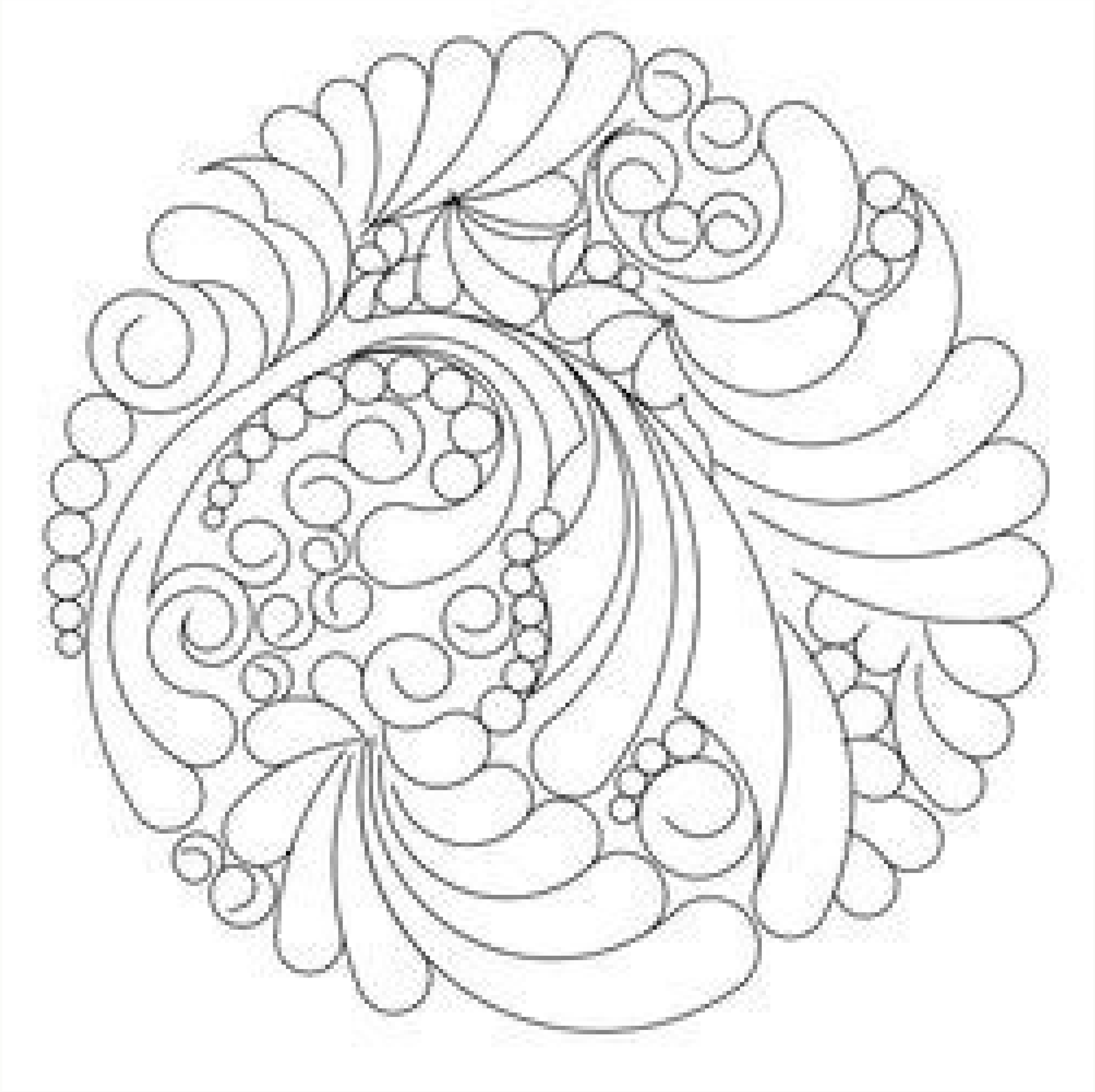
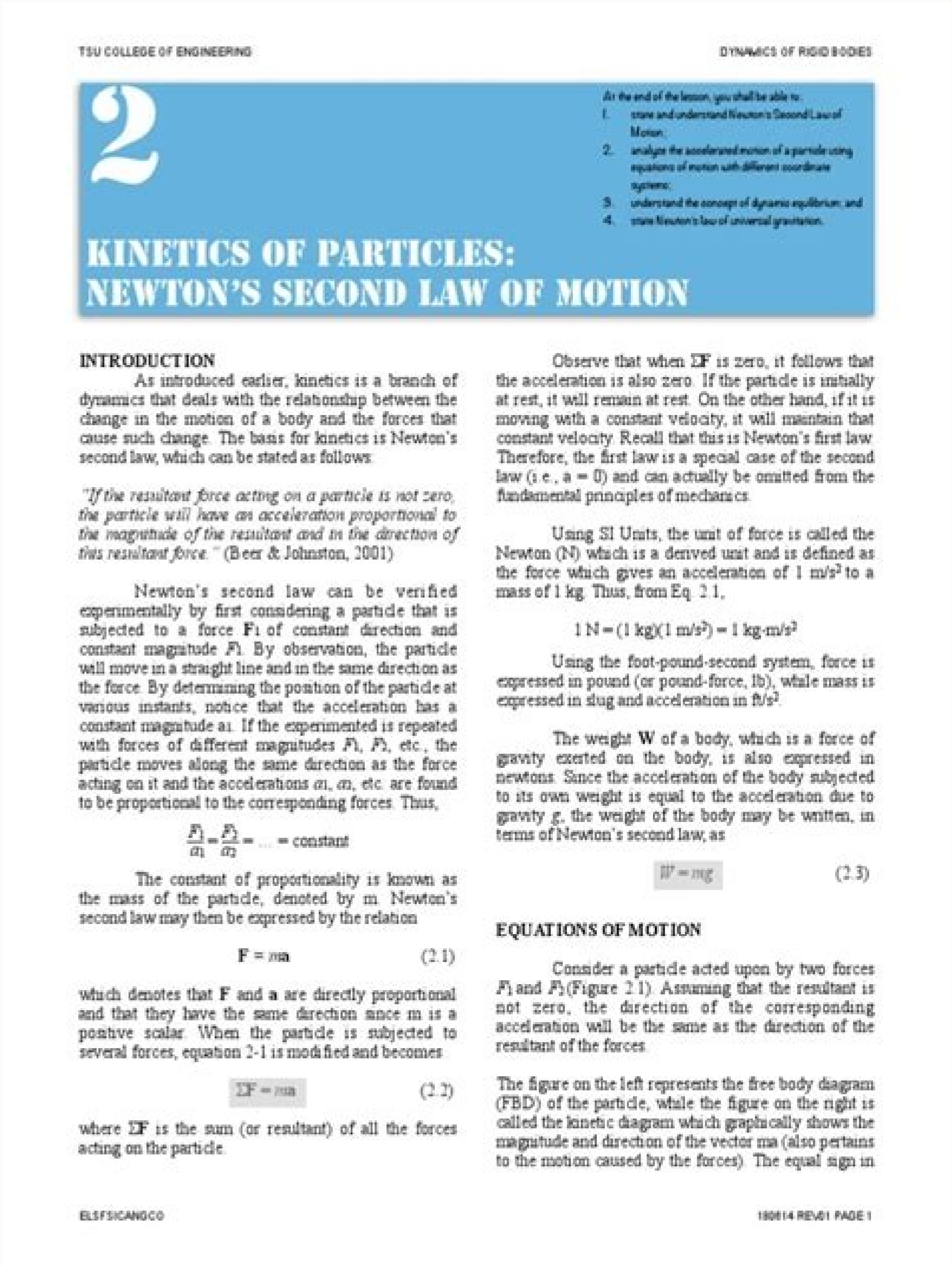
Circular motion pdf mahesh tutorials





