Inertia, solids, elasticity, sound, thermodynamics, electromagnetism

Inertia:

Inertial reference frame moves without acceleration (it includes rotation (centripetal acceleration) and linear acceleration)

Reference frame is coordinate system with clock.

Inertial force is fictitious, it is result of reference frame not being inertial.

Some scientists think that inertia forces are the result of attraction of distant stars.

During circular rotation with the same speed, we compensate centripetal force with fictitious centrifugal force of inertia.

Question:

Explain inertial force.

Solids:

Movement of solid is described as movement of its centre of mass and rotation around the centre of mass.

Moment of inertia

The simplest moment of inertia around axis I = mR2.

m is mass.

R is distance from mass m to axis of rotation.

For solids moments of inertia are calculated as integrals.

Torque t through moments of inertia I and angular acceleration a:

$$I\_{11}a\_{1}+I\_{12}a\_{2}+I\_{13}a\_{3}=t\_{1}$$

$$I\_{21}a\_{1}+I\_{22}a\_{2}+I\_{23}a\_{3}=t\_{2}$$

$$I\_{31}a\_{1}+I\_{32}a\_{2}+I\_{33}a\_{3}=t\_{3}$$

$$\left[\begin{matrix}I\_{11}&I\_{12}&I\_{13}\\I\_{21}&I\_{22}&I\_{23}\\I\_{31}&I\_{32}&I\_{33}\end{matrix}\right]\left[\begin{matrix}a\_{1}\\a\_{2}\\a\_{3}\end{matrix}\right]=\left[\begin{matrix}t\_{1}\\t\_{2}\\t\_{3}\end{matrix}\right]$$

$$\sum\_{c=1}^{3}I\_{mc}a\_{c}=t\_{m}$$

m = 1, 2, 3.

We use Cramer Rule

en.wikipedia.org/wiki/Cramer%27s\_rule

$$D=det\left[\begin{matrix}I\_{11}&I\_{12}&I\_{13}\\I\_{21}&I\_{22}&I\_{23}\\I\_{31}&I\_{32}&I\_{33}\end{matrix}\right]=$$

= I(1, 1) \* (I(2, 2) \* I(3, 3) - I(2, 3) \* I(3, 2)) –

I(1, 2) \* (I(2, 1) \* I(3, 3) - I(3, 1) \* I(2, 3)) +

I(1, 3) \* (I(2, 1) \* I(3, 2) - I(3, 1) \* I(2, 2))

$$D\_{1}=det\left[\begin{matrix}t\_{1}&I\_{12}&I\_{13}\\t\_{2}&I\_{22}&I\_{23}\\t\_{3}&I\_{32}&I\_{33}\end{matrix}\right]$$

$$D\_{2}=det\left[\begin{matrix}I\_{11}&t\_{1}&I\_{13}\\I\_{21}&t\_{2}&I\_{23}\\I\_{31}&t\_{3}&I\_{33}\end{matrix}\right]$$

$$D\_{3}=det\left[\begin{matrix}I\_{11}&I\_{12}&t\_{1}\\I\_{21}&I\_{22}&t\_{2}\\I\_{31}&I\_{32}&t\_{3}\end{matrix}\right]$$

$$a\_{1}=\frac{D\_{1}}{D}$$

$$a\_{2}=\frac{D\_{2}}{D}$$

$$a\_{3}=\frac{D\_{3}}{D}$$

D must not be zero.

Question:

Find torque for given tensor of inertia and angular acceleration.

a1 = s mod 10

a2 = s mod 20

a3 = s mod 30

I11 = s mod 11

I12 = s mod 12

I13 = s mod 13

I21 = s mod 21

I22 = s mod 22

I23 = s mod 23

I31 = s mod 31

I32 = s mod 32

I33 = s mod 33

Dim a(3), I(3, 3), torque(3)

s = 99107088

a(1) = s Mod 10

a(2) = s Mod 20

a(3) = s Mod 30

I(1, 1) = s Mod 11

I(1, 2) = s Mod 12

I(1, 3) = s Mod 13

I(2, 1) = s Mod 21

I(2, 2) = s Mod 22

I(2, 3) = s Mod 23

I(3, 1) = s Mod 31

I(3, 2) = s Mod 32

I(3, 3) = s Mod 33

For c = 1 To 3

torque(c) = 0

For cc = 1 To 3

torque(c) = torque(c) + I(c, cc) \* a(cc)

Next cc

MsgBox torque(c)

Next c

Question:

Calculate angular acceleration for given tensor of inertia and torque.

