Horizontal Plane

1. **If μ_s, μ_k and μ_r are the coefficient of static, kinetic and rolling frictions between two surfaces, then**

   (1) $\mu_s<\mu_k<\mu_r$ (2) $\mu_s>\mu_k<\mu_r$ (3) $\mu_s<\mu_k>\mu_r$ (4) $\mu_s>\mu_k>\mu_r$

2. **The coefficient of static friction is**

   (1) Always less than one (2) Usually less than one

   (3) Always negative (4) Always greater than one

3. **A pulling force making an angle θ to the horizontal is applied on a block of weight W, placed on a table. If the angle of friction is ϕ, the magnitude of the force required just to move the body is equal to**

   (1) $\frac{W\cos\phi}{\cos(\theta-\phi)}$ (2) $\frac{W\sin\phi}{\cos(\theta-\phi)}$ (3) $\frac{W\tan\phi}{\sin(\theta-\phi)}$ (4) $\frac{W\sin\phi}{g\tan(\theta-\phi)}$

4. **When a person walks on a rough surface**

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

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

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

   (4) None of the above is correct.

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

   (1) The forward direction on the rear wheel and in backward direction on the front wheel.

   (2) The forward direction on the front wheel and in backward direction on the rear wheel

   (3) The forward direction on both the front and the rear wheels.

(4) The backward direction on both the front and rear wheels.

6. Consider the following statements and identify the correct statements.

A) Frictional force always opposes motion.

B) Static frictional force is always greater than kinetic frictional force for a given pair of surfaces.

C) Frictional force is a non conservative force.

1) All statements are true
2) Only B and C are true
3) Only C is true
4) Only B is true

7. Sand is dusted on the railway tracks during rainy season to

1) Make it always wet
2) Increase friction
3) To reduce consumption of fuel
4) None

8. The angle made by the resultant of normal reaction and limiting value of frictional force with normal to the surface is called

1) Angle of repose
2) Angle of friction
3) Critical angle
4) None of the above

9. The kinetic friction is always

A) Less than static friction.

B) Greater than rolling friction.

1) Both A and B are true
2) Both A and B are false
3) A is false and B is true
4) B is false and A is true

10. Consider the following statement A and B and identify the correct answer:

A: When a person walks on a rough surface, the direction of frictional force exerted by the surface on the person is opposite to the direction of his motion

B: When cycle is in motion, the force of friction exerted by the ground on the front wheel is in the backward direction.

1) A and B are correct.
2) A is correct B wrong.
3) A and B are wrong.
4) A is wrong B is correct.

11. Which of the following is correct?

1) Using ball bearings, sliding friction changes to rolling friction.

2) Lubricants decrease friction since inter molecular forces are weak in liquids.

3) Over polishing increases friction since surface adhesion increases.

4) All of the above.

12. Lubrication reduces friction because

1) Lubricant molecules act as ball bearings

2) Laws of limiting friction are not applicable

3) The relative motion in between solid and liquid

4) None of the above

13. A cyclist pedals the cycle for some time and then stops peddling, then

1) Frictional force on the back wheel is in the direction of motion and front wheel is opposite to the direction of motion.

2) Frictional force on the back wheel is opposite to the direction of motion and front wheel is in the direction of motion.

3) Frictional force on the both the wheels are opposite to the direction of motion.

4) Frictional force on the both the wheels are in the direction of motion.

14. Car tires are made of rubber and not of iron because

1) Rubber is cheaper than iron

2) Iron tires produce noise

3) Rubber can give circular shape easily than iron

4) Friction between rubber & concrete is less than that between iron & concrete.

15. Aero planes are streamlined to reduce

1) Fluid Friction
2) Sliding Friction
3) Kinetic Friction
4) Limiting Friction

16. It is easier to pull a lawn roller than to push it because pulling

1) Involves sliding friction
2) Involves dry friction
3) Increases the effective weight
4) Decreases normal reaction.

