then the coefficient of friction is (assume $g = 10\ m/s^2$) **[JIPMER 2002]**

[CPMT 2000]

(a) $1/\sqrt{3}$ (b) $2/\sqrt{3}$

(c) $\sqrt{3}$ (d) $2\sqrt{3}$

20. 300 *Joule* of work is done in sliding up a 2 *kg* block on an inclined plane to a height of 10 *metres*. Taking value of acceleration due to gravity '*g*' to be 10 m/s^2, work done against friction is **[MP PMT 2002]**

(a) 100 *J* (b) 200 *J*

(c) 300 *J* (d) Zero

21. A 2 *kg* mass starts from rest on an inclined smooth surface with inclination 30° and length 2 *m*. How much will it travel before coming to rest on a frictional surface with frictional coefficient of 0.25 **[UPSEAT 2003]**

(a) 4 *m* (b) 6 *m*

(c) 8 *m* (d) 2 *m*

22. A block rests on a rough inclined plane making an angle of 30^o 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 $g = 10\ m/s^2$) **[AIEEE 2004]**

(a) 2.0 (b) 4.0

(c) 1.6 (d) 2.5

23. A body takes time *t* to reach the bottom of an inclined plane of angle θ with the horizontal. If the plane is made rough, time taken now is 2*t*. The coefficient of friction of the rough surface is

(a) $\frac{3}{4}\tan\theta$ (b) $\frac{2}{3}\tan\theta$

(c) $\frac{1}{4}\tan\theta$ (d) $\frac{1}{2}\tan\theta$

24. A block is kept on an inclined plane of inclination θ of length *l*. The velocity of particle at the bottom of inclined is (the coefficient of friction is μ)

(a) $\sqrt{2gl(\mu\cos\theta - \sin\theta)}$ (b) $\sqrt{2gl(\sin\theta - \mu\cos\theta)}$

(c) $\sqrt{2gl(\sin\theta + \mu\cos\theta)}$ (d) $\sqrt{2gl(\cos\theta + \mu\sin\theta)}$

Critical Thinking

Objective Questions

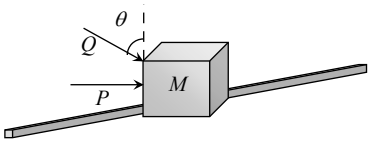
1. A block of mass *m* lying on a rough horizontal plane is acted upon by a horizontal force *P* and another force *Q* inclined at an angle θ to the vertical. The block will remain in equilibrium, if the coefficient of friction between it and the surface is **[Haryana CEE 1996]**

(a) $\frac{(P + Q\sin\theta)}{(mg + Q\cos\theta)}$

(b) $\frac{(P\cos\theta + Q)}{(mg - Q\sin\theta)}$

(c) $\frac{(P + Q\cos\theta)}{(mg + Q\sin\theta)}$

(d) $\frac{(P\sin\theta - Q)}{(mg - Q\cos\theta)}$



2. Which of the following is correct, when a person walks on a rough surface **[IIT 1981]**

(a) The frictional force exerted by the surface keeps him moving

(b) The force which the man exerts on the floor keeps him moving

(c) The reaction of the force which the man exerts on floor keeps him moving

(d) None of the above

3. A block of mass 0.1 *kg* is held against a wall by applying a horizontal force of 5 *N* on the block. If the coefficient of friction between the block and the wall is 0.5, the magnitude of the frictional force acting on the block is **[IIT 1994]**

(a) 2.5 *N* (b) 0.98 *N*

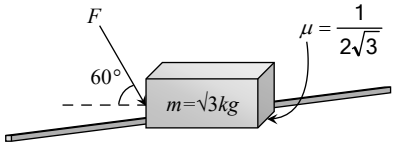
(c) 4.9 *N* (d) 0.49 *N*

4. A body of mass *M* is kept on a rough horizontal surface (friction coefficient μ). A person is trying to pull the body by applying a horizontal force but the body is not moving. The force by the surface on the body is *F*, where **[MP PET 1997]**

(a) $F = Mg$ (b) $F = \mu Mgf$

(c) $Mg \le F \le Mg\sqrt{1+\mu^2}$ (d) $Mg \ge F \ge Mg\sqrt{1+\mu^2}$

5. What is the maximum value of the force *F* such that the block shown in the arrangement, does not move **[IIT-JEE Screening 2003]**

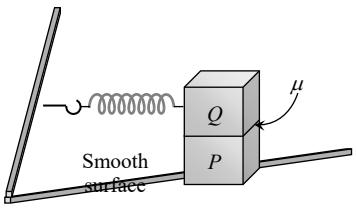


(a) 20 N (b) 10 N

(c) 12 N (d) 15 N

6. A block P of mass m is placed on a frictionless horizontal surface. Another block Q of same mass is kept on P and connected to the wall with the help of a spring of spring constant k as shown in the figure. μ_s is the coefficient of friction between P and Q. The blocks move together performing *SHM* of amplitude A. The maximum value of the friction force between P and Q is