torque(1) = s Mod 10

torque(2) = s Mod 20

torque(3) = s Mod 30

Dim a(3), I(3, 3), torque(3)

s = 99107088

torque(1) = s Mod 10

torque(2) = s Mod 20

torque(3) = s Mod 30

I(1, 1) = s Mod 11

I(1, 2) = s Mod 12

I(1, 3) = s Mod 13

I(2, 1) = s Mod 21

I(2, 2) = s Mod 22

I(2, 3) = s Mod 23

I(3, 1) = s Mod 31

I(3, 2) = s Mod 32

I(3, 3) = s Mod 33

determinant = I(1, 1) \* (I(2, 2) \* I(3, 3) - I(2, 3) \* I(3, 2)) - I(1, 2) \* (I(2, 1) \* I(3, 3) - I(3, 1) \* I(2, 3)) + I(1, 3) \* (I(2, 1) \* I(3, 2) - I(3, 1) \* I(2, 2))

If determinant = 0 Then GoTo 1

'MsgBox determinant

I(1, 1) = torque(1)

I(2, 1) = torque(2)

I(3, 1) = torque(3)

determinant1 = I(1, 1) \* (I(2, 2) \* I(3, 3) - I(2, 3) \* I(3, 2)) - I(1, 2) \* (I(2, 1) \* I(3, 3) - I(3, 1) \* I(2, 3)) + I(1, 3) \* (I(2, 1) \* I(3, 2) - I(3, 1) \* I(2, 2))

a(1) = determinant1 / determinant

MsgBox a(1)

I(1, 1) = s Mod 11

I(2, 1) = s Mod 21

I(3, 1) = s Mod 31

I(1, 2) = torque(1)

I(2, 2) = torque(2)

I(3, 2) = torque(3)

determinant2 = I(1, 1) \* (I(2, 2) \* I(3, 3) - I(2, 3) \* I(3, 2)) - I(1, 2) \* (I(2, 1) \* I(3, 3) - I(3, 1) \* I(2, 3)) + I(1, 3) \* (I(2, 1) \* I(3, 2) - I(3, 1) \* I(2, 2))

a(2) = determinant2 / determinant

MsgBox a(2)

I(1, 2) = s Mod 12

I(2, 2) = s Mod 22

I(3, 2) = s Mod 32

I(1, 3) = torque(1)

I(2, 3) = torque(2)

I(3, 3) = torque(3)

determinant3 = I(1, 1) \* (I(2, 2) \* I(3, 3) - I(2, 3) \* I(3, 2)) - I(1, 2) \* (I(2, 1) \* I(3, 3) - I(3, 1) \* I(2, 3)) + I(1, 3) \* (I(2, 1) \* I(3, 2) - I(3, 1) \* I(2, 2))

a(3) = determinant3 / determinant

MsgBox a(3)

I(1, 3) = s Mod 13

I(2, 3) = s Mod 23

I(3, 3) = s Mod 33

' Checking correctness of the solution:

For c = 1 To 3

'MsgBox torque(c)

Next c

For c = 1 To 3

torque(c) = 0

For cc = 1 To 3

torque(c) = torque(c) + I(c, cc) \* a(cc)

Next cc

'MsgBox torque(c)

Next c

GoTo 2

1 determiniantIsZero = 0

MsgBox "Determinant = 0, no solutions"

2 ThereAreSolusions = 2

Checking for 2

Dim a(2), I(2, 2), torque(2)

s = 99107088

torque(1) = s Mod 10

torque(2) = s Mod 20

I(1, 1) = s Mod 11

I(1, 2) = s Mod 12

I(2, 1) = s Mod 21

I(2, 2) = s Mod 22

determinant = I(1, 1) \* I(2, 2) - I(1, 2) \* I(2, 1)

If determinant = 0 Then GoTo 1

'MsgBox determinant

I(1, 1) = torque(1)

I(2, 1) = torque(2)

determinant1 = I(1, 1) \* I(2, 2) - I(1, 2) \* I(2, 1)

a(1) = determinant1 / determinant

'MsgBox a(1)

I(1, 1) = s Mod 11

I(2, 1) = s Mod 21

I(1, 2) = torque(1)

I(2, 2) = torque(2)

determinant2 = I(1, 1) \* I(2, 2) - I(1, 2) \* I(2, 1)

a(2) = determinant2 / determinant

'MsgBox a(2)

I(1, 2) = s Mod 12

I(2, 2) = s Mod 22

' Checking correctness of the solution:

For c = 1 To 2

MsgBox torque(c)

Next c

For c = 1 To 2

torque(c) = 0

For cc = 1 To 2

torque(c) = torque(c) + I(c, cc) \* a(cc)

Next cc

MsgBox torque(c)

Next c

GoTo 2

1 determiniantIsZero = 0

MsgBox "Determinant = 0, no solutions"

2 ThereAreSolusions = 2

Elasticity

The most general case of elastic body deformation and stress:

$$σ\_{ij}=\sum\_{m=1}^{3}\sum\_{n=1}^{3}E\_{ijmn}ε\_{mn}\_{}$$

i,j,m,n = 1, 2, 3.