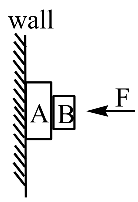
17. Two blocks A and B are pressed against a vertical wall by applying a horizontal force 'F' as shown in the figure. There is no friction between A and B. Then

a) Both the blocks A and B can be at rest for any magnitude of F.

b) B can be at rest A moves down for smaller magnitude of F.

c) Both A and B will move down for smaller magnitude.

d) A can be at rest and B moves down for larger magnitude of F.



1) a and b are correct

2) c and d are correct

3) a and d are correct

4) b and c are correct

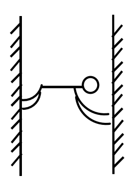
18. A man thinks to remain in equilibrium by pushing in his hands and feet against two vertical parallel walls as the shown in the figure

a) He must exert equal forces on both walls.

b) The forces of friction at both walls must be equal.

c) The coefficients of friction between man and wall must be the same at both ends.

d) Friction must be present on both walls.



1) a and b are correct

2) a and c are correct

3) a and d are correct

4) all correct

19. A): Friction helps the motion of a body on a rough surface.

(R): Frictional force is electromagnetic in nature.

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).

(2) Both (A) and (R) are true and (R) is not the correct explanation of (A).

(3) (A) is true but (R) is false.

(4) (A) is false but (R) is true.

20. (A): Brakes of very small contact area are not used although friction is independent of area.

(R): Friction resists motion.

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).

(2) Both (A) and (R) are true and (R) is not the correct explanation of (A).

(3) (A) is true but (R) is false.

(4) (A) is false but (R) is true.

21. (A): More force is required to push a body up a rough inclined plane than that to move the same body down the same plane.

(R): The friction always acts parallel to inclined plane down wards.

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).

(2) Both (A) and (R) are true and (R) is not the correct explanation of (A).

(3) (A) is true but (R) is false.

(4) (A) is false but (R) is true.

22. (A): A bus is moving with constant speed on a rough horizontal surface. It gains K.E., when some passengers get down from the bus.

(R): Friction depends on normal reaction which in turn depends on mass.

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).

(2) Both (A) and (R) are true and (R) is not the correct explanation of (A).

(3) (A) is true but (R) is false.

(4) (A) is false but (R) is true.

23. (A): When a bicycle is being pedaled, the friction on the front wheel is in a direction opposite to the motion of bicycle.

(R): The rear wheel while being pedaled pushes the front wheel on rough road due to which the friction opposes the relative motion.

(1) Both (A) and (R) are true and (R) is the correct explanation of (A).

(2) Both (A) and (R) are true and (R) is not the correct explanation of (A).

(3) (A) is true but (R) is false.

(4) (A) is false but (R) is true.

24. A): When a body moves on rough surface the mechanical energy is not constant.

R): Friction is non-conservative force.

1) Both (A) and (R) are true and (R) is the correct explanation of (A).

2) Both (A) and (R) are true and (R) is not the correct explanation of (A).

3) (A) is true but (R) is false.

4) (A) is false but (R) is true.

25. Match the items mentioned in the lists I and II below

List-1	**List-2**
a) Static friction	e) Constant for a given pair of surfaces
b) Limiting friction	f) Independent of area of contact
c) Kinetic friction	g) Self adjusting
d) Rolling friction	h) Has the least magnitude for a given normal reaction

(1) a-e, b-f, c-g, d-h (2) a-h, b-f, c-e, d-g (3) a-g, b-e, c-f, d-h (4) a-g, b-h, c-f, d-e

26. A block is in limiting equilibrium on a rough horizontal surface. If the net contact force is $\sqrt{3}$ times the normal force, the coefficient of static friction is

1) $\sqrt{2}$ 2) $\frac{1}{\sqrt{2}}$ 3) 0.5 4) $\frac{1}{\sqrt{3}}$

27. A homogeneous chain lies in limiting equilibrium on a horizontal table of coefficient of friction 0.5 with part of it hanging over the edge of the table. The fractional length of the chain hanging down the edge of the table is

