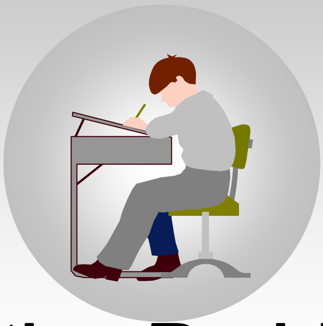


Practice Problems

▶ *Basic level*

1. 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

2. Which one of the following is not used to reduce friction [Kerala (Engg.) 2001]

(a) Oil (b) Ball bearings (c) Sand (d) Graphite

3. 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

(a) 10 *kg wt* (b) 89 *kg wt* (c) 49 *kg wt* (d) 5 *kg wt*

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

5. 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°

[KCET (Engg./Med.) 2000]

(a) 1.173 (b) 1.732 (c) 2.732 (d) 1.677

6. 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

[CPMT 2000]

(a) 19.6 sin 45° (b) 19.6 cos 45° (c) 9.8 sin 45° (d) 9.8 cos 45°

7. To avoid slipping while walking on ice, one should take smaller steps because of the [BHU 1999]

(a) Friction of ice is large (b) Larger normal reaction

(c) Friction of ice is small
(d) Smaller normal reaction

8. Two bodies having the same mass, 2 kg each have different surface areas 50 m^2 and 100 m^2 in contact with a horizontal plane. If the coefficient of friction is 0.2, the forces of friction that come into play when they are in motion will be in the ratio

[EAMCET (Med.) 1999]

(a) 1 : 1
(b) 1 : 2
(c) 2 : 1
(d) 1 : 4

9. Starting from rest, a body slides down a 45^o 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

10. Brakes of very small contact area are not used although friction is independent of area, because friction

(a) Resists motion
(b) Causes wear and tear
(c) Depends upon the nature of materials
(d) Operating in this case is sliding friction

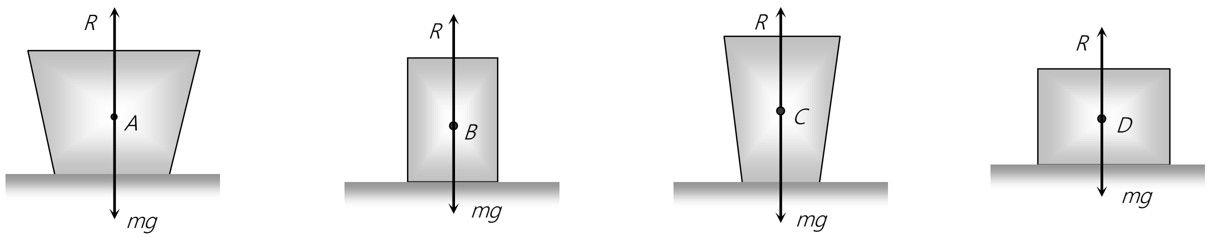
11. The angle between frictional force and the instantaneous velocity of the body moving over a rough surface is

(a) Zero
(b) $\pi/2$
(c) π
(d) Equal to the angle of friction

12. What happens to the coefficient of friction, when the normal reaction is halved

(a) Halved
(b) Doubled
(c) No change
(d) Depends on the nature of the surface

13. What can be inferred regarding the limiting frictional force in the following four figures



(a) $F_A = F_B = F_C = F_D$
(b) $F_A > F_B > F_C > F_D$
(c) $F_A < F_B < F_C < F_D$
(d) $F_A = F_B < F_C < F_D$

14. A force of 98 Newton is required to drag a body of mass 100 kg on ice. The coefficient of friction will be

(a) 0.98
(b) 0.89
(c) 0.49
(d) 0.1

15. 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 coefficients of static and sliding friction are 0.5 and 0.4 respectively. The acceleration of the body is

(a) $6\,m/\sec^2$ (b) $4.9\,m/\sec^2$ (c) $3.92\,m/\sec^2$ (d) $1\,m/\sec^2$

16. A particle is projected along a line of greatest slope up a rough plane inclined at an angle of 45^o with the horizontal. If the coefficient of friction is $\frac{1}{2}$, then the retardation is

(a) $\frac{g}{\sqrt{2}}$ (b) $\frac{g}{2\sqrt{2}}$ (c) $\frac{g}{\sqrt{2}}\left[1+\frac{1}{2}\right]$ (d) $\frac{g}{\sqrt{2}}\left[1-\frac{1}{2}\right]$