$σ\_{ij}$ is tensor of stress, stress is pressure.

$ε\_{mn}$ is tensor of deformation, deformation is relative extension.

$E\_{ijmn}$ is tensor of elastic constants.

Sound

Sound is a mechanical wave.

Sound is a longitudinal wave, which means that the propagation of the wave is in the same direction as oscillation.

Soundwave needs environment to propagate.

The denser the environment, the faster the sound in this environment.

Doppler effect:

Doppler effect is change in frequency of the wave due to motion of the source of the wave.

Because the speed of the wave is constant, frequency of the wave changes: if motion of the source towards the observer, then frequency increases, if the motion of the source away from the observer, then the frequency decreases.

c = λf

c is the speed of sound, which is 343 meters per second in this case.

λ is the wavelength of the sound wave.

f is the frequency of the sound wave.

Question:

Calculate Doppler effect for sound.

Frequency changed; wavelength changed from 17 meters to 16 meters because of the speed of the source of sound.

Which direction does the source of sound move?

Frequencies:

f = c/BIG\_Wave\_Length

F = c/small\_wave\_length

f = Fc/(c+v)

v = -c + Fc/f

BIG\_Wave\_Length = 17

small\_wave\_length = 16

' c is speed of sound

c = 343

f\_small = c / BIG\_Wave\_Length

F\_BIG = c / small\_wave\_length

wavelengthchange = BIG\_Wave\_Length - small\_wave\_length

MsgBox wavelengthchange

v = -c + c \* F\_BIG / f\_small

MsgBox v

https://physics16.weebly.com/uploads/5/9/8/5/59854633/doppler4effect2019nov.txt

Fluid

Buoyant force

F = ρgV

F is force.

ρ is density of the fluid.

V is volume of the body, which is submerged to the fluid.

Question:

Find buoyant force for water ρ = 1000 kg/m3, g = 10 m/s2, V = s m3.

en.wikipedia.org/wiki/Archimedes%27\_principle

s = 99107088

ro = 1000

g = 10

V = s

F = ro \* g \* V

MsgBox F

Thermodynamics

Increase in temperature of body means increase of average velocity of particles of body.

Black clothes vs white clothes

White clothes keep the temperature the same. Black clothes cause heat exchange.

Question:

Are black or white clothes warmer? Why?

If bodies are heated, then they expand because of bigger velocities of the particles.

There is linear extension of the length due to heat.

Volume change is not cubed but times 3 because linear extensions are small compared to 1.

Question:

The thermal expansion rate α is 1/k. The temperature change is T degrees.

 a. Find the extension of m meters rod due to the temperature change.

 b. Find the approximate volume change of m meters cubed cube due to the temperature change.

n = 15108097

k = n Mod 10000

T = n mod 100

L = n mod 35

a = 1 / k

d = T \* L \* a

MsgBox d

V = 3\*T\*a\*L\*L\*L+3\*T\*T\*a\*a\*L\*L\*L+(T\*L\*a)\*(T\*L\*a)\*(T\*L\*a)

V = 3\*T\*a\*L

MsgBox V

 http://physics16.weebly.com/uploads/5/9/8/5/59854633/thermal4expansion.txt

Heat flows from hot to cold.

Specific heat capacity C is heat necessary to increase the temperature of the body by 1 degree.

Question:

There are two bodies in a thermodynamically isolated system: C1 m1 T1 and C2 m2 T2.

Find the resulting temperature T. m1 = k, m2 = 2k. C1 = k/11, C2 = k/222, T1 = k/111, T2 = k/22

n = 15108097

k = n Mod 10000

'

m1 = k

c1 = k / 11

t1 = k / 111

'

m2 = 2 \* k

c2 = k / 222

t2 = k / 22

'

t = (t1 \* c1 \* m1 + t2 \* c2 \* m2) / (m1 \* c1 + m2 \* c2)

MsgBox t

http://physics16.weebly.com/uploads/5/9/8/5/59854633/result4temperature.txt

P is directly proportional to V2.

T is proportional to P.

T is temperature.

P is pressure.

V is velocity.

Energy of particles

E = 1.5kT

T is temperature.

k = 1.380649×10-23 JK-1

en.wikipedia.org/wiki/Boltzmann\_constant

In ideal gas there is no interaction between the infinitely small particles.

Ideal gas is good enough model for many applications.

PV = nRT

P is pressure.

V is volume.

n is number of moles of substance.

R = 8.31446261815324 joules per kelvin per mole

T is temperature.

