5. Friction – Multiple Choice Questions

1. Static and Limiting Friction

1. 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

(a) 20% (b) 25%

(c) 35% (d) 15%

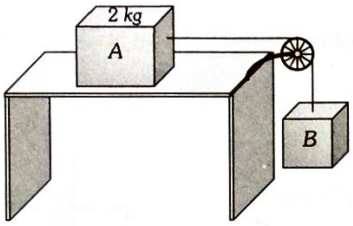
2. The coefficient of static friction, μ_s, between block A of mass 2 kg and the table as shown in the figure is 0.2. What would be the maximum mass value of block B so that the two blocks do not move? The string and the pulley are assumed to be smooth and massless. $(g = 10 m/s^2)$

(a) 2.0 kg

(b) 4.0 kg

(c) 0.2 kg

(d) 0.4 kg



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

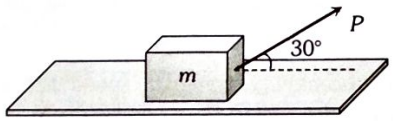
(a) Friction of ice is large

(b) Larger normal reaction

(c) Friction of ice is small

(d) Smaller normal reaction

4. 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



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

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

5. 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

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

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

6. 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

(a) 0.38 (b) 0.44

(c) 0.52 (d) 0.60

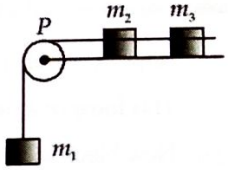
7. A system consists of three masses m_1, m_2 and m_3 connected by a string passing over a pulley P. The mass m_1 hangs freely and m_2 and m_3 are on a rough horizontal table (the coefficient of friction = μ). The pulley is frictionless and of negligible mass. The downward acceleration of mass m_1 is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

(a) $g(1-2\mu)/3$

(b) $g(1-2\mu)/2$

(c) $g(1-g\mu)/9$

(d) $2g\mu/3$



2. Kinetic Friction

1. 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

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

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

2. A conveyor belt is moving at a constant speed of 2 m/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

(a) Zero (b) 0.4 m

(c) 1.2 m (d) 0.6 m

3. 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 $[g = 10 ms^{-2}]$

(a) 30 m (b) 40 m

(c) 72 m (d) 20 m

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

(a) 5 N (b) 6 N

(c) 5.88 N (d) 8 N

5. 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

(a) $r \geq \frac{\mu g}{\omega^2}$ (b) $r = \mu g \omega^2$

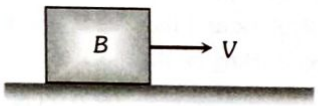
(c) $r < \frac{\omega^2}{\mu g}$ (d) $r \leq \frac{\mu g}{\omega^2}$

6. A body moves along a circular path of radius $10m$ and the coefficient of friction is 0.5. What should be its angular speed in rad/s if it is not to slip from the surface ($g=9.8\ ms^2$)

(a) 5 (b) 10

(c) 0.1 (d) 0.7

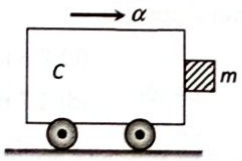
7. A block B is pushed momentarily along a horizontal surface with an initial velocity V. If μ is the coefficient of sliding friction between B and the surface, block B will come to rest after a time



(a) $V/(g\mu)$ (b) $g\mu/V$

(c) g/V (d) V/g

8. 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

(a) $\alpha < \frac{g}{\mu}$ (b) $\alpha > \frac{mg}{\mu}$

(c) $\alpha > \frac{g}{\mu m}$ (d) $\alpha \geq \frac{g}{\mu}$

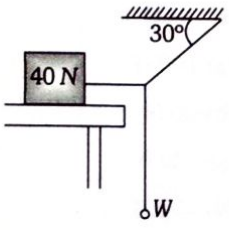
9. In the figure given, the system is in equilibrium. What is the maximum value that W can have if the friction force on the $40\,N$ block cannot exceed $12.0\,N$

(a) $3.45\,N$

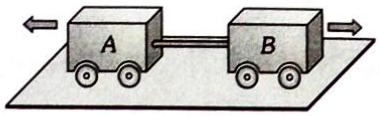
(b) $6.92\,N$

(c) $10.35\,N$

(d) $12.32\,N$



10. 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



(a) 32 m (b) 24 m

(c) 16 m (d) 12 m

11. 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

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

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

12. 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)

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

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

13. The backside of a truck is open and a box of 40kg is placed 5m away from the rear end. The coefficient of friction of the box with the surface of the truck is 0.15. The truck starts from rest with $2m/s^2$ acceleration. Calculate the distance covered by the truck when the box falls off

(a) 20 m (b) 30 m

(c) 40 m (d) 50 m

3. Motion on Inclined Surface

1. 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

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

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

2. An ice cube is kept on an inclined plane of angle 30°. Coefficient of kinetic friction between block and incline plane is $1/\sqrt{3}$. What is acceleration of block

(a) Zero (b) 2 m/s^2

(c) 1.5 m/s^2 (d) 5 m/s^2

3. A body of mass 100 g is sliding from an inclined plane of inclination 30°. What is the frictional force experienced if $\mu = 1.7$