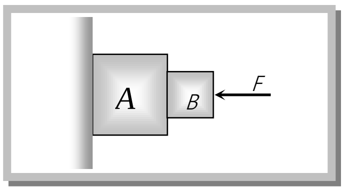
17. A block moves down a smooth inclined plane of inclination θ. Its velocity on reaching the bottom is *v*. If it slides down a rough inclined plane of same inclination its velocity on reaching the bottom is *v*/*n*, where *n* is a number greater than 0. The coefficient of friction μ is given by

(a) $\mu = \tan\theta\left[1-\frac{1}{n^2}\right]$ (b) $\mu = \cot\theta\left[1-\frac{1}{n^2}\right]$ (c) $\mu = \tan\theta\left[1-\frac{1}{n^2}\right]^{\frac{1}{2}}$ (d) $\mu = \cot\theta\left[1-\frac{1}{n^2}\right]^{\frac{1}{2}}$

18. Consider a car moving along a straight horizontal road with a speed of 72 *km*/*hr*. If the coefficient of static friction between the tyres and the road is 0.5, the shortest distance in which the car can be stopped is $(g = 10\,m/s^2)$

(a) 30 *m* (b) 40 *m* (c) 72 *m* (d) 20 *m*

19. All the surfaces shown in the figure are rough. The direction of friction on *B* due to *A* is



(a) Zero

(b) To the left

(c) Upwards

(d) Downwards

20. A body of mass *M* just starts sliding down an inclined plane (rough) with inclination θ, such that $\tan\theta = 1/3$. The force acting on the body down the plane in this position is

(a) Mg (b) $\frac{Mg}{3}$ (c) $\frac{2}{3}Mg$ (d) $\frac{Mg}{\sqrt{10}}$

▶▶ *Advance level*

21. Consider the following statements

Assertion (*A*) : It is difficult to move a cycle along the road with its brakes on.

Reason (*R*) : Sliding friction is greater than rolling friction.

Of these statements [AIIMS 2002]

(a) Both *A* and *R* are true and the *R* is a correct explanation of the *A*

(b) Both *A* and *R* are true but the *R* is not a correct explanation of the *A*

(c) *A* is true but the *R* is false

(d) Both *A* and *R* are false

(e) *A* is false but the *R* is true

22. 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°

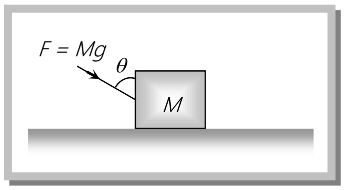
23. A block of mass 2 *kg* rests on a rough inclined plane making an angle of 30^o with the horizontal. The coefficient of static friction between the block and the plane is 0.7. The frictional force on the block is [IIT-JEE 1980]

(a) 9.8 *N* (b) $0.7 \times 9.8 \times \sqrt{3}\ N$ (c) $9.8 \times \sqrt{3}\ N$ (d) $0.7 \times 9.8\ N$

24. A body of weight *W* is lying at rest on a rough horizontal surface. If the angle of friction is θ, then the minimum force required to move the body along the surface will be

(a) $W \tan\theta$ (b) $W \cos\theta$ (c) $W \sin\theta$ (d) $W \cos\theta$

25. A block of mass *M* is placed on a rough horizontal surface as shown in the figure. A force *F* = *Mg* acts on the block. It is inclined to the vertical at an angle θ. The coefficient of friction is μ. The block can be pushed along the surface only when



(a) $\tan\theta \geq \mu$

(b) $\cot\theta \geq \mu$

(c) $\tan\theta/2 \geq \mu$

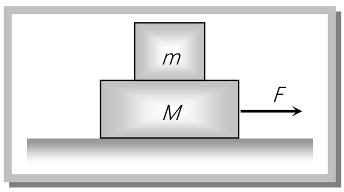
(d) $\cot\theta/2 \geq \mu$

26. A plane is inclined at an angle θ with the horizontal. A body of mass *m* rests on it. If the coefficient of friction is μ, then the minimum force that has to be applied parallel to the inclined plane to make the body just move up the inclined plane is

(a) $mg \sin\theta$ (b) $\mu\, mg \cos\theta$

(c) $\mu\, mg \cos\theta - mg \sin\theta$ (d) $\mu\, mg \cos\theta + mg \sin\theta$

27. A block of mass *m* is placed on another block of mass *M* which itself is lying on a horizontal surface. The coefficient of friction between the two blocks is μ_1 and that between the block of mass *M* and horizontal surface is μ_2. What maximum horizontal force can be applied to the lower block so that the two blocks move without separation