One mole contains NA = 6.02214076×1023 elementary entities, which can be atoms, molecules, ions, or other particles. The number of particles in a mole is the Avogadro number NA expressed in mol-1.

For gas at room temperature, one mole is approximately 22.4 litres.

Question:

Give P from PV = nRT. R = 2 + m25. V = 3 + m35. n = s.

https://en.wikipedia.org/wiki/Ideal\_gas\_law

s = 19107012

L = s Mod 10

m = s Mod 35

T = s Mod 100

k = s Mod 10000

E = s Mod 8

q = s Mod 17

R = s Mod 25

d = 2 + (T - L) / 10

Pi = 4 \* Atn(1)

R = R + 2

V = 3 + m

n = s

P = n \* R \* T / V

MsgBox P

Real gas

In real gas particles interact and are finite in size.

$$p=\frac{RT}{V\_{m}-b}-\frac{a}{V\_{m}^{2}}$$

Vm is molar volume.

a and b are parameters, that are determined experimentally for each gas.

Question:

Find real gas pressure.

https://en.wikipedia.org/wiki/Real\_gas

$$p=\frac{RT}{V\_{m}-b}-\frac{a}{V\_{m}^{2}}$$

a = m25

b = m9

Vm = s

R = m8

T = m100

s = 19107012

m25 = s Mod 25

m9 = s Mod 9

m8 = s Mod 8

m100 = s Mod 100

a = m25

b = m9

Vm = s

R = m8

T = m100

p = R \* T / (Vm - b) - a / Vm ^ 2

MsgBox p

Electromagnetism

Electric charge is physical property of matter that causes it to experience force when placed into electric field.

Electric field is space where electric force acts.

Electric current is flux of electric charges.

In classical physics, electric current is similar to the flow of the fluid.

Electrostatics

Coulombs law in electrostatics is similar to Newton law of gravity, the difference is that gravity can only attract and, in our part of the Universe, gravity is much weaker than electrostatic force, which can repel and attract.

Question:

Find the force between two charges of L and T Coulombs, m meters apart.

s = 16108088

T = s Mod 100

m = s Mod 35

L = s Mod 10

charge1 = L

charge2 = T

Coulomb\_constant = 10 ^ 10

Coulomb\_force = Coulomb\_constant \* L \* T / m ^ 2

MsgBox Coulomb\_force

http://physics16.weebly.com/uploads/5/9/8/5/59854633/coulomb\_force.txt

Voltage

Voltage V between two points is work to move unitary charge between these two points.

Question:

Capacitor

d is distance between the plates of the capacitor

W is work

F is force

d is distance

Q is change

W=Fd

F = W/d

E = F/Q=W/(Qd)

V = W/Q

Ed = V

Current I = Q/t

Ed = V (uniform field strength (electric field)). E = m8. d = d2.

s = 19107012

L = s Mod 10

T = s Mod 100

k = s Mod 10000

E = s Mod 8

d = (T - L) / 10

V = E \* d

MsgBox V

https://physics16.weebly.com/uploads/5/9/8/5/59854633/uniform4electromagnetic4field2019nov.txt

Question:

F = Eq (field and force (electricity)). E = m8. q = m17.

s = 19107012

L = s Mod 10

T = s Mod 100

k = s Mod 10000

E = s Mod 8

q = s Mod 17

F = E \* q

MsgBox F

https://physics16.weebly.com/uploads/5/9/8/5/59854633/force4electromagnetic4field2019nov.txt

Electric circuits

There are many electronic elements in electric circuits.

Resistor causes drop of voltage.

Capacitor accumulates electric charge and then releases it.

Inductor induces electromagnetic field.

Diode allows electric current only in one direction.

Transistor is a switch.

Ohm law: V = IR

en.wikipedia.org/wiki/Ohm%27s\_law

Question:

Calculate voltage V for I = T Amperes and R = L Ohms.

s = 99107088

T = s Mod 100

L = s Mod 10

I = T

R = L

V = I \* R

MsgBox V

Resistivity $ρ$ for specific material is resistance of a wire of 1 meter long and 1 meter squared in cross-section.

Question:

Find $R=\frac{ρL}{A}. $ A = m25. ρ = m17. L = m10.

s = 19107012

L = s Mod 10

ro = s Mod 17

A = s Mod 25

R = L \* ro / A

MsgBox R

https://physics16.weebly.com/uploads/5/9/8/5/59854633/resistivity2019nov.txt

Electric current follows the path of the least resistance.

