**5-LAWS OF MOTION**

**1. Linear Momentum and Newton’s Second Law of Motion**

1. Linear momentum, *p = mv* 2. According to Newton’s second law, Applied force = Rate of change of linear momentum or  **2.Impulse of a Force**

1. Impulse = Force x time = Change in momentum or  2. = Area under force – time (F – t) graph.

**3. Newton’s Third Law and Motion in a Lift**

1. Reaction = - Action 2. The apparent weight of a man in a lift: (i) When the lift moves upwards with acceleration *a*,  (ii) When the lift moves downwards with acceleration *a*, R = *m (g-a)* (iii) When the lift falls freely, *a* = g, so *R m (g – a) = m (g – g) = 0*  (iv) When the lift is at rest or moves with uniform velocity, *a = 0, so*  *R = m (g – 0) = mg*

**4. Conservation of Linear Momentum**

1. In the absence of any external force, vector sum of the linear momenta of a system of particles remains constant.  constant 2. For a two body system,  3. Recoil velocity of a gun,  where M is the mass of the gun, *m* the mass of bullet and *v* is the velocity of the bullet.

**5. Rocket Propulsion**

1. Resultant force on the rocket F = upthrust on the rocket - weight of the rocket =  2. Acceleration of the rocket after time t  3. Velocity of the rocket after time t,  If the effect of gravity is neglected, then  ****

4. Burn-out speed of the rocket, 

Here : *u* = Velocity of exhaust gases *v0* = Initial velocity of the rocket *v* = Velocity of the rocket at any instant t *m0* = Initial mass of the rocket *m* = Final mass of the rocket *mr* = Mass of the empty rocket *dm/dt* = Rate of ejection of fuel

**6. Equilibrium of Concurrent Forces**

1. A number of forces acting at the same point are called concurrent forces. 2. A number of concurrent forces are said to be in equilibrium if there resultant is zero.  3. If and are three concurrent forces in equilibrium. (i)  (ii)  (Lami’s theorem)

**7. Motion of Connected Bodies**

1. When a number of bodies are connected together by strings, rods, etc., it is convenient to draw a free body diagram for each body separately by showing all the forces acting on it. 2. Equation of motion for each body is written by equating the net force acting on the body to its mass times the acceleration produced.

**8. Coefficient of friction and Angle of Friction**

1. Coefficient of limiting friction =  or  or  2. Coefficient of kinetic friction =  or  or  3. For a body placed on horizontal surface, R = *mg*   and  4. Static friction.  or  5. Kinetic friction,  6. If  is the angle of friction, then μs = tan 7. If  is the angle of repose, then μs =  8. Angle of repose = Angle of friction i.e.  9. For a body moving on a rough horizontal surface with retardation *a*,  10.  and 

Where μr is the coefficient of rolling friction, *fr* is the rolling friction and *r* is the radius of the rolling body.

**9.Motion along Rough Inclined Plane**

1. For a body placed on an inclined plane of inclination  Normal reaction, *R = mg cos* Friction, *f = μR = μ mg cos*  2. When a body moves down an inclined plane without any acceleration, net downward force needed is *F = mg sin*  *- f = mg* (sin - μ cos) Work done, *W = Fs* = *mg* (sin - μ cos) s 3. When a body moves up an inclined plane without acceleration, net upward force needed is *F = mg sin* + f = mg (sin  + μ cos) W = *mg (sin*  + μ cos ) s 4. When a body moves up an inclined plane, with acceleration *a*, net upward force needed is *F = ma + mg sin*  + *f* = *m (a + g sin*  + μg cos ) W = *m (a + g sin*  + μ g cos ) s

**10. Centripetal Force**

1. For a body moving, along a horizontal circular path, centripetal force is  2. Centrifugal force is equal to centripetal force in magnitude but acts away from the centre

**11. Banking of Roads and Bending of a Cyclist**

1.A vehicle taking a circular turn on a level road. If μ is the coefficient of friction between tyres and road, then the maximum velocity with which the vehicle can safely take a circular turn of radius r is given by   2. *Banking of tracks (roads).* The maximum velocity with which a vehicle (in the absence of friction) can negotiate a circular road of radius *r* and banked at an angleis given by  When the frictional forces are also taken into account, the maximum safe velocity is given by  3. *Bending of a cyclist*. In order to take a circular turn of radius *r* with speed *v*, the cyclist should bend himself through an angle from the vertical such that. 

**12. Motion in a Vertical Circle**

1. Velocity of the body at any point at a height *h* from the lowest point.  2. Tension in the string at any point  3. Tension at the lowest point,  4. Tension at the highest point,  5. Difference in tensions at the highest and lowest points,  6. Minimum velocity at the lowest point for looping the vertical loop,  7. Velocity at the highest point for looping the loop, 