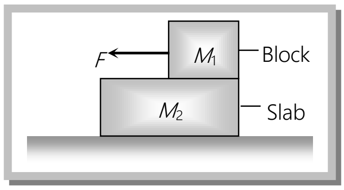
(a) $(M + m)(\mu_2 - \mu_1)g$

(b) $(M - m)(\mu_2 - \mu_1)g$

(c) $(M - m)(\mu_2 + \mu_1)g$

(d) $(M+m)(\mu_2+\mu_1)g$

28. A block of mass M_1 is placed on a slab of mass M_2. The slab lies on a frictionless horizontal surface. The coefficient of static friction between the block and slab is μ_1 and that of dynamic friction is μ_2. A force F acts on the block M_1. Take g = 10 ms^{-2}. If M_1 = 10 kg, M_2 = 30 kg, μ_1 = 0.5, μ_2 = 0.15 and F = 40 N, what will be the acceleration with which the slab will move



(a) 5 ms^{-2}

(b) 2 ms^{-2}

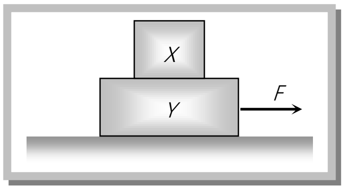
(c) 1 ms^{-2}

(d) Zero

29. In the above problem if F = 100 N, what will be the acceleration with which the slab will move

(a) 5 ms^{-2} (b) 2 ms^{-2} (c) 1 ms^{-2} (d) None of these

30. A block X of mass 4 kg is lying on another block Y of mass 8 kg. As shown in the figure. When the force acting on X is 12N, block X is on the verge of slipping on Y. The force F in Newton necessary to make both X and Y move simultaneously will be



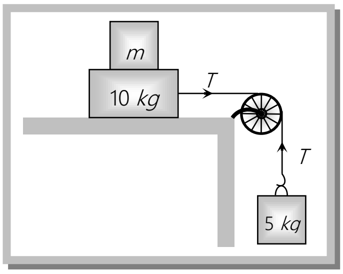
(a) 36

(b) 3.6

(c) 0.36

(d) 3.6

31. Two masses 10 kg and 5kg are connected by a string passing over a pulley as shown. If the coefficient of friction be 0.15, then the minimum weight that may be placed on 10 kg to stop motion is



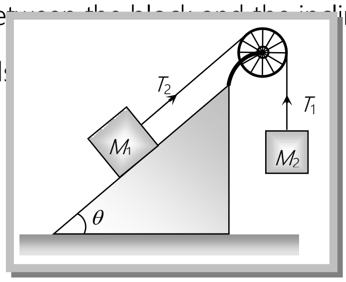
(a) 18.7 kg

(b) 23.3 kg

(c) 32.5 kg

(d) 44.3 kg

32. Two blocks of mass M_1 and M_2 are connected with a string which passes over a smooth pulley. The mass M_1 is placed on a rough inclined plane as shown in the figure. The coefficient of friction be[illegible]ined plane is μ. What should be the maximum mass M_2 so that block M_1 slides downward[illegible]



(a) $M_2 = M_1(\sin\theta + \mu\cos\theta)$

(b) $M_2 = M_1(\sin\theta - \mu\cos\theta)$

(c) $M_2 = M_1/(\sin\theta + \mu\cos\theta)$

(d) $M_2 = M_1/(\sin\theta - \mu\cos\theta)$

33. A car starts from rest to cover a distance s. the coefficient of friction between the road and the tyres is μ. The minimum time in which the car can cover the distance is proportional to

(a) μ (b) $\sqrt{\mu}$ (c) $\frac{1}{\mu}$ (d) $\frac{1}{\sqrt{\mu}}$

34. An engine of mass 50,000 kg pulls a coach of mass 40,000 kg. If there is a resistance of 1 N per 100 kg acting on both the engine and the coach, and if the driving force of the engine be 4,500 N, then the acceleration of the engine is

(a) 0.08 m/s^2 (b) Zero (c) 0.04 m/s^2 (d) None of these

35. In the above question, then tension in the coupling is

(a) 2,000 N (b) 1,500 N (c) 500 N (d) 1000 N

36. An aeroplane requires for take off a speed of 72 km/h. The run of the ground is 100m.The mass of the plane is $10^4\ kg$ and the coefficient of friction between the plane and the ground is 0.2. The plane accelerates uniformly during take off. What is the acceleration of the plane

(a) 1 m/s^2 (b) 2 m/s^2 (c) 3 m/s^2 (d) 4 m/s^2

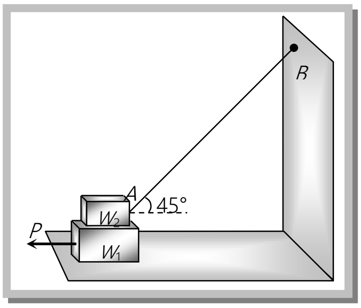
37. The force required to just move a body up an inclined plane is double the force required to just prevent it from sliding down. If ϕ is angle of friction and θ is the angle which incline makes with the horizontal then