**Direct current** (**DC**) is one-directional [flow](https://en.wikipedia.org/wiki/Electric_current) of [electric charge](https://en.wikipedia.org/wiki/Electric_charge). An [electrochemical cell](https://en.wikipedia.org/wiki/Electrochemical_cell) is a prime example of DC power. Direct current may flow through a [conductor](https://en.wikipedia.org/wiki/Conductor_%28material%29) such as a wire, but can also flow through [semiconductors](https://en.wikipedia.org/wiki/Semiconductor), [insulators](https://en.wikipedia.org/wiki/Electrical_insulation), or even through a [vacuum](https://en.wikipedia.org/wiki/Vacuum) as in [electron or ion beams](https://en.wikipedia.org/wiki/Electron_beam). The electric current flows in a constant direction

Question:

Calculate the series and the parallel circuits with e.m.f. of T Volts and the resistors L+1, 2 and 3 ohms respectively.

s = 16108088

T = s Mod 100

L = s Mod 10

emf = T

V = emf

R1 = L + 1

R2 = L + 2

R3 = L + 3

' For series circuit:

R = R1 + R2 + R3

current\_I = V / R

MsgBox current\_I

V1 = current\_I \* R1

V2 = current\_I \* R2

V3 = current\_I \* R3

MsgBox V1

MsgBox V2

MsgBox V3

' For parallel circuit:

‘ R = R1 \* R2 \* R3 / (R1 \* R2 + R1 \* R3 + R2 \* R3)

current\_I = V / R

MsgBox current\_I

current\_I1 = V / R1

current\_I2 = V / R2

current\_I3 = V / R3

MsgBox current\_I1

MsgBox current\_I2

MsgBox current\_I3

http://physics18.weebly.com/uploads/5/9/8/5/59854633/series\_parallel\_circuits.txt

Kirchoff law says that for electric circuit with e.m.f. E with internal resistance r and active resistance R.

E = I(R+r)

I is current in the circuit.

Question:

Show that Maximum loss in circuit with internal resistance r and external resistance R is when R = r.

E = I(R+r)

waste = RI2.

$$I=\frac{E}{R+r}$$

$$RI^{2}=\frac{RE^{2}}{\left(R+r\right)^{2}}$$

Take derivative, equate it to zero and find the Maximum.

derivative-calculator.net

$$\left(RI^{2}\right)^{'}=E^{2}\frac{\left(R+r\right)^{2}-2R(R+r)}{\left(R+r\right)^{4}}=E^{2}\frac{r-R}{\left(R+r\right)^{3}}=0$$

R = r for maximum waste (loss).

We found maximum loss (waste) when R = r because minimum loss (waste) is when R = 0.

**Alternating current** (**AC**) is an [electric current](https://en.wikipedia.org/wiki/Electric_current) which periodically reverses direction and changes its magnitude continuously with time, in contrast to [direct current](https://en.wikipedia.org/wiki/Direct_current) (DC), which flows only in one direction. Alternating current is the form in which [electric power](https://en.wikipedia.org/wiki/Electric_power) is delivered to businesses and residences, and it is the form of [electrical energy](https://en.wikipedia.org/wiki/Electrical_energy) that consumers typically use when they plug [kitchen appliances](https://en.wikipedia.org/wiki/Kitchen_appliance), televisions, fans and electric lamps into a [wall socket](https://en.wikipedia.org/wiki/Wall_socket). A common source of DC power is a [battery cell](https://en.wikipedia.org/wiki/Battery_%28electricity%29) in a [flashlight](https://en.wikipedia.org/wiki/Flashlight). The abbreviations *AC* and *DC* are often used to mean simply *alternating* and *direct*, respectively, as when they modify [*current*](https://en.wikipedia.org/wiki/Electric_current) or [*voltage*](https://en.wikipedia.org/wiki/Voltage).

en.wikipedia.org/wiki/Alternating\_current

**Faraday's law of induction** (or simply **Faraday's law**) is a basic law of [electromagnetism](https://en.wikipedia.org/wiki/Electromagnetism) predicting how a [magnetic field](https://en.wikipedia.org/wiki/Magnetic_field) will interact with an [electric circuit](https://en.wikipedia.org/wiki/Electric_circuit) to produce an [electromotive force](https://en.wikipedia.org/wiki/Electromotive_force) (emf)—a phenomenon known as [electromagnetic induction](https://en.wikipedia.org/wiki/Electromagnetic_induction). It is the fundamental operating principle of [transformers](https://en.wikipedia.org/wiki/Transformer), [inductors](https://en.wikipedia.org/wiki/Inductor), and many types of [electric motors](https://en.wikipedia.org/wiki/Electric_motor), [generators](https://en.wikipedia.org/wiki/Electrical_generator) and [solenoids](https://en.wikipedia.org/wiki/Solenoid).

The **Maxwell–Faraday equation** (listed as one of [Maxwell's equations](https://en.wikipedia.org/wiki/Maxwell%27s_equations)) describes the fact that a spatially varying (and also possibly time-varying, depending on how a magnetic field varies in time) electric field always accompanies a time-varying magnetic field, while Faraday's law states that there is emf (electromotive force, defined as electromagnetic work done on a unit charge when it has traveled one round of a conductive loop) on the conductive loop when the magnetic flux through the surface enclosed by the loop varies in time.

