- Rotational motion
  All points move in circles about an axis within the body
- Rigid body
  A rigid body is an object with a definite shape that doesn't change
- Torque(moment of a force)
  It is the product of the force and the perpendicular distance between the line of action of the force and the rotational axis
- Newton's first law for rotational motion(rotational equilibrium)
  - An object continues to remain stationary or to move at a constant angular velocity unless an external torque acts on it
  - Condition of equilibrium: net force equals 0, net torque equals 0
- Moment of inertia
  Inertia is a quantity that measures the resistance to change in rotational motion
- Newton's second law for rotational motion
  The net torque acting on a rigid body is the product of the moment of inertia and the angular acceleration
- Center of mass
  The point that moves as though the whole mass were concentrated there
  - An external force applied at the center of mass causes linear but not angular acceleration
  - If not applied at center of mass, there will be linear and rotational motion
- Rolling without slipping
  The point of contact between the wheel and the floor is instantaneously at rest
- Angular momentum
  The angular momentum of an object is the product of the moment of inertia of this object and its angular velocity
  - The net torque of an object is the rate of change of angular momentum of body
- Newton's third law of rotational motion
  When object A applies a torque to object B, then the object will apply an equal and opposite torque to object A
- Conservation of angular momentum
  When the net torque on a system is zero, the total angular momentum of system remains constant

- Kepler's first law of planetary motion
  The path of each planet around the sun is an ellipse with the sun at on focus
- Kepler's second law of planetary motion
  A line joining a planet and the sun sweeps out equal areas in equal time
  - 无普适性，严谨来说只适用于太阳系
- Kepler's third law of planetary motion
  The square of a planet's orbital time period T, is proportional to the cube of its average orbital radius, R

- Newton's universal law of gravitation
  Every single point mass attracts every other point mass with a force that is directly proportional to the product of their masses and inversely proportional to the square of their separation
- Newton's law of gravitation
  1. Masses much smaller than their separation can be regarded as point mass
  2. 球体（密度均匀的）等同于中心的 point mass
- Gravitational field
  A region of space where a mass experiences a force because of its mass
- Gravitational field strength
  Force per unit mass experienced by a test point mass placed in the field
- Gravitational potential energy
  - The work done against field in bringing the mass from infinity to the point
  - Why negative?
    1. Gravitational forces are attractive
    2. Work done against field is negative
- Gravitational potential
  - The work done per unit mass in bringing a small test mass from infinity to the point
  - If test mass move in the direction of field, work is done by the gravitational force, the gravitational potential decreases, and the gravitational potential energy decreases
  - Gravitational field strength is the negative of the rate of change of gravitational potential to the change in distance to the center of the planet
  - $g = -\frac{\Delta V}{\Delta r}$
- Orbital motion: E_k, E_p, E_T

$$E_k = \frac{GMm}{2r}$$

$$E_p = -\frac{GMm}{r}$$

$$E_T = -\frac{GMm}{2r}$$

- Escape speed
  The minimum speed needed to be able to escape completely from the gravitational field of the planet
- Orbit and atmosphere
  In the atmosphere of a planet, as the radius of orbital motion decreases, the speed of the satellite increases

Transferring charge:

a) Charging by friction
   When friction occurs between substances, electrons are transferred between their

surfaces.

b) Charging and discharging by contact
-When objects come in contact with each other, excess electrons, or a deficit of electrons, may be shared between them
-Charged objects will become discharged if they are connected to the ground

c) Charging by electrostatic induction
Charge separation caused without contact, by a nearby charge is known as electrostatic induction

Electric charge is quantized—elementary charge, e
The amount of electric charge on a body is always an integral multiple of a basic unit

Conservation of Charge:
Charge can neither be created nor destroyed. The net charge of an isolated system is conserved.

Coulomb's Law:
The force experienced by two point charges is directly proportional to the product of their charges and inversely proportional to the square of their separation.
Permittivity: ability to transfer an electric force and field（?

Electric field:
A region of space where a charged object experiences a force due to its charge.
Electric field strength:
Force per unit charge experienced by a small positive test charge
**注意区分三个公式的使用场景

Electric field lines
- Gives the direction of the field
- The field strength is given by the density of the lines
- Positive->negative
- Higher potential->lower potential
- Never touches each other, why?
  - Field lines gives the force on a charge
  - If crosses, particle would move in two directions, which is impossible

Conductors:
- The electric field inside a conductor is zero in static situation
- Any net charge on a conductor distributes itself on the surface
- The electric field is always perpendicular to the surface of a conductor
- Outside of a spherical conductor, usually views it the same way as point charge

Electric potential energy:
The work done in bringing a charge q from infinity to the point

*往定义式里代数据的时候一定要把电荷正负带进去

Electric Potential:
The work done per unit charge as a small positive test charge q is moved from infinity to the point
*同上，代数据记得代符号
Unit: Volts, 1JC-1
-potential & potential energy all scalar

Electrovolt: a unit of energy
1 eV: work done when a charge equal to one electron charge is taken across a potential difference of 1 volt

- In graph of potential verses distance, slope is electric field
- Field strength points in direction of decreasing potential
- Electric field inside a conducting sphere is zero
- Electric potential inside the sphere is constant

Currents and Circuits:
Electric Currents:
When an electric field is applied across the conductor, the electrons drift in one direction and there is a current.
Current: the rate of flow of electrical charge
Potential difference: Work done per unit charge on moving a positive charge between two points along the path of the current.
One volt:
The potential difference between two points when one joule of energy is transferred by one coulomb passing between the two points.

Resistance: the ratio of potential difference across it to the current in it
Resistivity:
The resistance between opposite faces of a cube of the material, of unit length and unit cross-sectional area.
-is constant for particular material at a particular temperature.

Ohm's Law:
For a conductor at constant temperature, the current in the conductor is proportional to the potential difference across it.
Ohmic device: resistance is constant at constant temperature
*用 IV 图求电阻一定不要画切线求，要严格用欧姆定律算

Heating Effect:

- When a current passes through a conductor, the free electrons collide with the lattice ions and transfer some energy to the ions
- The ions vibrate about their equilibrium positions with increased kinetic energy. Temperature of the conductor increases

Electrical Sensors:

- Thermistor: T ↑ R ↓
- LDR: light intensity ↑ R ↓
- Strain gauge: stretched R ↑

EMF (Electromotive Force)

Work done per unit charge in moving a charge from one terminal of the battery to the other.

*work done: other forms of energy→electrical energy

Motion in Electromagnetic Fields:

Magnetic Field:

A region of space where a small test magnet experiences a turning force

Magnetic Field lines:

- Show the path that the north pol of a magnet would take: heading away from a north pole and ending up at a south pole
- Does NOT cross each other
- Closer the line, stronger the field

地理南极=地磁北极
地磁北极=地理南极
指南针北极指的是地理北极，地磁南极

Moving charges gives rise to magnetic fields

Magnetic Flux density B: force per unit length of conductor per unit current carried placed at right angles to the field.