PHYSICS

BOOKS - CHHAYA PHYSICS (BENGALI ENGLISH)

FRICTION

Numerical Examples

1. To set a body mass 5 kg in motion over a horizontal surface a minimum force of 30 N

has to be applied. What is the value of the coefficient of friction?

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2. An iron block of mass 10 kg is kept on a horizontal floor. The block is pulled by a rope at an angle 30° with the floor. What should be the minimum force necessary to set the block in motion. Given μ = 0.5

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3. A body moving on the surface of the earth at 14 $\mathrm{m.s}^{-1}$ comes to rest due to friction after covering 50 m. Find the coefficient of friction between the body and the earth's surface. Given, acceleration due to gravity = 9.8 $\mathrm{m.s}^{-2}$.

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4. A man holds a book vertically between his two palms so that it does not fall. The mass of book is 1 kg and the force exerted by each

palm is $2.5kg \times g$. Find the coefficient of friction between the book and the palm.

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5. A block of mass 0.1 kg is kept pressed onto a wall by applying a horizontal force of 5 N. If the coefficient of friction between the block and the wall is 0.5, find the force of friction on the block.

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6. Part of a uniform chain of length L is hanging out of a table. If the coefficient of friction between the chain and the table is ,μ estimate the maximum length of the chain that can hang without slipping.

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7. A tram is moving with an acceleration of 49 cm . s^{-2} using 50% of its motor power the remaining 50% is used up to overcome

friction. Find the coefficient of friction between the wheel and the tram line.

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8. A body is kept on a horizontal rough plane. The plane is then gradually raised to an inclination of 30° with the horizontal and the body starts to slide down. The body descends 12 m along the inclined plane in the next 4 s. Find the coefficients of static and kinetic friction between the surfaces in contact.

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9. To initiate an upward motion of a body along an inclined plane the minimum force required is twice the force required to keep the body at rest on the same incline . If the coefficient of friction is μ prove that the inclination of the plane is $\theta = \tan^{-1}(3\mu)$.

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10. A body of mass 5×10^{-3} kg is projected upwards along a plane inclined at an angle of 30° with the horizontal. If the time required by the body to move up the incline is half the time required for it to slide down find the coefficient of friction between the surface and the body.

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11. The upper half of an inclined surface is perfectly smooth but the lower half is rough . A body starts sliding down the plane and stops immediately on reaching the bottom. The inclination of the plane is 30° with the horizontal. Show that the frictional resistance of the rough part of the surface is equal to the weight of the body.

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12. A book of mass 5 kg is kept on a horizontal table. It is connected to a weight of mass 2 kg by a weightless string passing over a smooth pulley . The part of the string on the table is horizontal, and the weight is hanging freely from the pulley. If the coefficient of kinetic friction between the table and the block is 0.2, find the acceleration of the block. What will be the tension in the string ?

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13. A block of mass m is sliding down a stationary inclined plane. The base of the inclined plane has a length l, and the coefficient of kinetic friction between the block and inclined surface is 0.14. What should be the inclination of the plane so that the block can slide down to the ground in minimum time?

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14. A coin slides down an inclined plane of inclination ϕ at a constant speed. Prove that if the coin is pushed up with a velocity u on that plane it can rise up to $\frac{u^2}{4g\sin\phi}$.

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15. The velocity of a 2.5 kg block sliding down an inclined plane (μ = 0.2) is found to be 1.5 $\mathrm{m.s}^{-1}$. One second later it has a velocity of 5

$m.s^{-1}$. What is the angle of the plane with respect to the horizontal?

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16. A,B and C are the three blocks of masses 3 kg , 4 kg and 8 kg respectively. The blocks are placed over one another Fig. Coefficient of friction between each pair of surfaces in contact is 0.25. A is connected to the wall by a massless rigid rod, B and C are connected by an inextensible thread passing over a rigidly

fixed smooth pulley. Find the force F required to pull C at a constant speed.

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17. A block of mass M is at rest on a table Fig. Coefficient of friction between the block and the table is μ. What can be the maximum weigth of B so that the system remains in equilibrium ?

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18. Calculate the minimum force required to drag a body of mass m, resting on a horizontal surface. The coefficient of friction between the body and the surface is μ.