Faraday's law had been discovered and one aspect of it (transformer emf) was formulated as the Maxwell–Faraday equation later. The equation of Faraday's law can be derived by the Maxwell–Faraday equation (describing transformer emf) and the [Lorentz force](https://en.wikipedia.org/wiki/Lorentz_force) (describing motional emf). The integral form of the Maxwell–Faraday equation describes only the transformer emf, while the equation of Faraday's law describes both the transformer emf and the motional emf.

en.wikipedia.org/wiki/Faraday%27s\_law\_of\_induction

Mathematically, mechanical oscillator and electromagnetic oscillation are similar.

An LC circuit is a type of electric circuit that is made up of an inductor which is expressed by the letter L, and a capacitor, represented by the letter C. Here, both are connected in a single circuit. An LC circuit is also referred to as a tank circuit, resonant circuit, or tuned circuit.

Question:

Find the frequency and the period of the harmonic oscillator. L = k μH and C = T μF.

$$Q^{''}+\frac{Q}{LC}=0$$

n = 15108097

k = n Mod 10000

T = n Mod 100

L = k \* 10 ^ (-6)

C = T \* 10 ^ (-6)

omega0 = 1 / Sqr(L \* C)

MsgBox omega0

pi = 4 \* Atn(1)

period = 2 \* pi / omega0

MsgBox period

http://physics16.weebly.com/uploads/5/9/8/5/59854633/rlc4circuit4natural4frequency4period.txt

An RLC circuit is an electrical circuit consisting of a resistor (R), an inductor (L), and a capacitor (C), connected in series or in parallel. The name of the circuit is derived from the letters that are used to denote the constituent components of this circuit, where the sequence of the components may vary from RLC.

Question:

$$Q^{''}+\frac{R}{L}Q^{'}+\frac{Q}{LC}=ε\_{m}\sin(\left(ωt\right))$$

Find the electrical current i in the circuit for R = T, L = 1/k, C = 1/s, ω = k, and εm = T.

http://physics16.weebly.com/uploads/5/9/8/5/59854633/2054\_ch21a.pdf

**Electrical resistivity** (also called **volume resistivity** or **specific electrical resistance**) is a fundamental [specific property](https://en.wikipedia.org/wiki/Specific_property) of a material that measures its [electrical resistance](https://en.wikipedia.org/wiki/Electrical_resistance) or how strongly it resists [electric current](https://en.wikipedia.org/wiki/Electric_current). A low resistivity indicates a material that readily allows electric current.

**Electrical conductivity** (or **specific conductance**) is the reciprocal of electrical resistivity. It represents a material's ability to conduct electric current.

en.wikipedia.org/wiki/Electrical\_resistivity\_and\_conductivity

A **semiconductor** is a material which has an [electrical conductivity](https://en.wikipedia.org/wiki/Electrical_resistivity_and_conductivity) value falling between that of a [conductor](https://en.wikipedia.org/wiki/Electrical_conductor), such as [copper](https://en.wikipedia.org/wiki/Copper), and an [insulator](https://en.wikipedia.org/wiki/Insulator_%28electricity%29), such as [glass](https://en.wikipedia.org/wiki/Glass). Its [resistivity](https://en.wikipedia.org/wiki/Electrical_resistivity_and_conductivity) falls as its temperature rises; metals behave in the opposite way. Its **conducting** properties may be altered in useful ways by introducing impurities ("[doping](https://en.wikipedia.org/wiki/Doping_%28semiconductor%29)") into the [crystal structure](https://en.wikipedia.org/wiki/Crystal_structure). When two differently doped regions exist in the same crystal, a [semiconductor junction](https://en.wikipedia.org/wiki/Semiconductor_junction) is created. The behavior of [charge carriers](https://en.wikipedia.org/wiki/Charge_carrier), which include [electrons](https://en.wikipedia.org/wiki/Electron), [ions](https://en.wikipedia.org/wiki/Ion), and [electron holes](https://en.wikipedia.org/wiki/Electron_hole), at these junctions is the basis of [diodes](https://en.wikipedia.org/wiki/Diode), [transistors](https://en.wikipedia.org/wiki/Transistor), and most modern [electronics](https://en.wikipedia.org/wiki/Electronics). Some examples of semiconductors are [silicon](https://en.wikipedia.org/wiki/Silicon), [germanium](https://en.wikipedia.org/wiki/Germanium), [gallium arsenide](https://en.wikipedia.org/wiki/Gallium_arsenide), and elements near the so-called "[metalloid staircase](https://en.wikipedia.org/wiki/Metalloid_staircase)" on the [periodic table](https://en.wikipedia.org/wiki/Periodic_table). After silicon, gallium arsenide is the second-most common semiconductor and is used in laser diodes, [solar cells](https://en.wikipedia.org/wiki/Solar_cell), microwave-frequency [integrated circuits](https://en.wikipedia.org/wiki/Integrated_circuit), and others. Silicon is a critical element for fabricating most electronic circuits.