[IIT-JEE (Screening) 2004]



(a) kA

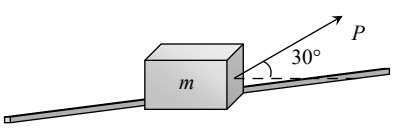
(b) $\frac{kA}{2}$

(c) Zero

(d) $\mu_s mg$

7. A body of mass m rests on horizontal surface. The coefficient of friction between the body and the surface is μ. If the mass is pulled by a force P as shown in the figure, the limiting friction between body and surface will be

[BHU 2004]



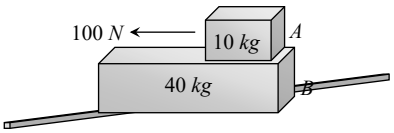
(a) μmg

(b) $\mu\left[mg+\left(\frac{P}{2}\right)\right]$

(c) $\mu\left[mg-\left(\frac{P}{2}\right)\right]$

(d) $\mu\left[mg-\left(\frac{\sqrt{3}P}{2}\right)\right]$

8. A 40 kg slab rests on a frictionless floor as shown in the figure. A 10 kg block rests on the top of the slab. The static coefficient of friction between the block and slab is 0.60 while the kinetic friction is 0.40. The 10 kg block is acted upon by a horizontal force 100 N. If $g = 9.8\ m/s^2$, the resulting acceleration of the slab will be **[NCERT 1982]**



(a) $0.98\ m/s^2$

(b) $1.47\ m/s^2$

(c) $1.52\ m/s^2$

(d) $6.1\ m/s^2$

9. A block of mass 2 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 **[IIT 1980; J & K CET 2004]**

(a) 9.8 N

(b) $0.7\times9.8\times\sqrt{3}\ N$

(c) $9.8\times\sqrt{3}\ N$

(d) $0.8\times9.8\ N$

10. When a bicycle is in motion, the force of friction exerted by the ground on the two wheels is such that it acts

[IIT 1990; Manipal MEE 1995; MP PET 1996]

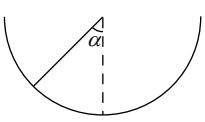
(a) In the backward direction on the front wheel and in the forward direction on the rear wheel

(b) In the forward direction on the front wheel and in the backward direction on the rear wheel

(c) In the backward direction on both front and the rear wheels

(d) In the forward direction on both front and the rear wheels

11. An insect crawls up a hemispherical surface very slowly (see the figure). The coefficient of friction between the insect and the surface is 1/3. If the line joining the centre of the hemispherical surface to the insect makes an angle α with the vertical, the maximum possible value of α is given by **[IIT-JEE 2001]**



(a) $\cot\alpha = 3$

(b) $\tan\alpha = 3$

(c) $\sec\alpha = 3$

(d) $\operatorname{cosec}\alpha = 3$

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. Assertion : On a rainy day, it is difficult to drive a car or bus at high speed.
Reason : The value of coefficient of friction is lowered due to wetting of the surface.

2. Assertion : When a bicycle is in motion, the force of friction exerted by the ground on the two wheels is always in forward direction.
Reason : The frictional force acts only when the bodies are in contact.

3. Assertion : Pulling a lawn roller is easier than pushing it.
Reason : Pushing increases the apparent weight and hence the force of friction.

4. Assertion : Angle of repose is equal to angle of limiting friction.
Reason : When the body is just at the point of motion, the force of friction in this stage is called as limiting friction.

5. Assertion : Two bodies of masses M and m ($M > m$) are allowed to fall from the same height if the air resistance for each be the same then both the bodies will reach the earth simultaneously.
Reason : For same air resistance, acceleration of both the bodies will be same.

6. Assertion : Friction is a self adjusting force.
Reason : Friction does not depend upon mass of the body.

7. Assertion : The value of dynamic friction is less than the limiting friction.
Reason : Once the motion has started, the inertia of rest has been overcome.

8. Assertion : The acceleration of a body down a rough inclined plane is greater than the acceleration due to gravity.
Reason : The body is able to slide on a inclined plane only when its acceleration is greater than acceleration due to gravity.

Answers

Static and Limiting Friction

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

Kinetic Friction

1	b	2	d	3	a	4	d	5	a
6	c	7	a	8	d	9	a	10	b
11	b	12	d	13	c	14	c	15	b
16	d	17	b	18	a	19	a	20	d
21	d	22	b	23	b	24	b	25	d
26	b	27	b	28	d	29	c	30	b
31	a	32	d	33	a	34	b	35	d
36	d								

Motion on Inclined Surface

1	b	2	b	3	c	4	a	5	a
6	c	7	a	8	d	9	d	10	c

11	b	12	a	13	a	14	d	15	c
16	b	17	c	18	d	19	a	20	a
21	a	22	a	23	a	24	b		

Critical Thinking Questions

1	a	2	c	3	b	4	c	5	a
6	b	7	c	8	a	9	a	10	ac
11	a								

Assertion & Reason

1	a	2	e	3	a	4	b	5	d
6	d	7	a	8	d				