Physics formulas: mechanics

[Science](), [Physics]()

Physics Formulas: Mechanics Mechanics is the oldest branch of physics. Mechanics deals with all kinds and complexities of motion. It includes various techniques, which can simplify the solution of a mechanical problem. Here are some of the often required physics formulas falling in mechanics domain. Motion in One Dimension The physics formulas for motion in one dimension (Also called Kinematical equations of motion) are as follows. (Here 'u' is initial velocity, 'v' is final velocity, 'a' is acceleration and t is time): * s = ut + ½ at2 * v = u + at * v2 = u2 + 2as * vav(Average Velocity) = (v+u)/2 Momentum, Force and Impulse Physics Formulas for momentum, impulse and force concerning a particle moving in 3 dimensions are as follows (Here force, momentum and velocity are vectors): * Momentum is the product of mass and velocity of a body. Momentum is calculate using the formula: P = m (mass) x v (velocity) * Force can defined as something which causes a change in momentum of a body. Force is given by the celebrated newton's law of motion: F = m (mass) x a (acceleration) * Impulse is a large force applied in a very short time period. The strike of a hammer is an impulse. Impulse is given by I = m(v-u) Pressure Pressure is defined as force per unit area: | | Pressure (P) = | Force (F)Force (A) | | Density Density is the mass contained in a body per unit volume. The physics formula for density is: | | Density (D) = | Mass(M)Volume (V) | | Angular Momentum Angular momentum is an analogous quantity to linear momentum in which the body is undergoing rotational motion. The physics formula for angular momentum (J) is given by: J = r x p where J denotes angular momentum, r is radius vector and p is linear momentum. Torque Torque can be defined as moment of force. Torque causes rotational motion. The formula for torque is: Ï„ = r x

F, where Ï„ is torque, r is the radius vector and F is linear force. Circular Motion The physics formulas for circular motion of an object of mass 'm' moving in a circle of radius 'r' at a tangential velocity 'v' are as follows: | | Centripetal force (F) = | mv2r | | | | Centripetal Acceleration (a) = | v2r | | Center of Mass General Formula for Center of mass of a rigid body is : | | R = | Î£Ni = 1 miriÎ£Ni = 1mi | | where R is the position vector for center of mass, r is the generic position vector for all the particles of the object and N is the total number of particles. Reduced Mass for two Interacting Bodies The physics formula for reduced mass (Î¼) is : | | Î¼ = | m1m2m1 + m2 | | where m1 is mass of the first body, m2 is the mass of the second body. Work and Energy Physics formulas for work and energy in case of one dimensional motion are as follows: W (Work Done) = F (Force) x D (Displacement) Energy can be broadly classified into two types, Potential Energy and Kinetic Energy. In case of gravitational force, the potential energy is given by P. E. (Gravitational) = m (Mass) x g (Acceleration due to Gravity) x h (Height) The transitional kinetic energy is given by ½ m (mass) x v2(velocity squared) Power Power is, work done per unit time. The formula for power is given as | | Power (P) = | V2R | = I2R | | where P= power, W = Work, t = time. Physics Formulas: Friction Friction can be classified to be of two kinds : Static friction and dynamic friction. Static Friction: Static friction is characterized by a coefficient of static friction Î¼ . Coefficient of static friction is defined as the ratio of applied tangential force (F) which can induce sliding, to the normal force between surfaces in contact with each other. The physics formula to calculate this static coefficient is as follows: | | Î¼ = | Applied Tangential Force (F)Normal Force(N) | | The amount of force required to slide a solid resting on flat surface depends on the co efficient of static friction and is given by the formula: FHorizontal = Î¼ x M(Mass of solid) x g (acceleration) Dynamic Friction: Dynamic friction is also characterized by the same coefficient of friction as static friction and therefore formula for calculating coefficient of dynamic friction is also the same as above. Only the dynamic friction coefficient is generally lower than the static one as the applied force required to overcome normal force is lesser. Physics Formulas for Moment of Inertia Here are some physics formulas for Moments of Inertia of different objects. (M stands for mass, R for radius and L for length): Object | Axis | Moment of Inertia | Disk | Axis parallel to disc, passing through the center | MR2/2 | Disk | Axis passing through the center and perpendicular to disc | MR2/2 | Thin Rod | Axis perpendicular to the Rod and passing through center | ML2/12 | Solid Sphere | Axis passing through the center | 2MR2/5 | Solid Shell | Axis passing through the center | 2MR2/3 | Newtonian Gravity Here are some important physics formulas related to Newtonian Gravity: Newton's Law of universal Gravitation: | | Fg = | Gm1m2r2 | | where * m1, m2 are the masses of two bodies * G is the universal gravitational constant which has a value of 6. 67300 Ã— 10-11 m3 kg-1 s-2 * r is distance between the two bodies Formula for escape velocity (vesc) = (2GM / R)1/2where, * M is mass of central gravitating body * R is radius of the central body Projectile Motion Here are two important physics formulas related to projectile motion: (v = velocity of particle, v0 = initial velocity, g is acceleration due to gravity, Î¸ is angle of projection, h is maximum height and l is the range of the projectile.) | | Maximum height of projectile (h) = | v0 2sin2Î¸2g | | Horizontal range of projectile (l) = v0 2sin 2Î¸ / g Simple Pendulum The physics formula for the period of a simple pendulum (T) = 2Ï€ âˆš(l/g)where * l is the length of the pendulum * g is acceleration due to gravity Conical Pendulum The Period of a conical pendulum (T) = 2Ï€ âˆš(lcosÎ¸/g) where * l is the length of the pendulum * g is acceleration due to gravity * Half angle of the conical pendulum Physics Formulas: Electricity Here are some physics formulas related to electricity. Resistance The physics formulas for equivalent resistance in case of parallel and series combination are as follows: Resistances R1, R2, R3 in series: Req = R1 + R2 + R3 Resistances R1 and R2 in parallel: | | Req = | R1R2R1 + R2 | | For n number of resistors, R1, R2… Rn, the formula will be: 1/Req = 1/R1 + 1/R2 + 1/R3…+ 1/Rn Ohm's Law Ohm's law gives a relation between the voltage applied a current flowing across a solid conductor: V (Voltage) = I (Current) x R (Resistance) Power In case of a closed electrical circuit with applied voltage V and resistance R, through which current I is flowing, | | Power (P) = | V2R | | = I2R. . . (because V = IR, Ohm's Law) Kirchoff's Voltage Law For every loop in an electrical circuit: Î£iVi = 0 where Vi are all the voltages applied across the circuit. Kirchoff's Current Law At every node of an electrical circuit: Î£iIi = 0 where Ii are all the currents flowing towards or away from the node in the circuit. Physics Formulas: Electromagnetism Here are some of the basic physics formulas from electromagnetism. The coulombic force between two charges at rest is | | (F) = | q1q24Ï€Îµ0r2 | | Here, * q1, q2 are charges * Îµ0 is the permittivity of free space * r is the distance between the two charges Lorentz Force The Lorentz force is the force exerted by an electric and/or magnetic field on a charged particle. (Lorentz Force) F = q (E + v x B) where * q is the charge on the particle * E and B are the electric and magnetic field vectors Physics