1) 1/2 2) 1/5 3) 1/3 4) 2/3

28. The rear side of truck is open and a box of mass 50kg is placed at 3.2m away from the open end. The co-efficient of friction between the box and the surface is 0.2. If the truck starts from rest and moves on a straight road with acceleration 2.1ms^{-2} the box falls off the truck after a time (g=10ms^{-2})

1) $\frac{8}{\sqrt{41}}$s 2) 4 s 3) 8 s 4) $\sqrt{8}$s

29. Two blocks of masses m and 3m on a horizontal surface are in constant with the ends of a horizontal mass less spring. The coefficient of friction between and surface and between 3m and surface is μ and μ /3 respectively. The two blocks are moved towards each other to compress the spring and then released. The two blocks move off in opposite direction covering distances S_1 and S_2 before coming to rest. S_1:S_2 is

1) 1:3 2) 3:1 3) 2:3 4) 3:5

30. A grinding machine whose wheel has a radius of $\frac{1}{\pi}$ is rotating a 2.5 rev/sec. A tool to be sharpened is held against the wheel with a force of 40N. If the coefficient of friction between the tool and wheel is 0.2, power required is

1) 40 W 2) 4W 3) 8W 4) 10W

31. The force of friction acting on a body when its velocity is 2m/s is 50N. When velocity increases to 4m/s, the force of friction will be

(1) 25 N (2) 50N (3) 7N (4) 10N

32. A uniform chain of length L lies on a table. If the coefficient of friction K l, then the maximum length of the chain which can hang from the edge of the table without the chain sliding down is

(1) $\frac{\mu L}{\mu - 1}$ (2) $\frac{\mu L}{\mu + 1}$ (3) $\frac{L}{\mu - 1}$ (4) $\frac{L}{\mu}$

33. A car is moving on a straight horizontal road with a speed of 72km/hr. If the coefficient of static friction between the tyre of the car and the road is 0.5, then the minimum distance within which the car can be stopped will be

(1) 20m (2) 40m (3) 72m (4) 30m

34. An eraser weighing 2N is pressed against the black board with a force of 5N. The coefficient of friction is 0.4. How much force parallel to the black board is required to slide the eraser upwards?

1) 2 N 2) 2.8 3) 4 N 4) 4.8 N

35. Two bodies having the same mass, 5 kg each, have different surface area $20m^2$ and $150m^2$ 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

1. 1: 1 2.1:2 3.2: 1 4.1: 4

36. A body of mass 60kg is pushed with just enough force to start it moving on a rough surface with μ_s = 0.5 and μ_k = 0.4 and the force continues to act afterwards. The acceleration of the body is

1. 0.98 m/sec^2 2. 3.92m/sec^2 3. 4.90m/sec^2 4. Zero

37. A block of mass 10kg is pushed by a force F on a horizontal rough surface moves with an acceleration $5m/s^2$ and when the horizontal force is doubled, it gets an acceleration of $18m/s^2$. Then the coefficient of friction is (assume $g = 10ms^{-2}$)

1. 0.8 2. 0.2 3. 0.4 4. 0.6

38. A van is moving with a speed of 72 kmph on a level road, where the coefficient of friction between tyres and road is 0.5, the minimum radius of curvature, the road must have, for safe driving of van, is ($g=10m/s^2$)

1. 80m 2. 40m 3. 20m 4. 4m

39. The maximum speed with which a car can be driven round a curve of radius 18m without skidding when $g = 10ms^{-2}$ and coefficient of friction between rubber tyres and the roadway is 0.2 is

1. 36 kmph 2. 18 kmph 3. 21.6 kmph 4. 14.4 kmph

40. A body is projected along a rough horizontal surface with a velocity of 6 m/s. If the body comes to rest after travelling a distance of 9m, the coefficient of sliding friction is ($g=10ms^{-2}$)

1. 0.5 2. 0.6 3. 0.4 4. 0.2

41. A uniform chain of length 'L' hangs partly from a table which is kept in equilibrium by friction. The maximum length that can stand without slipping is '*l*', and then the coefficient of friction between the table and the chain is