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19. A block of mass 4 kg is kept on a smooth horizontal table surface Fig. Another body of mass 1 kg is placed over one end of the block.

Length of the block is 150 cm. Coefficient of friction between the block and the body is 0.1. If a force of 10^6 dyn is applied on the block when does the body fall off the block?

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20. At what maximum height with respect to the lowest point of a hollow sphere of radius r can a particle stay at rest inside it? Given the

coefficient of friction between the sphere and the particle is μ.

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Section Related Questions

1. What is friction? What is the origin of friction?

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2. Friction is a self adjusting force- explain.

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3. What is meant by limiting friction?

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4. What is meant by the term coefficient fo friction?

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5. A block of mass 2kg is placed on the floor. The coefficient of static friction is 0.4. A force F of 2.5N is applied on the block . Calculate the force of friction between the block and the floor.

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6. A force of 98N is just able to move a block of mass 20kg on a rough horizontal surface.

Calculate the coefficient of friction and the angle of friction.

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7. What is meant by angle of friction? How is this related to the coefficient of friction?

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8. Establish the relationship between angle of repose and coefficient of friction

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9. 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 inclined plane , then find the angle between the inclined plane and the horizontal.

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Higher Order Thinking Skill Hots Questions

1. Why should one take short footsteps while walking on ice (or oily surface) ?

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2. In rainy season sand is sometimes thrown on railway tracks. Why?

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3. Show that coefficient of friction is a dimensionless quantity.

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4. A chair is kept on the floor. When does friction act between them? Where does this force act? Is the magnitude of this force a constant ?

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5. Can the value of the coefficient of friction be greater than 1?

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6. Explain why it is difficult to write on a paper surface that is too smooth or too rough.

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7. A body of mass m is kept over an object of mass M. The object is at rest on smooth. Coefficient of static friction between the two bodies is μ . What is the minimum force that needs to be applied on the object, so that the body will be about to slip over it?

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8. The effectiveness of the brake of a car does not depend on the area of contact of the

brakeshoe with the rim of the wheel - explain.

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9. While polishing a substance if the polishing cloth is pressed hard a considerable amount of heat is developed. Why ?

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10. Will there be any change in the coefficient of friction between the surfaces of two

objects, If they are taken to the moon ?

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11. When the wheels of a car are bogged down in mud, why cannot the car move forward?

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12. After a rainfall one should not drive very fast on a wet asphalt road. Explain.

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13. A body of mass m is placed on a platform of mass M ($m < M$), moving with a velocity v. If the coefficient of friction between the platform and the mass is μ then for how long will the body continue to slide on the platform and what distance will it cover during that time?

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14. How does the accelerator increase the speed of a car?

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Exercise Multiple Choice Questions

1. During acceleration of a bicycle the direction of force of static friction exerted by the ground on the wheels is

A. against the direction of motion of the front wheel and along the direction of motion of the rear wheel

B. along the motion of front wheel and against the motion of rear wheel

C. against the motion of both the wheels

D. along the motion of both the wheels

Answer: A

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2. A block of mass 0.1 kg is kept pressed against a wall by applying a force of 5 N horizontally on the block. Coefficient of friction between the block and the wall is 0.5. Friction acting on the block is.

A. 2.5 N

B. 0.98 N

C. 4.9 N

D. 0.40 N

Answer: B

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3. A piece of stone of mass 1 kg slides over ice at 2 $\mathrm{m.s}^{-1}$ and comes to rest in 10 s. In this case the friction force is

A. 0.2 N

B. 20 N

C. 10 N

D. 1 N

Answer: A

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4. A uniform chain of length l is lying on a rough table and $\frac{1}{n}$ th of its length is hanging from the table's edge. If the chain is about to slide off the table the coefficient of friction between the chain and the table is

A. $\frac{1}{n}$

B. $\frac{1}{n-1}$

C. $\frac{1}{n+1}$

D. $\frac{n-1}{n+1}$

Answer: B

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5. If the coefficient of friction is $\frac{1}{\sqrt{3}}$, the height up to which a particle can rise and stay inside a hollow sphere of radius r is (inner surface of the sphere is rough)

