1. THE PARTICLE

1.1 DECOMPOSITION OF FORCES ON A PLANE: An **inclined plane** is a flat supporting surface tilted at an angle, with one end higher than the other, used as an aid for raising or lowering a load. The inclined plane is one of the six classical simple machines defined by Renaissance scientists. Inclined planes are widely used to move heavy loads over vertical obstacles; examples vary from a ramp used to load goods into a truck, to a person walking up a pedestrian ramp, to an automobile or railroad train climbing a grade.

Moving an object up an inclined plane requires less force than lifting it straight up, at a cost of an increase in the distance moved. The mechanical advantage of an inclined plane, the factor by which the force is reduced, is equal to the ratio of the length of the sloped surface to the height it spans. Due to conservation of energy, the same amount of mechanical energy (work) is required to lift a given object by a given vertical distance, disregarding losses from friction, but the inclined plane allows the same work to be done with a smaller force exerted over a greater distance.

The angle of friction, also sometimes called the angle of repose, is the maximum angle at which a load can rest motionless on an inclined plane due to friction, without sliding down. This angle is equal to the arctangent of the coefficient of static friction μ_s between the surfaces.

Two other simple machines are often considered to be derived from the inclined plane. The wedge can be considered a moving inclined plane or two inclined planes connected at the base. The screw consists of a narrow inclined plane wrapped around a cylinder.

The term may also refer to a specific implementation; a straight ramp cut into a steep hillside for transporting goods up and down the hill. It may include cars on rails or pulled up by a cable system; a funicular or cable railway, such as the Johnstown Inclined Plane.

Uses

Inclined planes are widely used in the form of loading ramps to load and unload goods on trucks, ships, and planes. Wheelchair ramps are used to allow people in wheelchairs to get over vertical obstacles without exceeding their strength. Escalators and slanted conveyor belts are also forms of inclined plane. In a funicular or cable railway a railroad car is pulled up a steep inclined plane using cables. Inclined planes also allow heavy fragile objects, including humans, to be safely lowered down a vertical distance by using the normal force of the plane to reduce the gravitational force. Aircraft evacuation slides allow people to rapidly and safely reach the ground from the height of a passenger airliner.

Other inclined planes are built into permanent structures. Roads for vehicles and railroads have inclined planes in the form of gradual slopes, ramps, and causeways to allow vehicles to surmount vertical obstacles such as hills without losing traction on the road surface. Similarly, pedestrian paths and sidewalks have gentle ramps to limit their slope, to ensure that pedestrians can keep traction. Inclined planes are also used as entertainment for people to slide down in a controlled way, in playground slides, water slides, ski slopes and skateboard parks.

HISTORY

Inclined planes have been used by people since prehistoric times to move heavy objects. The sloping roads and causeways built by ancient civilizations such as the Romans are examples of early inclined planes that have survived, and show that they understood the value of this device for moving things uphill. The heavy stones used in ancient stone structures such as Stonehenge are believed to have been moved and set in place using inclined planes made of earth, although it is hard to find evidence of such temporary building ramps. The Egyptian pyramids were constructed using inclined planes, Siege ramps enabled ancient armies to surmount fortress walls. The ancient Greeks constructed a paved ramp 6 km (3.7 miles) long, the Diolkos, to drag ships overland across the Isthmus of Corinth.

However the inclined plane was the last of the six classic simple machines to be recognized as a machine. This is probably because it is a passive, motionless device (the load is the moving part), and also because it is found in nature in the form of slopes and hills. Although they understood its use in lifting heavy objects, the ancient Greek philosophers who defined the other five simple machines did not include the inclined plane as a machine. This view persisted among a few later scientists; as late as 1826 Karl von Langsdorf wrote that an inclined plane "...is no more a machine than is the slope of a mountain.The problem of calculating the force required to push a weight up an inclined plane (its mechanical advantage) was attempted by Greek philosophers Heron of Alexandria (c. 10 - 60 CE) and Pappus of Alexandria (c. 290 - 350 CE), but they got it wrong.

It wasn't until the Renaissance that the inclined plane was classed with the other simple machines. The first correct analysis of the inclined plane appeared in the work of enigmatic 13th century author Jordanus de Nemore, however his solution was apparently not accepted by other philosophers of the time. Girolamo Cardano (1570) proposed the incorrect solution that the input force is proportional to the angle of the plane. Then at the end of the 16th century, three correct solutions were published within ten years, by Michael Varro (1584), Simon Stevin (1586), and Galileo Galilee (1592). Although it was not the first, the derivation of Flemish engineer Simon Stevin is the most well-known, because of its originality and use of a string of beads (see box).In 1600, Italian scientist Galileo Galilei included the inclined plane in his analysis of simple machines in Le Meccaniche ("On Mechanics"), showing its underlying similarity to the other machines as a force amplifier.

The first elementary rules of sliding friction on an inclined plane were discovered by Leonardo da Vinci (1452-1519), but remained unpublished in his notebooks. They were rediscovered by Guillaume Amontons (1699) and were further developed by Charles-Augustin de Coulomb (1785). Leonhard Euler (1750) showed that the tangent of the angle of repose on an inclined plane is equal to the coefficient of friction.

1.1.1. FORCE ON A PARTICLE: Throughout the whole of the known universe there are only 2 types of particle: Particles that make up matter and particle that carry force. They are the only 2 types found so far. Now you may be thinking that, yes there may only be two categories but I bet they're filled with hundreds of different subgroups and types. Thankfully this isn't the case, particles follow specific rules and once you known them everything gets a lot easier.