[Semiconductor devices](https://en.wikipedia.org/wiki/Semiconductor_device) can display a range of different useful properties, such as passing current more easily in one direction than the other, showing variable resistance, and having sensitivity to light or heat. Because the electrical properties of a semiconductor material can be modified by doping and by the application of electrical fields or light, devices made from semiconductors can be used for amplification, switching, and [energy conversion](https://en.wikipedia.org/wiki/Energy_conversion).

en.wikipedia.org/wiki/Semiconductor

A **P-type semiconductor** is a type of semiconductor. When a trivalent impurity (like Boron, Aluminum etc.) is added to an intrinsic or pure semiconductor (silicon or germanium), it is said to be a p-type semiconductor. Trivalent impurities such as boron (B), gallium (Ga), indium (In), aluminum (Al) etc. are called acceptor impurity. Ordinary semiconductors are made of materials that do not conduct (or carry) an [electric current](https://simple.wikipedia.org/wiki/Electric_current) very well but are not highly resistant to doing so either, metalloids, such as Silicon (Si), Germanium (Ge), Arsenic (As), and a few other element commonly used for the main body of semiconductors. They fall halfway between [conductors](https://simple.wikipedia.org/wiki/Electrical_conductor) and [insulators](https://simple.wikipedia.org/wiki/Insulator_%28electricity%29) and so are called semiconductors. For an electric current to flow, [electrons](https://simple.wikipedia.org/wiki/Electrons) have to move through a material. In order to move, there must be an [electron hole](https://simple.wikipedia.org/wiki/Electron_hole) in the material for the electron to move into. A p-type semiconductor has more holes than electrons. This allows the current to flow along the material from hole to hole but only in one direction.

Semiconductors are most often made from silicon. Silicon is an element with four electrons in its outer shell. To make a p-type semiconductor, extra materials like [boron](https://simple.wikipedia.org/wiki/Boron) or [aluminum](https://simple.wikipedia.org/wiki/Aluminium%22%20%5Co%20%22Aluminium) are added to the silicon. These materials have only three electrons in their outer shell. When the extra material replaces some of the silicon it leaves a hole where the fourth electron would have been if the semiconductor was pure silicon.

simple.wikipedia.org/wiki/P-type\_semiconductor

An **N-type semiconductor** is a type of material used in [electronics](https://simple.wikipedia.org/wiki/Electronics).

It is made by adding an impurity to a pure semiconductor such as silicon or germanium. The impurities used may be [phosphorus](https://simple.wikipedia.org/wiki/Phosphorus), [arsenic](https://simple.wikipedia.org/wiki/Arsenic), [antimony](https://simple.wikipedia.org/wiki/Antimony), [bismuth](https://simple.wikipedia.org/wiki/Bismuth) or some other [chemical element](https://simple.wikipedia.org/wiki/Chemical_element). They are called donor impurities. The impurity is called a *donor* because it gives a free [electron](https://simple.wikipedia.org/wiki/Electron) to a semiconductor. The purpose of doing this is to make more charge carriers, or [electron](https://simple.wikipedia.org/wiki/Electrons) wires available in the material for [conduction](https://simple.wikipedia.org/wiki/Electrical_conductivity). The final material is a lot more conductive than the original silicon or germanium.

simple.wikipedia.org/wiki/N-type\_semiconductor

A **p–n junction** is a boundary or interface between two types of [semiconductor materials](https://en.wikipedia.org/wiki/Semiconductor_material), [p-type](https://en.wikipedia.org/wiki/P-type_semiconductor) and [n-type](https://en.wikipedia.org/wiki/N-type_semiconductor), inside a single [crystal](https://en.wikipedia.org/wiki/Crystal) of semiconductor. The "p" (positive) side contains an excess of [holes](https://en.wikipedia.org/wiki/Electron_hole), while the "n" (negative) side contains an excess of [electrons](https://en.wikipedia.org/wiki/Electron) in the outer shells of the electrically neutral [atoms](https://en.wikipedia.org/wiki/Atom) there. This allows electric current to pass through the junction only in one direction. The p- and n-type regions creating the junction are made by [doping](https://en.wikipedia.org/wiki/Doping_%28semiconductor%29) the semiconductor, for example by [ion implantation](https://en.wikipedia.org/wiki/Ion_implantation), [diffusion](https://en.wikipedia.org/wiki/Diffusion) of [dopants](https://en.wikipedia.org/wiki/Dopant), or by [epitaxy](https://en.wikipedia.org/wiki/Epitaxy) (growing a layer of crystal doped with one type of dopant on top of a layer of crystal doped with another type of dopant).