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At the end of the lesson, you shall be able to:

1. state and understand Newton's Second Law of Motion;
2. analyze the accelerated motion of a particle using equations of motion with different coordinate systems;
3. understand the concept of dynamic equilibrium; and
4. state Newton's law of universal gravitation.

KINETICS OF PARTICLES: NEWTON'S SECOND LAW OF MOTION

INTRODUCTION

As introduced earlier, kinetics is a branch of dynamics that deals with the relationship between the change in the motion of a body and the forces that cause such change. The basis for kinetics is Newton's second law, which can be stated as follows:

"If the resultant force acting on a particle is not zero, the particle will have an acceleration proportional to the magnitude of the resultant and in the direction of this resultant force." (Beer & Johnston, 2001)

Newton's second law can be verified experimentally by first considering a particle that is subjected to a force $\mathbf{F}_1$ of constant direction and constant magnitude F_1. By observation, the particle will move in a straight line and in the same direction as the force. By determining the position of the particle at various instants, notice that the acceleration has a constant magnitude a_1. If the experimented is repeated with forces of different magnitudes F_1, F_2, etc., the particle moves along the same direction as the force acting on it and the accelerations a_1, a_2, etc. are found to be proportional to the corresponding forces. Thus,

$$\frac{F_1}{a_1} = \frac{F_2}{a_2} = \ldots = \text{constant}$$

The constant of proportionality is known as the mass of the particle, denoted by m. Newton's second law may then be expressed by the relation

$$\mathbf{F} = m\mathbf{a} \qquad (2.1)$$

which denotes that **F** and **a** are directly proportional and that they have the same direction since m is a positive scalar. When the particle is subjected to several forces, equation 2-1 is modified and becomes

$$\Sigma\mathbf{F} = m\mathbf{a} \qquad (2.2)$$

where $\Sigma\mathbf{F}$ is the sum (or resultant) of all the forces acting on the particle.

Observe that when $\Sigma\mathbf{F}$ is zero, it follows that the acceleration is also zero. If the particle is initially at rest, it will remain at rest. On the other hand, if it is moving with a constant velocity, it will maintain that constant velocity. Recall that this is Newton's first law. Therefore, the first law is a special case of the second law (i.e., a = 0) and can actually be omitted from the fundamental principles of mechanics.

Using SI Units, the unit of force is called the Newton (N) which is a derived unit and is defined as the force which gives an acceleration of 1 m/s^2 to a mass of 1 kg. Thus, from Eq. 2.1,

$$1\text{ N} = (1\text{ kg})(1\text{ m/s}^2) = 1\text{ kg·m/s}^2$$

Using the foot-pound-second system, force is expressed in pound (or pound-force, lb), while mass is expressed in slug and acceleration in ft/s^2.

