**INTRODUCTION I**

• How can models be classified?  
A model is a representation of a system; it is an analogy for some kind of system that is very hard to build the real scale version of. E.g. If you work with an atom, or a building.

• How to classify models by their structure? What are iconic, analog, symbolic/mathematical/analytical models?  
Iconic: A miniature model of for instance a building.  
Analog: A miniature model of a physics system, for instance with air over an airplane  
Symbolic: A mathematical formula/representation

• How to classify models by their function? What are descriptive, predictive, prescriptive/normative models?  
Usually mathematical are the strongest models as they are both general and predictive.  
Descriptive: Describes how something should generally be done.   
Predictive: Can tell us something about what will happen, before it happens  
Prescriptive: Describes exactly how something should be done, down to the smallest detail.

• What does a mathematical model consist of?  
It is a series of mathematical symbols, usually with the explanation for the symbols included.  
It will be a descriptive model with predictive capabilities.

• What is a physical simulation? What is a computer simulation? What does the latter consist of?  
A physical simulation is a simulation of one physical system by another e.g. simulating gravity of outer space, using a space suit under water, using an upwards air current (bubbles) to reduce the weight of the suit.

A computer simulation is a simulation of real life physics using a computers processing power. This can be used to simulate car crashes, parachute lift data, weather forecasts etc.

A computer simulation almost always requires a mathematical model describing:  
- The system; in particular, the important components  
- The time evolution of the system; for mechanical systems: equation of motion  
- The initial conditions and other input  
In almost all cases approximations are necessary

• What are typical examples of applications and purposes of computer simulation of physics?  
Weather simulations, Computer Games (especially Flight and other vehicle simulators), Forces on an object (Airplane, Windmill etc.), animations and 3D movies

**INTRODUCTION II**

• What is a game engine? What does it consist of?  
A Game engine is a combination of many different engines all packaged into one, together with different libraries.   
Often a game engine will include:  
Physics Engine for calculating physics on objects, including collision detection  
Rendering Engines (Lighting, Animation Etc.)  
Audio Engine for playing sounds, ex. 3D audio effects.  
The game engine Unity3D for example uses NVIDIA PhysX for physics, OpenGL and DirectX for graphics, fmod for sound etc.

• What is a physics engine? What is a physics effects engine? What is the difference?  
A physics engine calculates how physics will make objects move and react to for instance collisions.  
A Physics Effects engine calculates how for instance glass can shatter and turn into particles, or how particles for explosions should move.

• What are the main tasks of a physics engine?  
Calculating motion and collisions of objects.

• Describe a typical pipeline of a physics engine. What are the main stages? What are they good for?  
- Predict positions based on the current motion of the object.  
- Detect collisions on the new position  
- Apply effects of eventual collision  
- Move based on the new motion

• What are trigger events? What can they be used for?  
When a rigidbody is flagged as a trigger, collisions will not apply any force, but the collision will still be detected. They can for instance be used for detecting if an object is in a desired area, for instance if ball hits the surface of water, the ball can pass through, but the physics should react differently under water than in air. The trigger event can then be used to detect if the ball is in the water or in the air.

• What is broad-phase collision detection? What techniques can be used for it? How do they work?  
Broad phase collision detection aims at reducing the amount of collisions that must be calculated.  
There are multiple different types of methods that can be used for this:  
Custom Defined Collision types: By defining what layers that can collide, you can heavily reduce amount of collisions.  
Pre-Defined Collision types: static collider, rigidbody collider, kinematic rigidbody collider, and 3 trigger versions  
The colliders are also often simplified automatically through the use of bounding boxes. Often done through AABB’s (Axis alligned bounding boxes)  
Sort and Sweep AABB’s: Usually done up to 3 times. One for each axis. All colliders is detected on each axis, if a pair is overlapping they are considered for the next check. If the pairs still overlap on the remaining axis, they are considered as colliding.

• What is narrow-phase collision detection?  
Narrow phase collision detection calculates the actual point of impact between two objects. If a point is colliding with another collider, an edge or a face. Only unity defined colliders will be considered, and it will only be run on the remaining collisions found in the broad phase collision detection.  
Very good for boxes and spheres  
Decent for convex meshes  
Less efficient for general meshes

**PARTICLES: KINEMATICS I**

• What is kinematics? What is dynamics? What is inverse kinematics in animation and robotics?  
Kinematics is the motion of an object without considering the cause of the motion  
Dynamics is the motion where the cause of the motion is also described  
Inverse kinematics is calculating the joints of a mesh, and as such being able to move the mesh in a natural way.