A. 0.5 r

B. 0.75 r

C. 0.95 r

D. 0.134 r

Answer: D

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6. A block of mass 5 kg is placed on a rough horizontal surface, Coefficient of static and sliding friction between the body and the surface are 0.7 and 0.5 respectively. A

horizontal force is applied on the block so that the block just starts moving. If the applied force continues to act even after the block is set in motion acceleration of the block will be [$g = 10\ m.s^{-2}$]

A. $1\ m.s^{-2}$

B. $2\ m.s^{-2}$

C. $3\ m.s^{-2}$

D. $4 m.s^{-2}$

Answer: B

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7. Graphs below show the variation of the frictional force against the force on a block applied parallel to the surface of contact of the block with a rough horizontal plane. Out of A, B, C,D which one is the correct graph?

A. 

B. 

C. 

D. 

Answer: B

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8. A tram is moving with an acceleration of 49 $cms.^{-2}$. If 50% of the engine power is used up to overcome friction and the remaining 50% is spent for increasing velocity, coefficient of friction between the wheel and the track should be

A. 0.3

B. 0.02

C. 0.05

D. 0.1

Answer: C

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9. In order to stop a car in shortest distance on a horizontal road one should

A. apply the brakes very hard so that the wheels stop rotating

B. apply the brakes hard enough to just prevent slipping

C. pump the brakes (Press and release)

D. shut the engine off and not apply brakes

Answer: B

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10. A boy of mass M is applying a horizontal force to slide a box of mass M' on a rough horizontal surface. The coefficient of friction between the shoes of the boy and the floor is μ and that between the box and the floor is μ'. In which of the following case it is certainly not possible to slide the box?

A. $\mu < \mu', M < M'$

B. $\mu > \mu', M < M'$

C. $\mu < \mu', M > M'$

D. $\mu > \mu', M > M'$

Answer: A

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Exercise Based On Motion On Inclined Surface

1. Angle of an inclined plane with the horizontal is θ. First half of the plane is smooth and the other half is rough. When a body is released from the top of the plane it

slides down and comes to rest at the bottom. Coefficient of friction between the body and the inclined plane is

A. $\mu = 2\tan\theta$

B. $\mu = \tan\theta$

C. $\mu = \frac{2}{\tan\theta}$

D. $\mu = \frac{1}{\tan\theta}$

Answer: A

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2. A body slides down an inclined plane of inclination θ. While sliding downwards the coefficient of friction is directly proportional to the displacement. The body slides down the plane with a

A. constant acceleration g sin θ

B. constant acceleration (g sin $\theta - \mu g \cos\theta$

)

C. constant retardation $(\mu g \cos\theta - g \sin\theta)$

D. variable acceleration

Answer: D

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3. For an object sliding on a plane the force of friction is less if the plane is inclined instead of being horizontal, because,

A. coefficient of friction decreases

B. normal force decreases

C. effective mass decreases

D. for an angle of inclination θ friction is inversely proportional to tan θ

Answer: B

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4. A body of mass m is pushed up with a velocity u along a plane of inclination θ. If coefficient of friction between the body and the inclined plane is μ displacement of the body before coming to rest is

A. $\frac{u^2\mu}{2g\sin\theta}$

B. $\frac{u^2\mu}{2g\cos\theta}$

C. $\frac{u^2}{4g\sin\theta}$

D. $\frac{u^2}{2g\cos\theta}$

Answer: C

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5. A mass placed on an inclined plane is just in equilibrium. If μ is the coefficient of friction of

the surface, then maximum inclination of the plane with the horizontal is

A. $\tan^{-1}\mu$

B. $\tan^{-1}(\mu/2)$

C. $\sin^{-1}\mu$

D. $\cos^{-1}\mu$

Answer: A

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6. A 13 m ladder is placed against a smooth vertical wall with its lower end 5 m from the wall. What should be the minimum coefficient of friction between the ladder and the floor so that it remains in equilibrium?