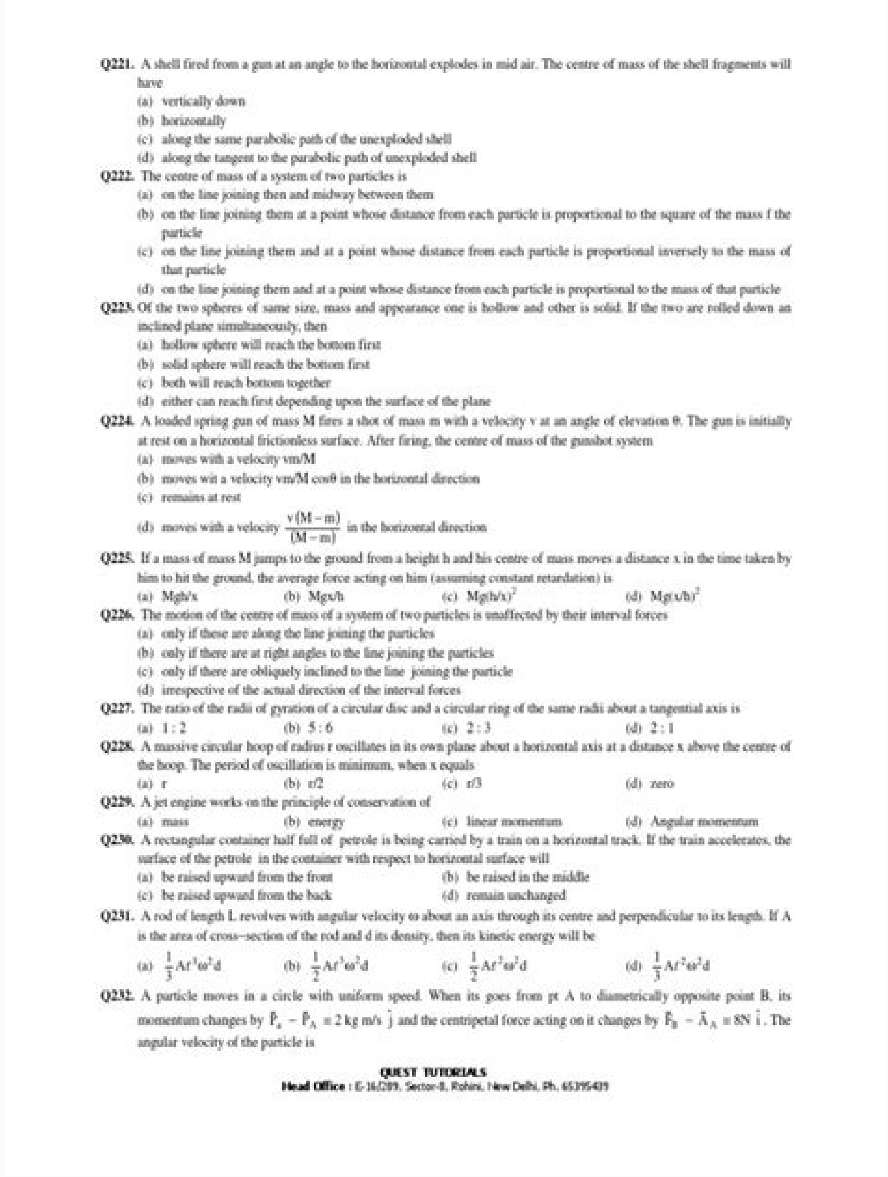
The weight **W** of a body, which is a force of gravity exerted on the body, is also expressed in newtons. Since the acceleration of the body subjected to its own weight is equal to the acceleration due to gravity g, the weight of the body may be written, in terms of Newton's second law, as

$$W = mg \qquad (2.3)$$

EQUATIONS OF MOTION

Consider a particle acted upon by two forces F_1 and F_2 (Figure 2.1). Assuming that the resultant is not zero, the direction of the corresponding acceleration will be the same as the direction of the resultant of the forces.

The figure on the left represents the free body diagram (FBD) of the particle, while the figure on the right is called the kinetic diagram which graphically shows the magnitude and direction of the vector ma (also pertains to the motion caused by the forces). The equal sign in



Q221. A shell fired from a gun at an angle to the horizontal explodes in mid air. The centre of mass of the shell fragments will have

(a) vertically down
(b) horizontally
(c) along the same parabolic path of the unexploded shell
(d) along the tangent to the parabolic path of unexploded shell

Q222. The centre of mass of a system of two particles is

(a) on the line joining then and midway between them
(b) on the line joining them at a point whose distance from each particle is proportional to the square of the mass f the particle
(c) on the line joining them and at a point whose distance from each particle is proportional inversely to the mass of that particle
(d) on the line joining them and at a point whose distance from each particle is proportional to the mass of that particle

Q223. Of the two spheres of same size, mass and appearance one is hollow and other is solid. If the two are rolled down an inclined plane simultaneously, then

(a) hollow sphere will reach the bottom first
(b) solid sphere will reach the bottom first
(c) both will reach bottom together
(d) either can reach first depending upon the surface of the plane

