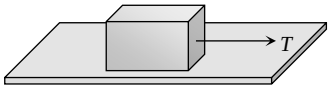
1. The coefficient of friction μ and the angle of friction λ are related as

(a) $\sin\lambda = \mu$ (b) $\cos\lambda = \mu$

(c) $\tan\lambda = \mu$ (d) $\tan\mu = \lambda$

2. In the figure shown, a block of weight 10 *N* resting on a horizontal surface. The coefficient of static friction between the block and the surface $\mu_s = 0.4$. A force of 3.5 *N* will keep the block in uniform motion, once it has been set in motion. A horizontal force of 3 *N* is applied to the block, then the block will



(a) Move over the surface with constant velocity

(b) Move having accelerated motion over the surface

(c) Not move

(d) First it will move with a constant velocity for some time and then will have accelerated motion

3. Which of the following statements is not true

(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

4. 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

(a) 980 *N* (b) 49 *N*

(c) 98 *N* (d) 490 *N*

5. Work done by a frictional force is

(a) Negative (b) Positive

(c) Zero (d) All of the above

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

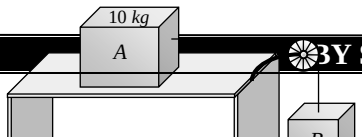
(c) 0.52 (d) 0.60

7. 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

(a) 75 *N* (b) 50 *N*

(c) 35 *N* (d) 25 *N*

8. 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



(a) 2 *kg*

(b) 2.2 *kg*

(c) 4.8 *kg*

(d) 200 *gm*

9. 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

10. 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 $g = 9.8\ m/s^2)$

(a) 9.33 *cal* (b) 10.21 *cal*

(c) 12.67 *cal* (d) 13.34 *cal*

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

(a) 10 *m* (b) 25 *m*

(c) 50 *m* (d) 250 *m*

12. 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

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

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

13. 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*

14. A block of mass 10 *kg* is placed on a rough horizontal surface having coefficient of friction μ = 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}

15. 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) $19.6\ m/s^2$

16. If μ_s, μ_k and μ_r are coefficients of static friction, sliding friction and rolling friction, then

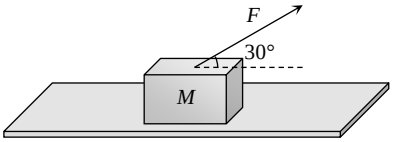
(a) $\mu_s < \mu_k < \mu_r$ (b) $\mu_k < \mu_r < \mu_s$

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

17. 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 $(g = 10\ m/s^2)$

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

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



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

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

18. 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*

19. 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

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

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

20. 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

21. 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

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

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

22. 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) $\frac{3}{4}$

23. 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°

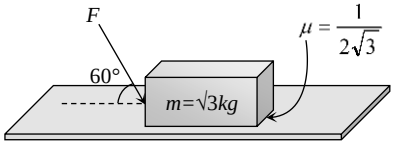
(c) 9.8 *sin* 45° (d) 9.8 cos 45°

24. 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 $g = 10\ m/s^2$)

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

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

25. What is the maximum value of the force *F* such that the block shown in the arrangement, does not move



(a) 20 *N* (b) 10 *N*

(c) 12 *N* (d) 15 *N*

26. A force of 19.6 *N* when applied parallel to the surface just moves a body of mass 10 *kg* kept on a horizontal surface. If a 5 *kg* mass is kept on the first mass, the force applied parallel to the surface to just move the combined body is

(a) 29.4 *N* (b) 39.2 *N*

(c) 18.6 *N* (d) 42.6 *N*

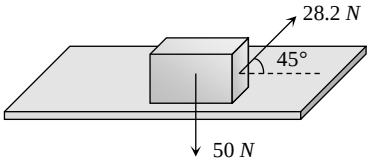
27. A body of weight 50 *N* placed on a horizontal surface is just moved by a force of 28.2 *N*. The frictional force and the normal reaction are

(a) 10 *N*, 15 *N*

(b) 20 *N*, 30 *N*

(c) 2 *N*, 3 *N*

(d) 5 *N*, 6 *N*



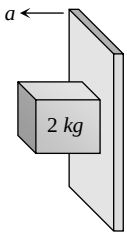
28. A rough vertical board has an acceleration '*a*' so that a 2 *kg* block pressing against it does not fall. The coefficient of friction between the block and the board should be

(a) $> g/a$

(b) $< g/a$

(c) $= g/a$

(d) $> a/g$



29. In the above question, if the lift is moving upwards with a uniform velocity, then the frictional resistance offered by the body is

(a) *Mg* (b) μMg

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

30. A motor car has a width 1.1 *m* between wheels. Its centre of gravity is 0.62 *m* above the ground and the coefficient of friction between the wheels and the road is 0.8. What is the maximum possible speed, if the centre of gravity inscribes a circle of radius 15 *m* ? (Road surface is horizontal)

(a) 7.64 *m*/*s* (b) 6.28 *m*/*s*

(c) 10.84 *m*/*s* (d) 11.23 *m*/*s*

1. (c)

2. (c) $F_l = \mu_s R = 0.4 \times mg = 0.4 \times 10 = 4\,N$ *i.e.* minimum 4*N* force is required to start the motion of a body. But applied force is only 3*N*. So the block will not move.

3. (c) Sliding friction is greater than rolling friction.

4. (b) $F = \frac{W}{\mu} = \frac{1 \times 9.8}{0.2} = 49\,N$

5. (d) Work done by friction can be positive, negative and zero depending upon the situation.