• What is a particle? How many and which degrees of freedom does it have? What other features does it have? What is the trajectory of a particle?

A particle (or point of mass), is specified by its time-depending position and its (usually time-independent) mass.  
-Strictly speaking r(t) is a point, not a vector.  
-The curve r(t) is called the trajectory of the particle.  
-The units are: [t] = s (second), [r(t)] = [x,y,z[t] = m (meters), [m] = kg (kilograms)  
-Particles have no volume and no orientation  
-Such a particle has only 3 degrees of freedom, namely translation in 3 dimensions  
Further attributes of particles include:  
-Physical particles have additional attributes (charge, magnetic moment, spin etc.)  
-In computer graphics, particles are often rendered as points and have attributes such as color, texture, shape, size, life time etc.  
-In simulation, particles are often projectiles with further attributes (material constant, spin etc.)

• What is the velocity and the acceleration of a particle? In which units are they measured? How can they be computed for continuous and discrete motions?

The particle’s velocity is   
The particle’s speed is   
The acceleration is   
The units of v(t) is m/s and a(t) is m/s2In numerical simulations, time is usually discretized:  
, where t0 is the starting time, ti is the time of the i-th time step, and Δt is the length of one time step.  
Note that , the position in the i-th time step is then:

• How can the velocity and position of a particle be computed from its acceleration?

Velocity:  
Position:

**PARTICLES: KINEMATICS II**

• What is a particle's angular speed? In which units is it measured?  
The angular speed is how fast the particle is rotating around a fixed axis. It is measured as a time derivative of the angle, and as such it is measured in

• What is the angular velocity of a particle?  
The absolute value of the angular velocity is always equal to the angular speed

• How can the (linear) velocity of a particle be computed from its position and its angular velocity?  
The linear motion will be calculated as:  
**w** = angular velocity  
**r**(t) = relative position  
C = center point

**PARTICLES: DYNAMICS I**

• What is the linear momentum and the angular momentum of a particle? In which units are they measured?  
The momentum is very much alike the the motion, except that weight is included in the calculation. This goes for both linear and angular momentum. Linear momentum depends on the motion of the coordinate system, and angular momentum depends on both the motion of the coordinate system, and the origin point.

Linear Momentum:  
Definition: = m\***v**  
 Unit:

Angular Momentum:  
Definition:  
Unit:

• What are force and torque? In which units are they measured?  
Force is work done on an object to make it move.  
Force is measured in Newtons:   
Torque is work done on an object to make it rotate  
Torque is measured in Newtonmeters

• What is the equation of motion for a single particle?  
For a single particle with varying mass:

For constant mass:

Or for static objects:

• How are multiple forces on the same particle combined?  
Through addition.   
In unity, if you use addforce, it will do this addition automatically at the end of the fixed update.

**PARTICLES: DYNAMICS II**

• For each of the following forces: What do they depend on and how? Give an example for each force.

− Gravity on the surface of the earth  
Force on a particle (or planet) of mass m1 at r1 due to a second particle (or planet) of mass m1 at r1:  
 where G = 6.67\*10-11Nm2/kg2­ which is the universal gravitational constant  
On the surface of Earth () the gravitation due to Earth is:  
 with g being 9.81m/s2.

The gravity on the surface of the earth depends only on the mass inside the sphere of radius r. All the contributions from outside cancel out as a consequence of the inverse-square law of gravitation.

− Gravity between astronomical objects

Two celestial (aka astronomical) objects, use the same formula as the gravity on earth, as G is a constant, and mass is independent of gravitational forces. This is also the reason why the moon doesn’t fly off into space, and instead rotate around earth.

− Dynamic/kinetic/sliding friction and rolling friction

Dynamic/kinetic/sliding friction is opposite to the moving body’s velocity v:  
. The normal force Fnormal is the part of the contact force parallel to the surface normal. An example of a dynamic friction, could be an aluminum box sliding down a steel plate. The friction constant in this case, would then be based on the two materials, steel and aluminum, making it possible to calculate how much force should be applied before the box would stop sliding.

Rolling friction is a variant of dynamic friction:  
. Rolling friction is usually significantly smaller than sliding friction, e.g. for car tires: = 0.01 to 0.02. Infinitely small particles cannot roll but it can make sense to simulate rolling spheres as particles.

