



5 Physical Quantities

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1) Velocity

- = change in position / change in time
- Velocity is a vector and has magnitude or direction, speed is scalar and only has magnitude
- Kinetic energy = $\frac{1}{2} (\text{mass})(\text{velocity})^2$
- Instantaneous velocity: the derivative of position with respect to time
- Magnetic force on a charged particle is = to the cross product of velocity and magnetic field strength
- Speed of sound is minimized in the SOFAR channel of the ocean



Question 1:

The hot spot that created the Hawaiian Islands is the largest discovered example of the zones of the core-mantle boundary named for having "ultra low" values of this quantity. In the ocean, the depth at which one form of this quantity is minimized is known as the SOFAR channel. Andrija Mohorovičić (MOH-hoh-roh-VEE-cheech) used the discrepancy in two different measures of this quantity to provide evidence for the existence of his namesake discontinuity. For an (*) S-wave, this quantity is equal to the square root of the bulk modulus divided by the density. Because this quantity is higher for P-waves than S-waves, P-waves are always measured first on a seismograph. For 10 points, name this quantity which, for a sound wave in the air, is around 343 meters per second.



2) Torque

- a turning or twisting force, causes rotation, measured in Newtons
- gyroscopic precession is also known as torque induced precession
- = Moment of Inertia * angular acceleration
- = Force * distance * $\sin(\theta)$
- time derivative of angular momentum
- torsion is deformation caused by this
- Direction can be determined by right hand rule
- Henry Cavendish calculated big G using a device whose governing equation is that this quantity equals "negative kappa theta"

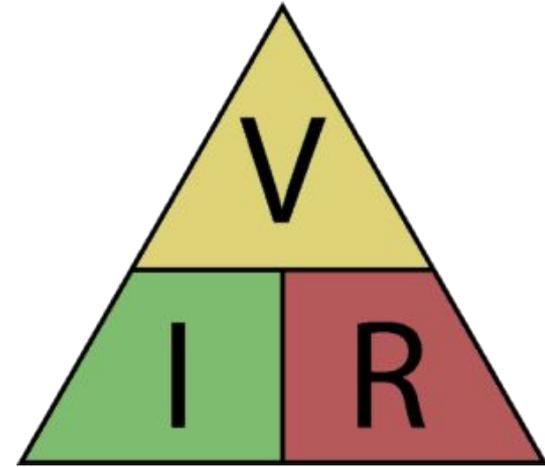


Question 2:

The polar moment of inertia is defined using a ratio of this quantity to the maximum shear stress on a beam. Henry Cavendish calculated big G using a device whose governing equation is that this quantity equals "negative kappa theta." This quantity is nonzero in a couple. For a wire loop placed in a field, this quantity equals the field strength times the dipole moment times the sine of the angle between them. The rate at which a top (*) precesses equals this quantity divided by the top's angular momentum. The net value for this quantity equals the angular acceleration times the moment of inertia, and is calculated by summing the cross product of each force and its distance to the axis. For 10 points, name this quantity that causes objects to rotate.

3) Current

- = voltage / resistance by Ohm law, measured in amperes
- power = current * voltage
- skin effect: current is distributed towards surface due to inductance
- A flow of electric charge.
- density of this quantity equals conductivity times the electric field
- “Dark” type: residual electric current flowing in a photoelectric device without light entering the device
- magnetic field is proportional to this quantity according to the Biot–Savart law



<https://www.build-electronic-circuits.com/ohms-law/>



Question 3:

The Laplacian of the magnetic vector potential is equal to the negative product of the permeability of free space and this quantity. The magnetic dipole moment is equal to area times this quantity. This quantity is multiplied by the cross product of the length and displacement vectors in the numerator of the (*) Biot-Savart law. This quantity is equal to the time derivative of charge and is also equal to voltage over resistance. For 10 points, name this quantity that quantifies the amount of flowing charge, measured in amperes.

4) Mass

- Property of how much matter is in an object
- Rotational analogue is inertia
- Gravitational force between two objects is proportional to the product of the masses
- Is transferred along an interface of two fluids due to a gradient of the surface tension
- SI unit of kilogram is defined by a cylinder of platinum-iridium alloy stored in Saint-Cloud, France



<https://www.atlasobscura.com/places/le-grand-k>



Question 4:

This quantity is imparted by spontaneous symmetry breaking via a mechanism described by a Mexican hat potential. Neutrinos possess a nonzero value for this quantity due to flavor oscillations. The reciprocal of the sum of the reciprocals of two values of this quantity gives the “reduced” form of this quantity. This quantity is generated by a field mediated by the (*) Higgs boson. Einstein’s equivalence principle relates the gravitational and inertial types of this quantity. Two measures of this quantity are multiplied in Newton’s law of gravity. For 10 points, name this quantity which equals energy when multiplied by the square of the speed of light.



5) Energy

- A body's ability to work
- Measured in Joules
- Kinetic energy = $(\frac{1}{2})mv^2$, Potential = mgh
- Total energy of a system is given by a Hamiltonian
- In classical mechanics, the conservation of this property is guaranteed by time translational symmetry through Noether's theorem
- Its sign can be used to determine if eccentricity of an orbit is greater or less than 1, orbit is bound if energy is negative



Question 5:

Under a canonical transformation, the operator for this quantity is replaced by its old form plus the partial time derivative of the generating function. When separating variables in the Hamilton–Jacobi equation, this quantity multiplied by time gives the difference between Hamilton’s characteristic and principal functions. The sign of this quantity determines whether an orbit has an eccentricity greater or less than 1, since it is negative only for bound orbits. A system with time translation symmetry will conserve this quantity according to Noether’s (“NUR-tuh’s”) theorem. In special relativity, this scalar quantity is divided by the speed of light and grouped with momentum to form a four-vector. For 10 points, name this quantity calculated by the Hamiltonian operator, which has kinetic and potential components.