A. 0.36

B. 0.72

C. 0.21

D. 0.52

Answer: C

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7. A box of mass 8 kg is placed on a rough inclined plane of inclination θ. It downward motion can be prevented by applying an upward pull F and it can be made to slide upwards by applying a force 2F. The coefficient of friction between the box and the inclined plane is

A. $\frac{1}{3}\tan\theta$

B. 3 $\tan\theta$

C. $\frac{1}{2}\tan\theta$

D. $2\tan\theta$

Answer: A

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Very Short Answer Type Questions Based On Fundamentals Of Friction

1. Can the value of the coefficient of friction be greater than 1?

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2. Does the force of friction depend on the area of contact ?

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3. On what factors does the coefficient of static friction depend?

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4. What is wet friction?

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5. Value of the angle of friction _____ on increasing the smoothness of the plane. [Fill in the blanks]

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6. Rolling friction is ____ than both static friction and kinetic friction. [Fill in the blanks]

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Short Answer Type Question I

1. What is the minimum force required to pull a mass m over a horizontal surface where coefficient of friction between the mass and the surface is μ?

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2. How lubricants reduce force of friction?

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3. It is easier to roll a barrel than to pull it along the road. Explain.

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4. A body is sliding down a plane at an angle of inclination θ. μ is the coefficient of friction.

What is the acceleration of the body?

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5. A body of mass m and momentum p is in motion over a rough surface. It stops after covering a distance x. What is the coefficient of friction between the body and the plane ?

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Problem Set I Based On Fundamentals Of Friction

1. What is the minimum force that needs to be applied on a body of mass 100 g, kept on a horizontal surface, to set the body in motion? Given, coefficient of friction between the surface and the body is 0.4 and the force acts parallel to the surface.

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2. A piece of stone came to rest after covering a distance of 20 m over an surface. If the initial

velocity of the stone was 1 $\mathrm{m.s}^{-1}$, what was the coefficient of friction between the stone and ice?

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3. A substance of mass 100 kg is to be pulled over a floor, Coefficient of static and sliding friction are 0.5 and 0.45 respectively. Find the force required to (i) set the substance in motion (ii) maintain the motion.

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4. A pot of mass 1 kg is raised vertically at a constant velocity by holding it firmly with both hands. Coefficient of friction between the hands and the pot is 0.2, what is the force applied by each hand?

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5. While lifting a 10 kg block vertically with a constant velocity, it is kept pressed against a wall by a horizontal force of 49 N. Coefficient

of friction between the block and the wall is 0.2. Find the upward force.

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6. A man manages to balance a block of mass 2 kg by pushing it in horizontal against an erect wall. If $\mu = 0.25$ between the wall and the block , and $\mu = 0.15$ between the block and the hand, find the force needed to be applied by the man.

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7. The length of a chain is 1 m. The chain is lying on a horizontal table. The coefficient of friction between the chain and the table is 0.25. What is the maximum length of the chain that can hang out without slipping ?

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8. A 4 kg block A is placed on 8 kg block B which rests on a smooth table. Block A just slips on B when a force of 12 N is applied on A.

What is the maximum horizontal force F on B required to make both A and B move together?

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9. A motor car running at the rate of $7\mathrm{m.s}^{-1}$ can be stopped by its brakes in 10 m. Prove that total resistance to the motion when brakes are on is one fourth of the weight of the car.

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10. A car is travelling at the rate of 70 km/hr. Suddenly the brakes are applied causing all the tyres to skid. How far will the car travel before coming to rest ? Given μ = 0.2.

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11. A body of mass 60 g is kept on an inclined plane of inclination 30° . If the downward resultant force is 0.1764 N, estimate the value of the coefficient of friction.

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12. The coefficient of friction between a plane inclined at 60° and a body of mass 100 g kept on that plane is $\frac{1}{\sqrt{3}}$,. What force should be applied along the plane so that the body can move upwards ?

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13. There is an inclined plane with length 13 m, heght 5 m and $\mu = \frac{1}{3}$. With what initial velocity a body is to be slided up the plane so that it just comes to rest at the top of the inclined plane ?

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Problem Set Ii Based On Fundamentals Of Friction

1. A tuck moving at 36 km. h^{-1} has to be brought to rest by applying brakes in such a way that there is no relative displacement of the goods in the truck with respect to the truck floor. Coefficient of friction between the goods and the truck floor is 0.2. Find the minimum distance the truck must move before it comes to rest .