1. $\frac{l^2}{L-l}$ 2. $\frac{l}{L}$ 3. $\frac{l}{L-l}$ 4. $\frac{L-l}{l}$

42. A car is moving on a circular level road of radius of curvature 300m. If the coefficient of friction is 0.3 and acceleration due to gravity is $10m/s^2$. The maximum speed the car can have is

1. 30 km/h 2. 81 km/h 3. 108 km/h 4. 162 km/h

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

1. $\frac{P}{2\mu \text{ Mg}}$ 2. $\frac{P^2}{2\mu \text{ Mg}}$ 3. $\frac{P^2}{2\mu \text{ M}^2\text{g}}$ 4. $\frac{P}{2\mu \text{ M}^2\text{g}}$

44. A rope lies on a table so that a part of it is hanging. The rope begins so slide when the length of the hanging part is 25% of the entire length. What is the coefficient of friction between the rope and the table

1. 0.2 2.0.33 3.0.5 4.0.75

45. An aero plane requires for takeoff speed of 72 kmph, the run on the ground being 100m. The mass of the plane is 10,000kg and the coefficient of friction between the plane and the ground is 0.2. Assume that the plane accelerates uniformly during the take off, the minimum force required by the engine of the plane to take off is

1. 2×10^4 N 2.1.96×10^4 N 3. 0.04×10^4 N 4.3.96×10^4 N

46. A horizontal force, just sufficient to move a body of mass 4kg lying on a rough horizontal surface is applied on it. The coefficients of static and kinetic friction between the body and the surface are 0.8 and 0.6 respectively. If the force continues to act even after the block has started moving, the acceleration of the block in ms^{-2} is ($g = 10ms^{-2}$)

1. 1/4 2. 1/2 3. 2 4. 4

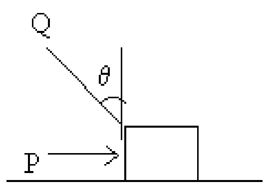
47. A body of weight 64 N is pushed with just enough force to start it moving across a horizontal floor and the same force continues to act afterwards. If the coefficients of static and dynamic friction are 0.6 and 0.4 respectively. The acceleration of the body will be (acceleration due to gravity =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

1. $\frac{g}{2}$ 2. 0.64g 3. $\frac{g}{32}$ 4. 0.2g

48. The horizontal acceleration that should be given to a smooth inclined plane of angle $\sin^{-1}\left(\frac{1}{l}\right)$ to keep an object stationary on the plane, relative to the inclined plane is

1. $\frac{g}{\sqrt{l^2-1}}$ 2. $g\sqrt{l^2-1}$ 3. $\frac{\sqrt{l^2-1}}{g}$ 4. $\frac{g}{\sqrt{l^2+1}}$

49. A block of mass, lying on a rough horizontal plane is acted upon by a horizontal force P and another force Q, inclined at an angle to vertical. The block will remain in equilibrium, if coefficient of friction between it and surface is



1. $\frac{(P+Q\sin\theta)}{(mg+Q\cos\theta)}$ 2. $\frac{(P\cos\theta+Q)}{(mg-Q\sin\theta)}$ 3. $\frac{(P+Q\cos\theta)}{(mg+Q\sin\theta)}$ 4. $\frac{(P\sin\theta-Q)}{(mg-Q\cos\theta)}$

50. A block of mass 2kg is placed on the surface of trolley of mass 20kg which is on a smooth surface. The coefficient of friction between the block and the surface of the trolley is 0.25. If a horizontal force of 2 N acts on the block, the acceleration of the system in ms^{-2} **is** $\left(g=10ms^{-2}\right)$