6. (a) Coefficient of friction $\mu_s = \frac{F_l}{R} = \frac{75}{mg} = \frac{75}{20 \times 9.8} = 0.38$

7. (a) $F = \mu R = 0.3 \times 250 = 75\ N$

8. (a) $\mu_s = \frac{m_B}{m_A} \Rightarrow 0.2 = \frac{m_B}{10} \Rightarrow m_B = 2\ kg$

9. (b)

10. (a) Work done = Force × Displacement $= \mu\, mg \times (v \times t)$

$W = (0.2) \times 2 \times 9.8 \times 2 \times 5$ *joule*

Heat generated $Q = \frac{W}{J} = \frac{0.2 \times 2 \times 9.8 \times 2 \times 5}{4.2} = 9.33\ cal$

11. (b) $S = \frac{u^2}{2\mu g} = \frac{(10)^2}{2 \times 0.2 \times 10} = 25\ m$

12. (c) $v = \sqrt{\mu g r} = \sqrt{0.5 \times 9.8 \times 40} = \sqrt{196} = 14\ m/s$

13. (a) $F_l = \mu mg = 0.6 \times 1 \times 9.8 = 5.88\ N$

Pseudo force on the block = $ma = 1 \times 5 = 5\ N$

Pseudo is less then limiting friction hence static force of friction = 5 *N*.

14. (b) $a = \frac{\text{Applied force} - \text{Kinetic friction}}{\text{mass}}$

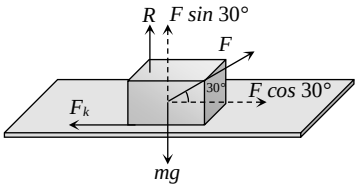
$= \frac{100 - 0.5 \times 10 \times 10}{10} = 5 m/s^2$

15. (b) From the relation $F - \mu mg = ma$

$a = \frac{F - \mu mg}{m} = \frac{129.4 - 0.3 \times 10 \times 9.8}{10} = 10\ m/s^2$

16. (c)

17. (a)



Kinetic friction = $\mu_k R = 0.2(mg - F\sin 30°)$

$= 0.2\left(5\times 10 - 40\times\frac{1}{2}\right) = 0.2(50-20) = 6\ N$

Acceleration of the block $= \frac{F\cos 30° - \text{Kinetic friction}}{\text{Mass}}$

$= \frac{40\times\frac{\sqrt{3}}{2} - 6}{5} = 5.73\ m/s^2$

18. (d) Kinetic energy of the cylinder will go against friction

$\therefore\ \frac{1}{2}mv^2 = \mu mgs \Rightarrow s = \frac{u^2}{2\mu g} = \frac{(10)^2}{2\times(0.5)\times 10} = 10\ m$

19. (a) $\mu = \tan\theta\left(1-\frac{1}{n^2}\right) = 1-\frac{1}{n^2}$ [As $\theta = 45°$]

20. (c) $\mu = \tan\theta\left(1-\frac{1}{n^2}\right)$

$\theta = 45°$ and $n = 2$ (Given)

$\therefore\ \mu = \tan 45°\left(1-\frac{1}{2^2}\right) = 1-\frac{1}{4} = \frac{3}{4} = 0.75$

21. (c) $a = g(\sin\theta - \mu\cos\theta) = 10(\sin 60° - 0.25\cos 60°)$

$a = 7.4\ m/s^2$

22. (a) $\mu = \tan\theta\left(1-\frac{1}{n^2}\right) = \tan 30\left(1-\frac{1}{2^2}\right) = \frac{\sqrt{3}}{4}$

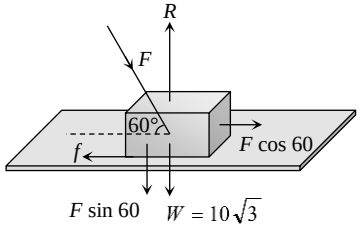
23. (a) For angle of repose,

Friction =Component of weight along the plane

$= mg\sin\theta = 2\times 9.8\times\sin 45^o = 19.6\sin 45^o$

24. (a) $\mu = \tan 30° = \frac{1}{\sqrt{3}}$.

25. (a)



$f = \mu R$

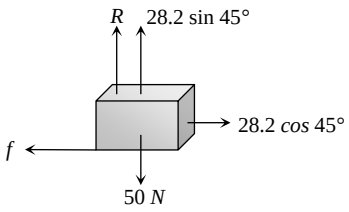
$F\cos 60° = \mu(W + F\sin 60°)$

Substituting $\mu = \frac{1}{2\sqrt{3}}$ & $W = 10\sqrt{3}$ we get $F = 20\ N$

26. (a) $F_l \propto R \quad \therefore \quad F_l \propto m$ *i.e.* limiting friction depends upon the mass of body. So, $\frac{(F_l)'}{(F_l)} = \frac{m'}{m} = \frac{10+5}{10}$

$\Rightarrow (F_l)' = \frac{3}{2} \times F_l = \frac{3}{2} \times 19.6 = 29.4\ N$

27. (b)



Frictional force = $f = 28.2 \cos 45° = 28.2 \times \frac{1}{\sqrt{2}} = 20\ N$

Normal reaction $R = 50 - 28.2 \sin 45° = 30\ N$

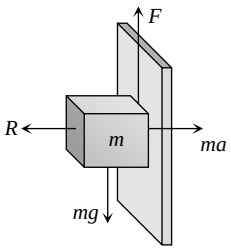
28. (a) For the limiting condition upward friction force between board and block will balance the weight of the block.

i.e. $F > mg$

$\Rightarrow \mu(R) > mg$

$\Rightarrow \mu(ma) > mg$

$\Rightarrow \mu > \frac{g}{a}$



29. (b) When the lift is moving upward with constant velocity then, $R = mg \quad \therefore \quad F = \mu R = \mu mg$

30. (c) $v = \sqrt{\mu g r} = \sqrt{0.8 \times 9.8 \times 15} = 10.84\ m/s$