The two groups are called Fermions and Bosons:

Fermions
Fermions are all particles that make up matter. The name comes from the fact that all particles of matter follow a certain set of laws called Fermi-Dirac Statistics, developed by Enrico Fermi and Paul Dirac in 1926.

All fermions in existence possess half integer spin i.e. 1/2, 3/2, 5/2 etc, for example every electron in the universe possesses a spin of 1/2. Fermions also obey the Pauli exclusion principle. This sounds complicated but it's relatively simple to describe. What it means is that only certain combinations of matter can exist in the same space, more specifically it states that

No two identical fermions may occupy the same quantum state simultaneously

For example take Helium, It's got a lowest energy shell for the electrons. You can put one electron in easy, however the Pauli Exclusion principle says 2 electrons can't occupy the same quantum state so the second one has to have the opposite spin. This then allows the 2 electrons because spin is part of the quantum state of the electron, so the two electrons are occupying different quantum states. The spin however can only be one of two things, up or down (+1/2 or -1/2). If for example you had a lithium atom, which has three electrons then the third electron can't fit into the 1st shell. So to fit it in it has to move up to the next shell. The entire Periodic table is built up from this principle.

There are two different types of fermions, Leptons and Quarks.

Leptons

There are six sub-atomic particles that make up the leptons; the Electron and the Electron Neutrino, the Muon and Muon Neutrino (which are basically heavier versions of the Electron and the Electron Neutrino), and the Tau and the Tau Neutrino (which are heavier versions still). The electron, muon and tau all have charges of -1 whereas all the neutrinos have charges of 0.

Quarks

Quarks are the other type of matter particle along with the leptons. Like the leptons there are six quarks, grouped in 3 sets of 2, with each successive group basically just a heavier version of the previous. Like the leptons the quarks in each set have a charge difference of 1, but instead of nice whole numbers the charges of quarks come in fractions of e. The six quarks are named Up, Down, Charmed, Strange, Top and Bottom.

Bosons

Bosons are the particles that carry force. They are characterised by having whole integer SPIN e.g. -1, 0, 1, and don't obey the Pauli Exclusion Principle, so you can have loads of them in the same space. Each of the fundamental forces of nature has its own Bosons.

For Electromagnetism the force carrier is the Photon. They are sometimes called virtual photons as they only exist for very small intervals of time or space. If an electron gets near another electron it emits a virtual photon which is absorbed by the second electron and lets it know it need to move away.

For The Strong Nuclear Force the boson is the Gluon. It has zero rest mass and zero charge. Despite there only being one boson for this force it can come in different Colours.

For Gravity the boson is theorized to be the Graviton. Its is thought to have zero rest mass and zero charge but has not been discovered yet.

The Weak Nuclear Force looks like the odd one out. It has three bosons, the W^+, W^- and the Z^0. None of them are mass less like the photon, on average they're about half the mass of a caffeine molecule.

Weak Nuclear Force:
Weak Nuclear Force 10 trillion, trillion times stronger than gravity. The weak nuclear force is responsible for all three types of nuclear decay; Alpha, Beta or Gamma. Alpha decay is the emission of a helium nucleus from an atom, Beta decay is when an electron or positron is emitted from an atom, and Gamma decay is the emission of a high energy photon from an atom. The weak nuclear force is the odd one out of all the forces. Firstly because of its bosons. The weak force has three bosons unlike the others which only have one each. The bosons are also unlike the others as they have charge and mass, so much mass in fact that they are heavier that atoms of Rubidium! This is why the force only acts over small distances. In one type of decay an Up quark can emits a W^-, that's a particle emitting something that is 40,000 times heavier! The weak force is also different as it only affects left handed particles or right handed antiparticles with flavour.

Strong Nuclear Force:

Inside a nucleus you have protons and neutrons. Due to the electromagnetic force however all of the protons in the nucleus are pushing each other apart trying to break free, the thing that holds them together is the Strong Nuclear force. Its 100 times stronger that EM, an affects all particles with colour. The Strong Nuclear

Force gets stronger with distance however is a very small ranged force only acting over a range of 10^{-15}m.

1.1.2 RESULTING FROM SEVERAL CONCURRENT FORCES: In a concurrent force system, all forces pass through a common point. In the previous case involving the application of two forces to a body, it was necessary for them to be colinear, opposite in direction, and equal in magnitude for the body to be in equilibrium. If three forces are APPLIED to a body, as shown in the figure, they must pass through a common point (O), or else the condition, $SM_o = 0$, will not be satisfied and the body will rotate because of unbalanced moment. Moreover, the magnitudes of the forces must be such that the force equilibrium equations.

It is fairly easy to see the reasoning for the first condition. Consider the two forces, F1 and F2, intersecting at point O in the figure. The sum of moments of these two forces about point 0 is obviously equal to zero because they both pass through 0. If F3 does not pass through 0, on the other hand, it will have some nonzero moment about that point. Since this nonzero moment will cause the body to rotate, the body will not be in equilibrium.

Therefore, not only do three nonparallel forces applied to a body have to be concurrent for the body to be in an equilibrium state, but their magnitudes and directions must be such that the force equilibrium con-ditions are satisfied (SFx = SFy = 0). Notice that there is no need for the moment equilibrium equation in this case since it is automatically satisfied.