(a) $\tan\theta = \tan\phi$ (b) $\tan\theta = 2\tan\phi$ (c) $\tan\theta = 3\tan\phi$ (d) $\tan\phi = 3\tan\theta$

38. A body is on a rough horizontal plane. A force is applied to the body direct towards the plane at an angle ϕ with the vertical. If θ is the angle of friction then for the body to move along the plane

(a) $\phi > \theta$ (b) $\phi < \theta$ (c) $\phi = \theta$ (d) ϕ can take up any value

39. In the arrangement shown $W_1 = 200\,N$, $W_2 = 100\,N$, $\mu = 0.25$ for all surfaces in contact. The block W_1 just slides under the block W_2



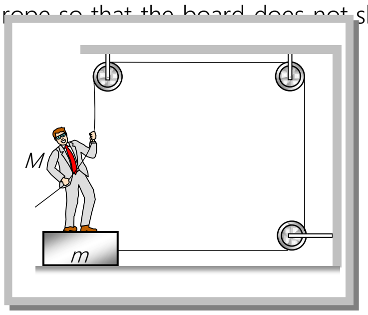
(a) A pull of $50\,N$ is to be applied on W_1

(b) A pull of $90\,N$ is to be applied on W_1

(c) Tension in the string AB is $10\sqrt{2}\,N$

(d) Tension in the string AB is $20\sqrt{2}\,N$

40. A board of mass m is placed on the floor and a man of mass M is standing on the board as shown. The coefficient of friction between the board and the floor is μ. The maximum force that the can exert on he rope so that the board does not slip on the floor is



(a) $F = \mu(M+m)g$

(b) $F = \mu mg$

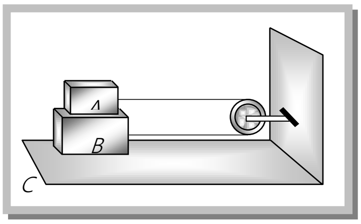
(c) $F = \frac{\mu Mg}{\mu + 1}$

(d) $F = \frac{\mu(M+m)g}{\mu + 1}$

41. A body slides over an inclined plane forming an angle of 45° with the horizontal. The distance *x* travelled by the body in time *t* is described by the equation $x = kt^2$, where $k = 1.732$. The coefficient of friction between the body and the plane has a value

(a) $\mu = 0.5$ (b) $\mu = 1$ (c) $\mu = 0.25$ (d) $\mu = 0.75$

42. Two blocks *A* and *B* of masses *m* and *M* respectively are placed on each other and their combination rests on a fixed horizontal surface *C*. A light string passing over the smooth light pulley is used to connect *A* and *B* as shown. The coefficient of sliding friction between all surfaces in contact is μ. If *A* is dragged with a force *F* then for both *A* and *B* to move with a uniform speed we have



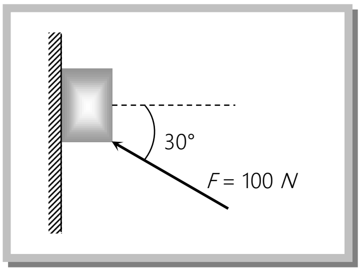
(a) $F = \mu(M+m)g$

(b) $F = \mu mg$

(c) $F = \mu(3M+m)g$

(d) $F = \mu(3m+M)g$

43. A force of 100 *N* is applied on a block of mass 3 *kg* as shown in figure. The coefficient of friction between the surface of the block is 1/4. The friction force acting on the block is

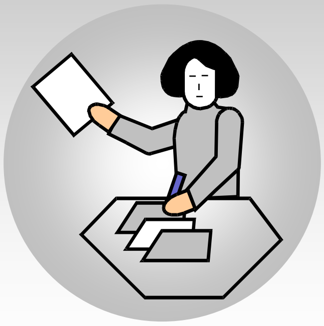


(a) 15 *N* downwards

(b) 25 *N* upwards

(c) 20 *N* downwards

(d) 20 *N* upwards



Answer Sheet (Practice problems)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
b	c	d	d	b	a	c	a	c	b
11.	12.	13.	14.	15.	16.	17.	18.	19.	20.
c	c	a	d	d	c	a	b	c	d
21.	22.	23.	24.	25.	26.	27.	28.	29.	30.
a	c	a	a	c	d	d	c	d	a
31.	32.	33.	34.	35.	36.	37.	38.	39.	40.
b	b	d	c	a	b	c	a	b, d	d
41.	42.	43.							
a	d	c							