− Static/dry friction

Static (or dry) friction is orthogonal to the surface normal and opposite to any force that tries to accelerate a resting body:  
. The coefficients and depend on the materials in contact and are measured by experiments. Static friction is usually significantly larger than dynamic friction.

− Traction friction

Traction friction is another variant of friction:  
Traction friction acts against a force that rotates a wheel (i.e., a torque). If rotating force > traction friction, the wheel starts slipping. Example: for a sports car on a dry road. This type of friction doesn't make much sense for particles

− Linear drag

A variant of friction is linear drag (or viscous drag / resistance): the force resisting the (slow) movement of objects in (thick) fluids (such as honey):  
 where v is the velocity of the object and C is a constant that depends on the object’s shape and on the fluid. In contrast to Coulomb friction, linear drag is linear in v. However, drag in most fluids (e.g., air or water) is quadratic in v.  
Linear drag is used in “dashpots”, which are used as dampers in mechanical machines. This will be an important element of the analogy to other physical systems.

**PARTICLES: DYNAMICS III**

• For each of the following forces: What do they depend on and how? Give an example for each force.

− Force by air pressure  
If air, or a fluid is put under pressure, it will apply a force to an area: This could for instance be in a cylinder with a piston, if air is pressed into the cylinder, the cylinder will move depending on the size of the piston and the difference in pressure between the two sides

− Buoyancy  
When an object is submerged in a fluid, gravity will pull it down. The more of the fluid there is above the object, the stronger gravity will pull on the fluids mass. This means, as the object submerges deeper, the force of the displaced fluid will increase, at some point the buoyancy force will be larger and start pushing the object upwards instead of gravity pulling it down.  
The buoyancy force is found by:  
   
e is the up direction and g is the gravitational pull in this formula.

− Force of a Hooke's spring  
Hookes law is just one way of calculating how springs move.   
Following this law, if the spring is compressed, the spring force will be facing outwards from the resting position, however if the spring is stretched, the force will pull it back towards the resting position.  
this force can be found through:  
   
r is the vector that goes from one end of the spring to the other.  
r0 is the length of the vector at rest  
k is the spring constant  
This law only works if the difference is not too large between r and r0

− Damping force in a spring  
In real life a spring will always have a degree of dampening, this dampening is caused by friction in the spring. The friction force can be found similarly to linear drag:

− Drag force in air with moving air, i.e. wind  
When an object is moving through the wind there will be multiple different velocities at work. The object that is moving in one direction and the wind moving in another. The “Apparent velocity “ This apparent velocity if found through:   
   
This velocity is the motion that the wind “experience” that the object is moving as. As such if there is a headwind, the velocity will be larger, and if there is a tailwind it will be lower. As such, when drag is calculated it will be of a large force when there is a headwind, and a lower force when there is a tailwind. The drag force is found through:

**PARTICLES: NUM. SOLUTION I**

• What is the system of differential equations for the equations of motion for N particles? What type is it of?

The equations of motions are: with the total force of . We can write this as: . In general, this vector equation is a system of coupled non-linear, second-order differential equations.  
The equations of motion determine the acceleration of a particle. Therefore, they are differential equations.

• How can it be transformed to a system of first-order differential equations?

This system of second-order differential equations can be converted into a (larger) system of first-order differential equations by using v(t) as a variable:  
 and

• What are the goals when choosing an algorithm for the numerical solution of these differential equations?

When choosing a method, our main goals usually are:

− accuracy (solution is an accurate simulation)

− stability (solution doesn't diverge after some time)

− robustness (algorithm works for all parameters)

− performance (algorithm can be computed quickly)

**PARTICLES: NUM. SOLUTION II**

• For the following methods, explain how they work and what their advantages and disadvantages are:

− explicit Euler method

**How do explicit euler method work?**

Advantages of the explicit Euler method:

− only one evaluation of f(t, y(t))   
− easy to implement

Disadvantages of the explicit Euler method:

− not very accurate (in comparison to other methods)   
− unstable for many applications (i.e. small changes in the initial condition can result in arbitrarily large errors later

− modified Euler method  
The modified euler use a normal euler step first, saves the value, and then calculates a new value based on the first step, and the step after that one. The average value of these two steps is taken thus giving the final value.  
Full Step:

Final Step:

− midpoint Euler method  
With the midpoint euler method we first calculate a half euler step. We save this position for a new calculation. In this calculation we start from the previous position, but calculate as if we move from the half step.  
Half Step:

Final Step:   
The drawback is that we have to do two calculations, but it ihas a quadratic error, instead of linear as in the explicit method

− implicit Euler method with iterated predictor-corrector method  
????