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

4. 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

(a) 0.33 (b) 0.25

(c) 0.75 (d) 0.80

5. 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

(a) 15° (b) 30°

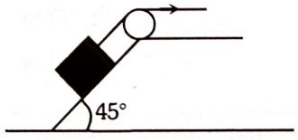
(c) 45° (d) 60°

6. 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

(a) 4 m (b) 6 m

(c) 8 m (d) 2 m

7. A block of mass 200kg is being pulled up by men on an inclined plane at angle of 45° as shown. The coefficient of static friction is 0.5. Each man can only apply a maximum force of 500N. Calculate the number of men required for the block to just start moving up the plane



(a) 10 (b) 15

(c) 5 (d) 3

4. IIT-JEE/AIEEE

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

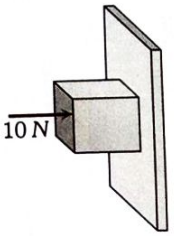
(a) The frictional force exerted by the surface keeps him moving

(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

2. 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]**



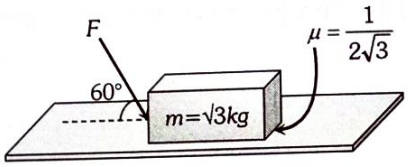
(a) 2 N

(b) 20 N

(c) 50 N

(d) 100 N

3. What is the maximum value of the force F such that the block shown in the arrangement, does not move? **[2003]**



(a) 20 N (b) 10 N

(c) 12 N (d) 15 N

4. 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 **[1994]**

(a) 2.5 N (b) 0.98 N

(c) 4.9 N (d) 0.49 N

5. 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) 1/6 m (b) 2/3 m

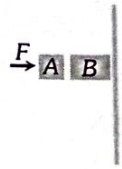
(c) 1/3 m (d) 1/2 m

6. 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 **[1980]**

(a) 9.8 N (b) $0.7\times9.8\times\sqrt{3}\,N$

(c) $9.8\times\sqrt{3}\,N$ (d) $0.8\times9.8\,N$

7. Given in the figure are two blocks A and B of weight 20N and 100N, 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) 100 N

(b) 80 N

(c) 120 N

(d) 150 N

8. 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 **[2003]**

(a) 0.01 (b) 0.02

(c) 0.03 (d) 0.06

9. 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) 100 *m* (b) 400 *m*

(c) 800 *m* (d) 1000 *m*

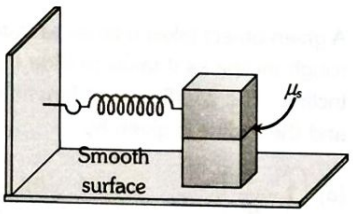
10. A block *P* of mass *m* is placed on a frictionless horizontal surface. Another block *Q* of same mass is kept on *P* and connected to the wall with the help of a spring of spring constant *k* as shown in the figure. μ_s is the coefficient of friction between *P* and *Q*. The blocks move together performing *SHM* of amplitude *A*. The maximum value of the friction force between *P* and *Q* is **[2004]**

(a) kA

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

(c) Zero

(d) $\mu_s mg$



11. 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 $g=10\ m/s^2$) **[2004]**

(a) 2.0 (b) 4.0

(c) 1.6 (d) 2.5

12. A point particle of mass *m*, moves along the uniformly rough track *PQR* as shown in the figure. The coefficient of friction, between the particle and the rough track equals μ. The particle is released, from rest, from the point *P* and it comes to rest at a point *R*. The energies, lost by the ball, over the parts, *PQ* and *QR*, of the track, are equal to each other and no energy is lost when particle changes direction from *PQ* to *QR*

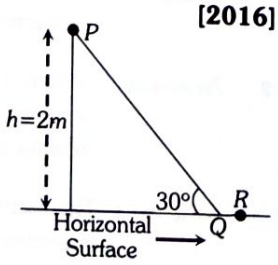
The values of the coefficient of friction μ and the distance $x(=QR)$, are respectively close to **[2016]**

(a) 0.2 and 3.5 *m*

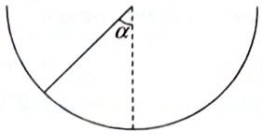
(b) 0.29 and 3.5 *m*

(c) 0.29 and 6.5 *m*

(d) 0.2 and 6.5 *m*



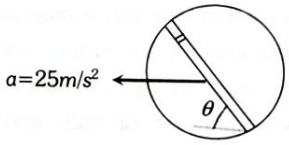
13. An insect crawls up a hemispherical surface very slowly (see the figure). The coefficient of friction between the insect and the surface is 1/3. If the line joining the centre of the hemispherical surface to the insect makes an angle α with the vertical, the maximum possible value of α is given by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



(a) $\cot\alpha=3$ (b) $\tan\alpha=3$

(c) $\sec\alpha=3$ (d) $\text{cosec}\,\alpha=3$

14. A circular disc with a groove along its diameter is placed horizontally. A block of mass 1*kg* is placed as shown. The co-efficient of friction between the block and all surfaces of groove in contact is $\mu=2/5$. The disc has an acceleration of 25 m/s^2. Find the acceleration of the block with respect to disc **[2006]**