Q224. A loaded spring gun of mass M fires a shot of mass m with a velocity v at an angle of elevation θ. The gun is initially at rest on a horizontal frictionless surface. After firing, the centre of mass of the gunshot system

(a) moves with a velocity vm/M
(b) moves wit a velocity vm/M cosθ in the horizontal direction
(c) remains at rest
(d) moves with a velocity $\frac{v(M-m)}{(M-m)}$ in the horizontal direction

Q225. If a mass of mass M jumps to the ground from a height h and his centre of mass moves a distance x in the time taken by him to hit the ground, the average force acting on him (assuming constant retardation) is

(a) Mgh/x (b) Mgx/h (c) $Mg(h/x)^2$ (d) $Mg(x/h)^2$

Q226. The motion of the centre of mass of a system of two particles is unaffected by their interval forces

(a) only if these are along the line joining the particles
(b) only if there are at right angles to the line joining the particles
(c) only if there are obliquely inclined to the line joining the particle
(d) irrespective of the actual direction of the interval forces

Q227. The ratio of the radii of gyration of a circular disc and a circular ring of the same radii about a tangential axis is

(a) 1 : 2 (b) 5 : 6 (c) 2 : 3 (d) 2 : 1

Q228. A massive circular hoop of radius r oscillates in its own plane about a horizontal axis at a distance x above the centre of the hoop. The period of oscillation is minimum, when x equals

(a) r (b) r/2 (c) r/3 (d) zero

Q229. A jet engine works on the principle of conservation of

(a) mass (b) energy (c) linear momentum (d) Angular momentum

Q230. A rectangular container half full of petrole is being carried by a train on a horizontal track. If the train accelerates, the surface of the petrole in the container with respect to horizontal surface will

(a) be raised upward from the front (b) be raised in the middle
(c) be raised upward from the back (d) remain unchanged

Q231. A rod of length L revolves with angular velocity ω about an axis through its centre and perpendicular to its length. If A is the area of cross–section of the rod and d its density, then its kinetic energy will be

(a) $\frac{1}{3}Al^3\omega^2d$ (b) $\frac{1}{2}Al^3\omega^2d$ (c) $\frac{1}{2}Al^2\omega^2d$ (d) $\frac{1}{3}Al^2\omega^2d$

Q232. A particle moves in a circle with uniform speed. When its goes from pt A to diametrically opposite point B, its momentum changes by $\vec{P}_B - \vec{P}_A = 2$ kg m/s $\hat{j}$ and the centripetal force acting on it changes by $\vec{F}_B - \vec{A}_A = 8N\,\hat{i}$. The angular velocity of the particle is