• How can the stability of the numerical solution be improved?  
More iterations will give a smaller inaccuracy, but the calculation time will be increased

**PARTICLES: MASS-SPRING SYS.**

• What is a mass-spring system?

Mass-spring systems are particle systems with “springs” (or any kind of force) only between specific pairs of particles.

• What is the difference to a general system of interacting particles?

Usually the number of springs attached to a single particle is bound by a constant; thus, the total number of springs is O(n) for n particles. General systems of interacting particles (e.g. n stars) have O(n2) pair-wise interactions.

Additionally, collisions between any pair of particles may be taken into account. This is similar to the general collision problem.

• For 1D, 2D, and 3D mass-spring systems:

− What are they used for?

1D mass-spring systems are used for ropes, bridges, hair, grass etc.

2D mass-spring systems are used to simulate cloths and other deformable surfaces, e.g. balloons, balloon tires, bubbles, surfaces of fluids etc.

3D mass-spring systems are used to simulate deformable volumetric objects, e.g. gelatinous blobs or (boneless) tissue and dolls. In practice, volumetric soft bodies are often avoided in computer graphics because their simulation is usually too expensive (and too hard to control).

− Which kinds of springs are used?

Structural springs and bending springs.  
In Unity, 1D mass-spring systems can be simulated using a chain of rigidbodies, with **spring joints** between them for structural and bending springs and **hinge joints** between them for angular springs.  
In some cases it is better to simulate the physics of a 1D mass-spring system in a script and render the system using a LineRenderer.

Springs to 1-neighborhood of a particular vertex (structural springs), and springs to 2-neighborhood of a particular vertex (bending and shearing springs). In unity the cloth component can be used for 2D cloth simulation.

Similarly to the 2D case, structural, bending and shearing springs are required. Additionally, diagonal shearing springs are required (for volume preservation)

**RIGID BODIES: KINEMATICS**

• What is a rigid body? How many and which degrees of freedom of the motion of a rigid body are there?

A rigid body is a set of particles connected by “sticks” instead of springs, as in spring systems. This gives the difference that the distance between two particles will always be the same.  
It can move in 3 axes, and it can rotate on 3 axes, and as such is having 6 Degrees Of Freedom

• How can the motion of a rigid body be specified?

The motion can be described as a motion of a body coordinate system. A coordinate system with orthogonal axis can be aligned with the body and this coordinate system will describe the motion

• What is the time derivative of the rotation matrix of a body coordinate system that rotates with a certain angular velocity?  
To find this derivative we need the skew method. Skew takes the transposed negative matrix. Through this we can get the derivative by:

• What is the time derivative of a quaternion that describes that orientation of a body coordinate system that rotates with a certain angular velocity?

The time derivative of a quarternion is:

**RIGID BODIES: DYNAMICS I**

• What is the total mass of a rigid body in terms of the masses of its particles?

− Where mi is the mass of the i-th particle.

• What is the center of mass of a rigid body in terms of the masses and positions of its particles?

− Where M is the total mass and ri the constant position of the i-th particle.

The center of mass of a rigid body, just moves like a particle.

• What is the total force and torque on a rigid body in terms of all the forces on and positions of its particles?

−Total force where is the sum of all external forces on the i-th particle.

−Total torque where is the external torque on the i-th particle.

• What is the total linear and angular momentum of a rigid body in terms of the positions, masses, and velocities of its particles?

− Where L represents the angular momentum and p the linear momentum.

**RIGID BODIES: DYNAMICS II**

• What is the relation between total force and total linear momentum?

where

• What is the relation between total torque and total angular momentum?

• What is the relation between angular momentum and angular velocity?

• What is the definition of the inertia tensor of a rigid body in terms of the masses and positions of its particles?

**RIGID BODIES: DYNAMICS III**

• What is the analogy between linear and angular motion?