$\cos\theta=4/5$ $\sin\theta=3/5$

(a) 10 m/s^2 (b) 5 m/s^2

(c) 20 m/s^2 (d) 1 m/s^2

15. A block of base $10\,cm\times10cm$ and height 15 *cm* is kept on an inclined plane. The coefficient of friction between them is $\sqrt{3}$. The inclination θ of this inclined plane from the horizontal plane is gradually increased from 0°. Then **[2009]**

(a) At $\theta=30°$, the block will start sliding down the plane

(b) The block will remain at rest on the plane up to certain θ and then it will topple

(c) At $\theta=60°$, the block will start sliding down the plane and continue to do so at higher angles

(d) At $\theta=60°$, the block will start sliding down the plane and on further increasing θ, it will topple at certain θ

5. NEET/AIPMT

1. Which one of the following statements is incorrect? **[2018]**

(a) Rolling friction is smaller than sliding friction

(b) Limiting value of static friction is directly proportional to normal reactions

(c) Frictional force opposes the relative motion

(d) Coefficient of sliding friction has dimensions of length

2. A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pulley at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and the table is μ_k. When the block A is sliding on the table, the tension in the string is **[2015]**

(a) $\frac{(m_2 - \mu k m_1)g}{(m_1 + m_2)}$ (b) $\frac{m_1 m_2(1+\mu_k)g}{(m_1+m_2)}$

(c) $\frac{m_1 m_2(1-\mu_k)g}{(m_1+m_2)}$ (d) $\frac{(m_2+\mu_k m_1)g}{(m_1+m_2)}$

3. 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 **[2013]**

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

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

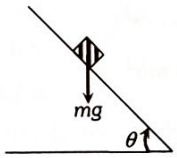
4. A plank with a box on it at one end is gradually raised about the other end. As the angle of inclination with the horizontal reaches 30° the box starts to slip and slides 4.0m down the plank in 4.0s. The coefficients of static and kinetic friction between the box and the plank will be, respectively **[2015]**

(a) 0.6 and 0.5

(b) 0.5 and 0.6

(c) 0.4 and 0.3

(d) 0.6 and 0.6



5. A block A of mass m_1 rests on a horizontal table. A light string connected to it passes over a frictionless pulley at the edge of table and from its other end another block B of mass m_2 is suspended. The coefficient of kinetic friction between the block and the table is μ_k. When the block A is sliding on the table, the tension in the string is **[2015]**

(a) $\frac{(m_2 - \mu k m_1)g}{(m_1 + m_2)}$ (b) $\frac{m_1 m_2(1+\mu_k)g}{(m_1+m_2)}$

(c) $\frac{m_1 m_2(1-\mu_k)g}{(m_1+m_2)}$ (d) $\frac{(m_2+\mu_k m_1)g}{(m_1+m_2)}$

6. A car is negotiating a curved road of radius R. The road is banked at an angle θ. The coefficient of friction between the tyres of the car and the road is μ_s. The maximum safe velocity on this road is **[2016]**

(a) $\sqrt{gR^2\frac{(\mu_s+\tan\theta)}{1-\mu_s\tan\theta}}$ (b) $\sqrt{gR\frac{(\mu_s+\tan\theta)}{1-\mu_s\tan\theta}}$

(c) $\sqrt{\frac{g}{R}\frac{(\mu_s+\tan\theta)}{1-\mu_s\tan\theta}}$ (d) $\sqrt{\frac{g}{R^2}\frac{(\mu_s+\tan\theta)}{1-\mu_s\tan\theta}}$

6. AIIMS

1. When two surfaces are coated with a lubricant, then they **[2001]**

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

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

2. 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 **[2002]**

(a) 75 N (b) 50 N

(c) 35 N (d) 25 N

3. 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 **[2002]**

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

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

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 **[2008]**

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

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

7. Assertion and Reason

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 : 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.

4. 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.

5. 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.

6. 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 an inclined plane only when its acceleration is greater than acceleration due to gravity.

7. Assertion : Use of ball bearings between two moving parts of machine is a common practice.

Reason : Ball bearings reduce vibrations and provide good stability.

5. Friction – Answers Keys

1. Static and Limiting Friction

1	a	2	d	3	c	4	c	5	d
6	a	7	a						

2. Kinetic Friction

1	a	2	b	3	b	4	a	5	d
6	b	7	a	8	d	9	b	10	c
11	d	12	d	13	a				

3. Motion on Inclined Surface

1	a	2	a	3	b	4	c	5	c
6	a	7	c						

4. IIT-JEE/AIEEE

1	c	2	a	3	a	4	b	5	a
6	a	7	c	8	d	9	d	10	b
11	a	12	b	13	a	14	a	15	b

5. NEET/AIPMT

1	d	2	b	3	d	4	a	5	b
6	b								

6. AIIMS

1	b	2	a	3	b	4	a

7. Assertion and Reason

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