Formulas for Relativistic Mechanics Here are some of the most important relativistic mechanics physics formulas. The transition from classical to relativistic mechanics is not at all smooth, as it merges space and time into one by taking away the Newtonian idea of absolute time. If you know what is Einstein's special theory of relativity, then the following formulas will make sense to you. Lorentz Transformations Lorentz transformations can be perceived as rotations in four dimensional space. Just as rotations in 3D space mixes the space coordinates, a Lorentz transformation mixes time and space coordinates. Consider two, three dimensional frames of reference S(x, y, z) and S'(x', y', z') coinciding with each other. Now consider that frame S' starts moving with a constant velocity v with respect to S frame. In relativistic mechanics, time is relative! So the time coordinate for the S' frame will be t' while that for S frame will be t. Consider | | Î³ = | 1â ˆš(1 - v2/c2) | | . The coordinate transformations between the two frames are known as Lorentz transformations and are given as follows: Lorentz Transformations of Space and Time x = Î³ (x' + vt') and x' = Î³ (x - vt) y = y' z= z' t = Î³(t' + vx'/c2) and t' = Î³(t - vx/c2) Relativistic Velocity Transformations In the same two frames S and S', the transformations for velocity components will be as follows (Here (Ux, Uy, Uz) and (Ux', Uy', Uz') are the velocity components in S and S' frames respectively): Ux = (Ux' + v) / (1 + Ux'v / c2) Uy = (Uy') / Î³(1 + Ux'v / c2) Uz = (Uz') / Î³(1 + Ux'v / c2) and Ux' = (Ux - v) / (1 - Uxv / c2) Uy' = (Uy) / Î³(1 - Uxv / c2) Uz' = (Uz) / Î³(1 - Uxv / c2) Physics Formulas for Momentum and Energy Transformations in Relativistic Mechanics Consider the same two frames (S, S') as in case of Lorentz coordinate transformations above. S' is moving at a velocity 'v' along the x-axis. Here again Î³is the Lorentz factor. In S frame (Px, Py, Pz) and in S' frame (Px', Py', Pz') are momentum components. Now we consider physics formulas for momentum and energy transformations for a particle, between these two reference frames in relativistic regime. Component wise Momentum Transformations and Energy Transformations Px = Î³(Px' + vE' / c2) Py = Py' Pz = Pz' E = Î³(E' + vPx) and Px' = Î³(Px - vE' / c2) Py' = Py Pz' = Pz E' = Î³(E - vPx) Physical Formulas for Quantities in Relativistic Dynamics All the known quantities in classical mechanics get modified, when we switch over to relativistic mechanics which is based on the special theory of relativity. Here are formulas of quantities in relativistic dynamics. Relativistic momentum p = Î³m0v where m0 is the rest mass of the particle. Rest mass energy E = m0c2 Total Energy (Relativistic) E = âˆš(p2c2 + m02c4)) Optics Physics Formulas Optics is one of the oldest branches of physics. There are many important optics physics formulas, which we need frequently in solving physics problems. Here are some of the important and frequently needed optics formulas. Snell's Law: | | Sin iSin r | = | n2n1 | = | v1v2 | | * where i is angle of incidence * r is the angle of refraction * n1 is refractive index of medium 1 * n2 is refractive index of medium 2 * v1, v2 are the velocities of light in medium 1 and medium 2 respectively Gauss Lens Formula: 1/u + 1/v = 1/f where * u - object distance * v - image distance * f - Focal length of the lens Bragg's Law of Diffraction: 2a Sin Î¸ = nÎ» where * a - Distance between atomic planes * n - Order of Diffraction * Î¸ - Angle of Diffraction * Î» - Wavelength of incident radiation Newton's Rings Formulas Here are the important physics formulas for Newton's rings experiment which illustrates diffraction. nth Dark ring formula: r2n = nRÎ» nth Bright ring formula: r2n =