• Answer:

|  |  |
| --- | --- |
| Linear motion | Angular motion |
| Position r | Angle θ |
| Speed *v* | Angular speed *ω* |
| Velocity v | Angular velocity **w** |
| Mass *m* | Inertia tensor *I* |
| Linear momentum p = *m* v | Angular momentum **L** = *I* **w** (= **r**×**p)** |
| Force F = dp / d*t* | Torque **τ** = d**L** / d*t* (=**r**×**F)** |
| Equation of motion F = m v̇ | Equation of motion **τ** = *I* **ẇ** + **w** × *I* **w** |

**RIGID BODIES: FORCES**

• What is the difference between a force on a particle and a force on a rigid body?

any force F on a rigid body will result in a torque in addition to the force itself. The torque depends on the point r where the force is applied (and the origin of the coordinate system). Thus, it's important to specify the point r in addition to the force F.

• What are the typical forces on boats, air planes, and cars and at which points do they apply?

A boat has aerodynamic drag (center of frontal area above water), buoyancy (center of displaced water), thrust (propeller), hydrodynamic drag (center of wetted area) and gravitation (center of mass).

An airplane has lift (center of pressure) both on the wings and tail fins, drag (center of frontal area), thrust (propeller) and gravitation (center of mass).

A car has a normal force (contact point) for each wheel, rolling friction (contact point) for each wheel, traction friction (contact point) for front or back wheels, drag (center of frontal area) and gravitation (center of mass).

• How does the stability of boats (and other vehicles) depend on the position of the center of mass?

The center of mass, of any vehicle, keeps the object in balance. If the center of mass is misplaced, the balance of the boat would be unstable.

• What is a free body diagram? What does it consist of?

Free body diagrams are images showing the one rigid body of interest and all external forces on it (but no internal forces). The arrows represent the magnitude of the forces and where they are applied. The vector sum of all external forces determines the acceleration of the center of mass of the rigid body. Usually, no other objects are included (thus: free body diagram), but sometimes the water line for a boat and a ramp for a car is included for clarity.

**SECOND HALF:**

**CLASSICAL SIMPLE MACHINES I**

• What is the main purpose of classical simple machines?  
Increase the magnitude of an applied force.

• What is the "mechanical advantage"?  
The mechanical advantage is the ratio between the force that you put into the machine, and the force you get out of it.

• What are the six classical simple machines?  
Pulley, Lever, Wedge, Screw, Wheel and axle,Inclined Plane

• How can the mechanical advantage of a lever be computed from an equilibrium of torques?  
by setting the sum of the forces to equal zero you can write the equation

By taking the magnitudes of these forces it can be written to find the mechanical advantage by:

• How can the mechanical advantage of a lever be computed from energy conservation?

**CLASSICAL SIMPLE MACHINES II**

• What are the forces on a body on an inclined plane?

With a direction upwards and vertically to the incline plane and applied in the contact position of the body with the incline plane. Θ is the angle of the incline plane

is the force that we apply be pushing the object on the incline plane.

• How can the mechanical advantage of an inclined plane be computed?

Mechanical Advantage (MA) =

• What is the lifting force of a frictionless wedge?

Wedge useful for splitting and lifting.

= where is the force we apply on the wedge and θ is the angle of the part of the wedge that we use to lift the object.

• How can the mechanical advantage of a frictionless wedge for lifting be computed?

MA =

**CLASSICAL SIMPLE MACHINES III**

• What is a pulley? What is its mechanical advantage? What is it useful for?  
The pulley is a force applied over a wheel to change the direction of the force applied. As such it has a MA = 1. It is useful to for instance lifting something heavy by using your whole weight.

• What is a gun tackle? What forces are relevant when it is used? What is its mechanical advantage?  
A gun tackle is a series of pulleys added together, the mechanical advantage is equal to the amount of pulleys added, and the relevant forces are the the pull force, the weight and the forces in between each pulley, which all are equally split.

• How can a pulley be implemented in Unity?  
By using two boxes, one at each side of the “wheel” and adding a spring with a configurable joint to the wheel and the two boxes, then limiting rotations , and adding a linear limit.

• What is a windlass? What is its mech. advantage?  
A windlass is a a wheel and axle with a rope attached, used to lift things by turning a wheel.

• How are the torque and angular velocity of two connected gears related to their radii?  
The contact point of the two gears will have the same velocity at the point, however that translates to two different angular velocities. As power is conserved the relation between radius, torque and angular velocity becomes:

• How and why does friction influence the mechanical advantage of classical simple machines?   
If friction is applied there will be a loss of power in the system, and as such extra force will have to be applied. Ass such we lose a bit of the mechanical advantage.  
This effect is different between the different classical machines

**ANALOGIES BETWEEN SYSTEMS I**

• What are the analogous physical quantities of linear and angular motion?