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2. A 10 g bullet with a horizontal velocity of 300 $\mathrm{m.s}^{-1}$, hits a wooden block of mass 290 g. After collision, the block and the bullet move together and come to rest after travelling 15 m horizontally. What is the coefficient of friction between the block and the horizontal plane on which it is kept?

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3. A force of 0.1176 N acts horizontally for 5 s on a 50 g block kept on a floor. What is the velocity attained by the block? Coefficient of sliding friction between the block and the floor is 0.2.

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4. Standing on an icy surface a man of mass 60 kg throws a stone of mass 3 kg horizontally at a velocity of 8 $\mathrm{m.s}^{-1}$. How far does he slide

back if the coefficient of sliding friction between the man and the icy surface is 0.02?

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5. Calculate the power of an engine which can maintain a speed of 50 $\mathrm{m.s}^{-1}$ for a train of mass 3×10^6 kg on a rough level track. The coefficient of friction is 0.05. Given g = 10 $\mathrm{m.s}^{-2}$

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Problem Set Ii Based On Motion On Inclined Surface

1. A body kept on an inclined plane has an angle of repose 30°. If the inclination is increased to 60°, with what acceleration will the body slide down the plane?

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2. Inclination of a plane 30° and the coefficient of sliding friction between a body

and this plane is $\frac{1}{3}$. If the body starts to move up along the plane at 91 cm.s^{-1}, how far will it rise before it stops?

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3. A body is pushed up an inclined plane with an initial velocity of 14.6 cm.s^{-1}. It takes 2 s to reach its maximum height. How much time will it take to slide down ? What distance did the body cover? Find the coefficient of sliding friction between the body and the inclined

plane. Given the angle of inclination of the plane is 30°.

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4. An object is pushed up along a plane of inclination 30°. It comes down to the initial point after some time with half the initial upward velocity. Find the coefficient of sliding friction between the body and the plane.

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5. When a body of mass 120 g, resting on a horizontal plane is pulled by a rope inclined at an angle 30° with the horizontal it acquires a velocity of 9.8 $\mathrm{m.s}^{-1}$ in 10 s. If the tension in the string is 0.588 N, what is the coefficient of sliding friction ? g = 9.8 $\mathrm{m.s}^{-2}$

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6. A body of mass 10 kg about to slide down a plane inclined at an angle 20° with the horizontal. What force along the plane if

applied upwards will just make the body slide upwards? [sin 20° = 0.3420]

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7. Two blocks of mass m_1 = 3 kg and $m_2 = \frac{1}{\sqrt{3}}$ kg are connected by a light inextensible string which passes over a smooth peg. The peg is fixed on the top of the wedge. The planes of the wedge supporting m_1 and m_2 are inclined at 30° and 60°

respectively with the horizontal. Calculate the acceleration of the masses .

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8. A piece of ice slides down a 45° incline in twice the time it takes to slide down a frictionless 45° incline. What is the coefficient of friction between ice and the incline?

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Hots Numerical Problems Based On Fundamentals Of Friction

1. A block of mass M is kept on a frictionless horizontal table. A body of mass m is kept on the block. If a force F, Parallel to the table top is applied on the block, the body on the block tends to slide backwards. What is the coefficient of static friction between the block and the body?

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Hots Numerical Problems Based On Motion On Inclined Surface

1. Time taken by a body to slide down a rough surface inclined at an angle θ , is n time that required by the body to slide down the same distance on a smooth surface inclined at θ also. Find the coefficient of sliding friction between the body and the plane.

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2. Two blocks kept on a surface of inclination 30° are connected by a weightless string. Each block is of mass 1 kg. Coefficients of friction of the lower and the upper block with the plane are $\frac{1}{4}$ and $\frac{1}{2}$ respectively. If the two blocks are released simultaneously, what will be the common acceleration along the inclined plane? What will be the tension in the string?

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3. The minimum force needed to move a block upward along a rough inclined plane is 3 times the minimum force needed to stop its downward motion. If the coefficient of friction is $\frac{1}{4}$ find the slope of the inclined plane.

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4. A block of mass 2 kg is placed on a plane inclined at an angle 30° with the horizontal. Coefficient of friction between the block and

the incline is $\frac{\sqrt{3}}{2}$. (i) Show that the block will not slide down the plane due to its weight alone. (ii) What force is needed to make the block slide down the incline without any acceleration? (iii) What force will be required to pull the block up along the incline without any acceleration?