(n + ½) RÎ» where * nth ring radius * Radius of curvature of the lens * Wavelength of incident light wave Quantum Physics Formulas Quantum physics is one of the most interesting branches of physics, which describes atoms and molecules, as well as atomic sub-structure. Here are some of the formulas related to the very basics of quantum physics, that you may require frequently. De Broglie Wave De Broglie Wavelength: | | Î» = | hp | | where, Î»- De Broglie Wavelength, h - Planck's Constant, p is momentum of the particle. Planck Relation The plank relation gives the connection between energy and frequency of an electromagnetic wave: | | E = hv = | hÏ‰2Ï€ | | where h is Planck's Constant, v the frequency of radiation and Ï‰ = 2Ï€v Uncertainty Principle Uncertainty principle is the bedrock on which quantum mechanics is based. It exposes the inherent limitation that nature imposes on how precisely a physical quantity can be measured. Uncertainty relation holds between any two non-commuting variables. Two of the special uncertainty relations are given below. Position-Momentum Uncertainty What the position-momentum uncertainty relation says is, you cannot predict where a particle is and how fast it is moving, both, with arbitrary accuracy. The more precise you are about the position, more uncertain will you be about the particle's momentum and vice versa. The mathematical statement of this relation is given as follows: | | Î” x. Î” p â‰¥ | h2Ï€ | | where Î” x is the uncertainty in position and Î” p is the uncertainty in momentum. Energy-Time Uncertainty This is an uncertainty relation between energy and time. This relation gives rise to some astounding results like, creation of virtual particles for arbitrarily short periods of time! It is mathematically stated as follows: | | Î” E. Î” t â‰¥ | h2Ï€ | | where Î” E is the uncertainty in energy and

Î” t is the uncertainty in time. This concludes my review of some of the important physics formulas. This physics formulas list, is only representative and is by no means anywhere near complete. Physics is the basis of all sciences and therefore its domain extends over all sciences. Every branch of physics theory abounds with countless formulas. If you resort to just mugging up all these physics formulas, you may pass exams, but you will not be doing real physics. If you grasp the underlying theory behind these formulas, physics will be simplified. To view physics through the formulas and laws, you must be good at maths. There is no way you can run away from it. Mathematics is the language of nature! The more things we find out about nature, more words we need to describe them. This has led to increasing jargonization of science with fields and sub-fields getting generated. You could refer to our glossary of science terms and scientific definitions for any jargon that is beyond your comprehension. It is not definitive but will certainly help you out with some physics terms. If you really want to get a hang of what it means to be a physicist and get an insight into physicist's view of things, read 'Feynman Lectures on Physics', which is a highly recommended reading, for anyone who loves physics! It is written by one of the greatest physicists ever, Prof. Richard Feynman, who really knew what it means to understand physics! Read and learn from the master