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Centriputical force = mass x acceleration centriptis the relationship between linear vault vea speed Â ‰ v = ‰ r, where ‰ ‰ ‰ ‰ ‰ = 2ã Following the road at steady speed, the car is in uniform circular motion. For our case, this second force is insignificant in comparison with weight. Do they have a significant effect on the production of a downward forces? For example, we took the case of a ring. If it acts along the speed of speed, it will increase your speed, on the other hand if it acts in opposition to the direction of speed, it will slow it down. This acceleration is called a centrupt acceleration or even radial acceleration and is given by the relationship: a = v2 / r where v is speed. Your magnitude is called speed and also has a direction. See a collection of examples resolved for this topic on our site Buzztutor.com Velocity is a vector amount. The car directs the constant speed on a hill in which the ridge of the curvature radius, in the vertical plane, is 30ã, m, as shown. And this new particle is placed in such a way and has such a mass which, when triggered by an external force, moves exactly the same way as the system it replaced. Now, if we are able to replace all these particles for only one particle. Secondly, drag and gasoline consumption, which benefits oil companies (at least in the short term). So do not worry! Let's now consider two particles. I do not recommend the following experiment, but if he can exercise 2Ã, KN, then he must endure, elastically, the weight of some people on it. Rc.m. (t) = {m1r1 (t) + m2r2 (t) + â € "MN RN (t)} / (M1 + m2 + â €" MN) The position of the mass center of A bodied body is a fixed point. (Note: A Web Page It is difficult to use the usual vector note. These are µ fun. (This seems more complex than A©. You are not reading a free view pages 4 to 5 not shown in this view. This route adds extra danger to maneuver, that is only one of the reasons for the µ, rarely FÃsica, that one should trust the Calculus here, instead of carrying out the experiment. There are two possibilities: first possibility if the speed is constant, the movement A© called uniform circular motion. In general, there is also a component below the force that the air exerts in the car *. Thus, acceleration and color speed are reorganizing this equation to give the color speed: vcritÃ¢ = Âª (RG) = 17 m.s'1 = 62 kph banknote that, while in contact with the road, the trolley is rotating in the vertical plane with angular velocity. Obviously, this point is not in the ring. Taking the weight of the car as 20 , a 10% increase in downward force would require the sheet to exercise 2 down. Now the Center down Capital acceleration When the car is at the top of the hill A© V2 / R, and this acceleration can not be greater than g. If you are not behind a web filter, make sure that the * .kastatic.org and * .kasandbox.org domains are unlocked. Let them have masses m1 and m2. Then I will use bold fonts to portray vectors). Other relations µ F: Since v = Ã∞ r also ©a second possibility to change the speed of the body in circular motion, a tangential force must be applied. Your weight There is one of these things. A mass body is moving in a circular path of radius r. At the ³ point, where contact with the road is lost, the forces exerted on the wheels are small, and so are the torques (which we will meet when we arrive at route). The direction of the velocity is along the tangent to the circular path. Rc.m. (t) = {m1r1 (t) + m2r2 (t)} / + m2) from above Of ³, for a two - part system, the center of mass is always between the two parts. Where it is depends on the shape of the body. First, they identify the style of the driver, which may provide a warning to other drivers. So it changes as the body is in different positions µ different times. This point may or may not be in the body. Consequently, the car, while in the air, continues to rotate at this rate. What are the descendants on it? It can change its direction, making it move in the circular path with constant speed. Also ©m is in the line that joins the two parts. Some street cars have a miniature version of this alum role. We can say Then we can write the instant angular velocity as dÃ Ì§ /dt Linear velocity = Circular path radius x Angular velocity Acceleration mÃ© dia = Change in angular acceleration / Time interval Linear acceleration = Circular path radius x Angular acceleration Then we find the center of mass of the system. The center of mass will be in its geo-geographic center. * Racing cars often have a large sheet whose effect, at high speed, will provide a downward force and thus allow greater friction forces for curves, braking and even accelerating. If you are not seeing this message, it means that we are having trouble loading external resources onto our site. Let r1 (t) and r2 (t) be the position vectors of the two parts at the instant of time t. And the acceleration along the radius towards the center. At the top of the hill, its acceleration is therefore descending and its magnitude is © v2/r. Center of body mass A A A Rod Mean point of the rod Ring Center of the sphere Center of the sphere Angular velocity mÃ© dia = angular displacement / time interval So, if The animation below arap arap iuqa adizudorper ©Ã e ,ralucriC otnemivoM olud³Ãm on adizudortni who might like to view it in slow motion. Consider that there are a number of particles forming a system, such that, when an external force is applied, the complete system moves as on. The position vector Rc.m.(t), giving the center of mass of this system is given by the formula. Now the motion is called non-uniform circular motion Net acceleration In non-uniform circular motion, speed as well as direction changes continuously. Speed is constant but the direction is changing continuously, so the motion is accelerated. Let's find the critical speed vcrit at which the car loses contact with the road. (See Air resistance to obtain an upper limit.) So, at the top of the hill, the weight is the only downwards force, and so the maximum downwards acceleration is g, which, as we saw in the Projectile module, is 9.8Ã Âm.s¢ÃÂÂ2. 9.8Ã Âm.s¢ÃÂÂ2.

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