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5. To slide a block up a rough plane of inclination 30° with the horizontal the

minimum force required is five times that required to slide the block down the plane. Both forces act parallel to the plane. What is the coefficient of friction between the block and the plane?

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6. Blocks A and B are kept on a plane inclined at an angle θ with the horizontal Fig. Masses of blocks are m_1 and m_2 and coefficients of friction with the plane are μ_1 and

$\mu_2(\mu_1 > \mu_2)$, respectively. (i) Find the force between the blocks when they slide down and (ii) the minimum value of the angle θ for which the two blocks are about to slide down.

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7. Time taken by a body to slide down a smooth plane of inclination 45° is two-third the time taken to slide down a similar but rough plane. What is the coefficient of sliding

friction between the body and the inclined plane?

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8. Using a weightless inextensible string and a frictionless pulley the blocks A and B of masses m and 2 m are kept along the two arms of a triangular wedge. Coefficient of friction between the wedge surfaces and the masses A and B are $\frac{2}{3}$ and $\frac{1}{3}$ respectively.The system of A and B is released from rest. Find (i)

acceleration of block A, (ii) tension in the string and (iii) magnitude and direction of the force of friction acting on block A.

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9. The angle of inclination of a plane is 30° with the horizontal. A uniform circular disc of mass m and radius R is rolling up the plane. If coefficients of both static and sliding friction are μ and only frictional and gravitational

forces are effective what is the force of friction acting on the disc and what is its direction along the inclined plane?

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10. A block of mass 25 kg is kept on a horizontal plane. The block is pulled in a direction 30° to the horizontal, and when the force is 100 N, the block start its motion. Find the coefficient on friction between the block and the plane.

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11. On application of brakes, the velocity of a train decreases from 72 km $.h^{-1}$ to 36 km.h^{-1} in 10 s, due to a constant retardation. Equilibrium of a box kept on a bunk of the train is about ot be disturbed. What is the coefficient of friction between the box and the bunk?

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12. In a hollow sphere the maximum height with respect to the lowest point at which a particle remains in equilibrium, is one-tenth of the radius of the sphere. What is the coefficient of friction between the sphere and the particle?

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13. A bock of mass M is on a horizontal table and is connected to an inextensible string. The

string passes over a frictionless pulley fitted at one edge of the table. At the other end, another block of mass m hangs vertically. Coefficient fo friction between the table and the block of mass is μ. Find the acceleration of the system.

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14. An aircraft after covering a distance of 100 m on the ground, acquires a velocity of 80 $\mathrm{km}.h^{-1}$. Mass of the aircraft is 10^4 kg and its

coefficient of friction with the ground is 0.2. What is the maximum force required by the engine of the plane for take off?

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15. Rear flapdoor of a lorry is open and a box of mass 40 kg is on the floor of the lorry, 5 m away from the open flap. Coefficient of friction between the box and the lorry floor is 0.15. The lorry starts from rest with an acceleration of 2

$m.s^{-2}$. How far will it go before the box slides off its floor?

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Entrance Corner Assertion Reason Type

1. These questions have statement I and statement II. Of the four choices given below, choose the one that best describes the two statements.

Statement I : If a body tries to slip over a

surface then friction acting on the body is necessarily equal to the limiting friction.

Statement II :Static friction can be less than the limiting friction.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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2. Statement II : Frictional heat generated by the moving ski is the chief factor which promotes sliding in skiing and waxing the ski makes skiing more easy.

Statement II : Due to friction energy dissipates

in the form of heat. As a result it melts the snow below it. Wax is water repellent.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: A

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3. Statement I : Coefficient of friction can be greater than unity.

Statement II : Frictional force depends on normal reaction and ratio of force of friction and normal reaction cannot exceed unity.

A. Statement I is true, statement II is true, statement II is a correct explanation for

statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: C

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4. Statement I : Static frictional force is always greater than kinetic frictional force.