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• How can one determine the equations of motions of mechanical systems?

????

• What is the "superposition principle" in physics?

The principle behind the addition of solutions is called superposition principle. It is only valid for linear differential equations, i.e. x(t) and its derivatives appear as linear factors of all forces except for the external force (or torque). This is usually not the case, but some machines can be approximately modeled this way. In those cases, the Laplace transform can be used to compute the resulting motion based on an input force. See the book "Mechanical System Design".

• What is the "inertia force"? What is it good for?

The equation of motion for a particle is where Fext is the sum of all external forces. However, some authors prefer to write the equation of motion as or: with the inertia force . The inertia force is just another way of taking accelerations into account such that the dynamic equation looks like a static equilibrium of forces. Note: either use accelerations or inertia forces, but never both at the same time.

• What are constraint forces?

Looking at dynamic friction forces

The "normal force" is a constraint force that avoids that the body intrudes into the plane. It is always orthogonal (i.e. "normal") to the constraint (the plane in this case). In general, constraint forces are difficult to compute because they depend on other forces and in order to compute those other forces, the constraint forces might be needed.

D'Alemberts principle states that all constraint forces can be ignored if one considers only forces in the direction of infinitesimal displacements δr that are allowed by the constraints:

**ANALOGIES BETWEEN SYSTEMS II**

• What is the force-voltage analogy between linear motion and electrical systems? Which quantities correspond to each other?

|  |  |
| --- | --- |
| Linear motion along x (Force-Voltage) | Electric circuit |
| Position x | Charge Q |
| Velocity | Current |
| Force F | Voltage V |
| Power = | Power = |
| Spring force | Capacitor |
| Friction force | Resistor |
| Inertial force | Inductor |

• In the force-voltage analogy, what is analogous to Kirchhoff's 2nd law (i.e. Kirchhoff's voltage law)?

|  |  |
| --- | --- |
| Forces on a rigid body:  , v = constant | Voltages in loop:  , = constant |
| Velocities between bodies:  , | Currents at node: V = constant , |

• What is the force-current analogy between linear motion and electrical systems? Which quantities correspond to each other?

• What is the analogy between hydraulics and linear motion?

Hydraulic systems use incompressible fluids under pressure to transmit power.

Typical quantities are: pressure p, volume V of fluid, area A of a piston, force F of a hydraulic cylinder.

**VIBRATIONS I**

• What is the equation of motion for a simple vibrating system including damping? What is the general solution? Which quantities characterize the solution?

In the notation of “The Physics of Musical Instruments”, the equation of motion is:

With and this becomes:

Often a Q factor or quality factor is used to compare the spring force to the damping force:

R is the dashpot constant, K is spring constant.

• Describe examples of systems that can be modeled with a simple vibrating system.

A spring of air, like a piston that can compress air by moving in a cylinder, vibrates like a mass attached to a spring.

Helmholtz Resonator with Neck: The mass of air in the neck of a Helmholtz resonator serves as the piston and the larger volume of air as the spring.

Simple Pendulum: A simple pendulum with mass m attached to a massless string of length L under gravity g oscillates in a harmonic motion

• How does a simple vibrating system react to a sinusoidal driving force?

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• What are the normal modes of a mass-spring system of two masses? How are they different?

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**VIBRATIONS II**

• What is the general equation of motion for transversal waves of a one-dimensional continuous system? What is the general solution?

f1 and f2 are arbitrary functions that explain the motion going right, and left.

• What is the general solution for standing waves of a string that is fixed at its two ends?   
 if the string is fixed at x = 0  
   
Thus:  
   
As such the wave will be reflected as a down pulse when it hits the fixed point.

**VIBRATIONS III**

• For a coupled two-mass system, how does the system react to a sinusoidal driving force?  
if the coupling is weak, when a sinusoidal force is the motion can be interbreted as oscilations.   
This will in turn result the energy being periodically transferred between the two masses. This will cause that one mass will drive the other, and then switch roles with the periods.

• What is an antiresonance?  
The antiresonance is when the vibrations cause that the mass which force is applied to does not move, but the other one makes the movement.  
The antiresonence is found at:

• Describe systems that feature an antiresonance.  
Bass reflex speaker: where the one mass is the speaker cone, and the other is the air  
Guitar or violin: where the one mass is the top plate, and the other is the air