1. 1.8 2. 1.0 3. 0.9 4. 0.09

Key

1)4	2)2	3)2	4)3	5)1	6) 3	7) 2	8) 2	9) 3
10) 4	11) 4	12) 3	13) 3	14) 4	15) 1	16) 4	17) 2	18) 3
19)2	20)2	21)2	22)1	23)1	24)1	25)3	26) 1	27) 3
28) 3	29) 2	30) 1	31)2	32)4	33)2	34) 4	35)1	36) 1
37) 1	38) 1	39) 3	40) 3	41) 1	42) 3	43) 3	44) 2	45) 4
46) 3	47) 4	48) 1	49) 1	50) 4				

Hints

26. $f_{net} = \sqrt{N^2 + f^2}$

$\sqrt{3}\ N = \sqrt{N^2 + \mu^2 N^2}$

$3N^2 = N^2\ (1+\mu^2)$

$\mu = \sqrt{2}$

27. $\frac{x}{L} = \frac{\mu}{\mu+1} = \frac{0.5}{1.5} \Rightarrow \left(\frac{x}{L}\right) = \frac{1}{3}$

28. $a^1 = a - \mu_k\ g$

$a^1 = 2.1 - 0.2\ (10)$

$a^1 = 0.1\ ms^{-2}$

$$f = \sqrt{\frac{2s}{a^1}} \Rightarrow f = \sqrt{\frac{2(3.2)}{0.1}} = 8\sec$$

29. $S = \frac{V^2}{2\mu g}$

$$\frac{S_1}{S_2} = \left(\frac{V_1}{V_2}\right)^2 \frac{\mu_2}{\mu_1}$$

$$\frac{S_1}{S_2} = \left(\frac{m_2}{m_1}\right)^2 \frac{\mu_2}{\mu_1}$$

$$\frac{S_1}{S_2} = \left(\frac{3m}{m}\right)^2 \frac{\mu}{3\mu}$$

$$\frac{S_1}{S_2} = \frac{3}{1}$$

30. P = fV

$$P = \mu F(r\,2\pi\,n)$$

$$P = (0.2)(40)\,\frac{1}{\pi}\,(2\pi)\,(2.5)$$

P = 40 W

31. Once the body comes into motion, the coefficient of dynamic friction remains constant.

32. mlg = lm (L–l) g

l = lL – l l

$$l = \frac{\mu L}{\mu + 1}$$

34. $\mu = \frac{mg}{F}$

$$F^1 = f_s + mg = \mu_s.F + mg$$

35. Concept

36. Net force $= (\mu_s - \mu_k)$ mg

Acceleration $= (\mu_s - \mu_k)\, g = 0.1 \times 9.8$

$= 0.98$ m/sec^2

37. $F - f = ma$

38. $\frac{mv^2}{r} = \mu_k$ mg

39. $S = \frac{v^2}{2\mu_k gr}$

40. $N = mg - mg\cos\theta$

$\mu N = mg\sin\theta$

41. Weight on the hanging part = (M/L) lg

Weight of part resting on the table

= M/L (L–l)g

Friction force = mR = m (M/L) (L–l)g

42. $F = mr\omega^2$

43. $F.S = \frac{p^2}{2M}$

$S = \frac{p^2}{2M.\mu Mg}$

44. $F - \mu mg = m\left(\frac{v^2 - u^2}{2S}\right)$

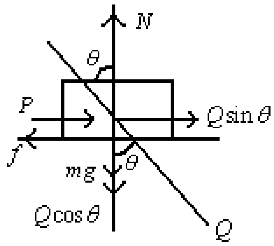
45. $F = \frac{\mu mg}{\cos\varphi - \mu \sin\varphi}$

46. $F - \mu_K mg = ma$

47. $a = (\mu_s - \mu_k)g$

48. $a = \frac{g}{\sqrt{l^2 - 1}}$

49.



N = mg + Q cos θ

P + Q sin θ = f

$P + Q.\sin\theta = \mu(mg + Q\cos\theta)$

$\mu = \left(\frac{P + Q\sin\theta}{mg + Q\cos\theta}\right)$

50. Block does not move $a = \frac{F}{m + M} = \frac{2}{22} = 0.09$