Statement II : Coefficient of static friction $\mu_s >$ coefficient of kinetic friction μ_k.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: D

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5. Statement I : The driver of a moving car sees a wall in front of him. To avoid collision he should apply brakes rather than take a turn away from the wall.

Statement II : Force of friction is needed to

stop the car or take a turn on a horizontal road.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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6. Statement I : Friction opposes motion of a body.

Statement II : Static friction is self adjusting while kinetic friction is constant.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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7. Statement I : A particle is thrown vertically upwards. If air resistance is taken into consideration then retardation in upward journey is more than the acceleration in downward journey.

Statement II : Some mechanical energy is lost in the form of heat due to air friction.

A. Statement I is true, statement II is true, statement II is a correct explanation for statement I.

B. Statement I is true, statement II is true, statement II is not a correct explanation for statement I.

C. Statement I is true, statement II is false.

D. Statement I is false, statement II is true.

Answer: B

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Entrance Corner Multiple Correct Answers Type

1. If the force of friction is equal to the force applied, then friction may be

A. static

B. kinetic

C. limiting

D. no conclusions can be drawn

Answer: A::C

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2. If the object is at rest, then friction may be

A. static

B. kinetic

C. limiting

D. no conclusions can be drawn

Answer: A::C

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3. Mark the correct statements about the friction between two bodies.

A. Static friction is always greater than the kinetic friction

B. Coefficient of static friction is always greater than the coefficient of kinetic friction

C. Limiting static friction is always greater than the kinetic friction.

D. Limiting friction is never less than static friction

Answer: B::C::D

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Entrance Corner Comprehension Type

1. A lift with a mass 1200 kg is raised from rest by a cable with a tension 1350kgf. After some time the tension drops to 1000kgf and the lift

comes to rest a height of 25 m above its initial point . (1 kgf=9.8 N).

What is the height at which the tension changes ?

A. 10.8 m

B. 12.5 m

C. 14.3 m

D. 16 m

Answer: C

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2. A lift with a mass 1200 kg is raised from rest by a cable with a tension 1350 g N. After some time the tension drops to 1000 g N and the lift comes to rest a height of 25 m above its initial point . (1 g N=9.8 N).

What is the greatest speed of the lift ?

A. $9.8\mathrm{m.s}^{-1}$

B. $7.5\mathrm{m.s}^{-1}$

C. $5.92\mathrm{m.s}^{-1}$

D. none of these

Answer: C

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Entrance Corner Integer Answer Type

1. 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. What is the weight of the block (in N)?

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Examination Archive With Solutions Wbchse

1. A block of mass M rests on an inclined plane. If the coefficient of friction between the block and the plane is μ, then the block will slide down the plane under its own weight when the angle of inclination is

A. $\theta > \tan^{-1}(\mu)$

B. $\theta > \tan^{-1}\left(\frac{1}{\mu}\right)$

C. $\theta < \tan^{-1}(\mu)$

D. $\theta < \tan^{-1}\left(\frac{1}{\mu}\right)$

Answer: A

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2. A block of mass 5 kg rests on a table. 8 N horizontal force is applied to push the block. Find out the force of friction between the block and the table. Given $\mu_s = 0.3 \text{and} \mu_k$=0.2,

between the block and the table and g = 10 $\mathrm{m.s}^{-2}$

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3. A block is placed on a horizontal surface. The block is pushed by applying a force F which acts at an angle of θ with the vertical . How much force will be required to move the block if friction coefficient μ ? Discuss the fact it $\tan\theta < \mu$.

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4. Establish the relation angle of friction and angle of repose.

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5. Explain with reason, whether the coefficient of friction between two surfaces can be zero.

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6. A coin slides down an inclined plane of inclination ϕ at a constant speed. Prove that if the coin is pushed up with a velocity u on that plane it can rise up to $\frac{u^2}{4g\sin\phi}$.

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7. An object of mass m rests on an inclined plane. The coefficient of friction between the object and the plane is μ. For what value of the angle of inclination θ, will the object move

downward with uniform speed under its own weight ?

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8. 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. $\frac{g(1-g\mu)}{9}$

B. $\frac{1g\mu}{3}$

C. $\frac{g(1-2\mu)}{3}$

D. $\frac{g(1-2\mu)}{2}$

Answer: C

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9. 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 isμ_k. When the block A is sliding on the table the tension in the string is

A. $\frac{(m_2 + \mu_k m_1)g}{(m_1 + m_2)}$

B. $\frac{(m_2 - \mu_k m_1)g}{(m_1 + m_2)}$

C. $\frac{m_1 m_2(1 + \mu_k)g}{(m_1 + m_2)}$

D. $\frac{m_1 m_2(1-\mu_k)g}{(m_1+m_2)}$

Answer: C

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10. Which one of the following statements is incorrect?

A. Frictional force opposes the relative motion

B. Limiting value of static friction is directly proportional to normal reaction

C. Rolling friction is smaller than sliding friction Coefficient of sliding friction has dimensions of length

D. Coefficient of friction is a dimensionless quantity.

Answer: D

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1. To determine the coefficient of friction between a rough surface and a block, the surface is kept inclined at 45° and the block is released from rest. The block takes a time t in moving a distance d. The rough surface is then replaced by a smooth surface and the same experiment is repeated. The block now takes a time t/2 in moving down the same distance d. The coefficient of friction is

A. $\frac{3}{4}$

B. $\frac{5}{4}$

C. $\frac{1}{2}$

D. $\frac{1}{\sqrt{2}}$

Answer: A

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2. Block B lying on a table weighs W. The coefficient of static friction between the block and the table is μ. Assume that the cord between B and the knot is horizontal. The

maximum weight of the block A for which the system will be stationary is

A. $\frac{W\tan\theta}{\mu}$

B. $\mu W\tan\theta$

C. $\mu W\sqrt{1+\tan^2\theta}$

D. $\mu W\sin\theta$

Answer: B

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3. A block of mass m_2 is placed on a horizontal table and another block of mass m_1 is placed on top of it. An increasing horizontal force F = at is exerted on the upper block but the lower block never moves as a result. If the co-efficient of friction between the blocks is μ_1 and that between the lower block and the table is μ_2, then what is the maximum possible value of μ_1 / μ_2?

A. $\frac{m_2}{m_1}$

B. $1 + \frac{m_2}{m_1}$

C. $\frac{m_1}{m_2}$

D. $1 + \frac{m_1}{m_2}$

Answer: B

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Examination Archive With Solutions Jee Main

1. Given in the figure are two blocks A and B of weight 20 N and 100 N, respectively. These are being pressed against a wall by a force F as

shown. If the coefficient of friction between the blocks is 0.1 and between block B and the wall is 0.15, the frictional force applied by the wall on block B is

A. 100 N

B. 80 N

C. 120 N

D. 150 N

Answer: C

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

A. 43.3 kg

B. 10.3 kg

C. 18.3 kg

D. 27.3 kg

Answer: D

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Cbse Scanner

1. Define angle of friction. The inclination θ of a rough plane is increased gradually. The ply on

the plane just comes into motion when inclination θ becomes 30°. Find coefficient of friction. If the inclination is further increased to 45° then find acceleration of the body along the plane. (g = 10 m.s^{-2})

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2. Given the magnitude and direction of the net force acting on a car moving with a constant velocity of 30 km.h^{-1} on a rough road.

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3. Two bodies A,B of masses 5 kg and 10 kg in contact with each other rest on a table against a rigid wall. The coefficient of friction between the bodies and the table is 0.15. A force of 200 N is applied horizontally to A. (i) What is the reaction of the partition? (ii) The actionreaction forces between A,B? (iii) What happens when the wall is removed ? Does the answer to (ii) change when bodies are in

motion ? [Ignore the difference between μ_s and μ_k]

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4. Define: (i) stopping distance of a vehicle (ii) reaction time during a free fall.

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5. Explain limiting friction and kinetic friction. State laws of limiting friction. Give two

methods of reducing friction. Show that kinetic friction is less than static friction.

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6. What is the acceleration of the block and trolley system shown in Fig given below if the coefficient of friction between the trolley and the surface is 0.04 ? What is the tension in the string ? (Take g = 10 m.s^{-2}). Neglect the mass of the string.

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7. A block of mass 3 kg slides down an incline of angle 30° with acceleration $\frac{g}{4}$. Complete the free body diagram and find the coefficient of kinetic friction.

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