p–n junctions are elementary "building blocks" of [semiconductor electronic devices](https://en.wikipedia.org/wiki/Semiconductor_device) such as [diodes](https://en.wikipedia.org/wiki/Diode), [transistors](https://en.wikipedia.org/wiki/Transistor), [solar cells](https://en.wikipedia.org/wiki/Solar_cell), [light-emitting diodes](https://en.wikipedia.org/wiki/Light-emitting_diode) (LEDs), and [integrated circuits](https://en.wikipedia.org/wiki/Integrated_circuit); they are the active sites where the electronic action of the device takes place. For example, a common type of [transistor](https://en.wikipedia.org/wiki/Transistor), the [bipolar junction transistor](https://en.wikipedia.org/wiki/Bipolar_junction_transistor) (BJT), consists of two p–n junctions in series, in the form n–p–n or p–n–p; while a diode can be made from a single p-n junction. A [Schottky junction](https://en.wikipedia.org/wiki/Schottky_junction) is a special case of a p–n junction, where metal serves the role of the n-type semiconductor.

en.wikipedia.org/wiki/P–n\_junction

A **diode** is a two-[terminal](https://en.wikipedia.org/wiki/Terminal_%28electronics%29) [electronic component](https://en.wikipedia.org/wiki/Electronic_component) that conducts [current](https://en.wikipedia.org/wiki/Electric_current) primarily [in one direction](https://en.wikipedia.org/wiki/One-way_traffic) (asymmetric [conductance](https://en.wikipedia.org/wiki/Electrical_conductance)). It has low (ideally zero) [resistance](https://en.wikipedia.org/wiki/Electrical_resistance_and_conductance) in one direction, and high (ideally infinite) resistance in the other.

A semiconductor diode, the most commonly used type today, is a [crystalline](https://en.wikipedia.org/wiki/Crystallinity) piece of [semiconductor](https://en.wikipedia.org/wiki/Semiconductor) material with a [p–n junction](https://en.wikipedia.org/wiki/P%E2%80%93n_junction) connected to two electrical terminals. It has an [exponential](https://en.wikipedia.org/wiki/Exponential_function) [current–voltage characteristic](https://en.wikipedia.org/wiki/Current%E2%80%93voltage_characteristic). Semiconductor diodes were the first [semiconductor electronic devices](https://en.wikipedia.org/wiki/Semiconductor_device). The discovery of asymmetric electrical conduction across the contact between a crystalline mineral and a metal was made by German physicist [Ferdinand Braun](https://en.wikipedia.org/wiki/Ferdinand_Braun) in 1874. Today, most diodes are made of [silicon](https://en.wikipedia.org/wiki/Silicon), but other semiconducting materials such as [gallium arsenide](https://en.wikipedia.org/wiki/Gallium_arsenide) and [germanium](https://en.wikipedia.org/wiki/Germanium) are also used.

The [obsolete](https://en.wikipedia.org/wiki/Obsolete) *thermionic diode* is a [vacuum tube](https://en.wikipedia.org/wiki/Vacuum_tube) with two [electrodes](https://en.wikipedia.org/wiki/Electrode), a heated [cathode](https://en.wikipedia.org/wiki/Cathode) and a [plate](https://en.wikipedia.org/wiki/Plate_electrode), in which electrons can flow in only one direction, from cathode to plate.

Among many uses, diodes are found in [rectifiers](https://en.wikipedia.org/wiki/Rectifier) to convert [alternating current](https://en.wikipedia.org/wiki/Alternating_current) (AC) power to [direct current](https://en.wikipedia.org/wiki/Direct_current) (DC), [demodulation](https://en.wikipedia.org/wiki/Demodulation) in [radio receivers](https://en.wikipedia.org/wiki/Radio_receiver), and can even be used for [logic](https://en.wikipedia.org/wiki/Boolean_Logic) or as [temperature sensors](https://en.wikipedia.org/wiki/Temperature_sensor). A common variant of a diode is a [light-emitting diode](https://en.wikipedia.org/wiki/Light-emitting_diode), which is used as [electric lighting](https://en.wikipedia.org/wiki/Electric_lighting) and status indicators on electronic devices.

en.wikipedia.org/wiki/Diode

A **transistor** is a [semiconductor device](https://en.wikipedia.org/wiki/Semiconductor_device) used to [amplify](https://en.wikipedia.org/wiki/Electronic_amplifier) or [switch](https://en.wikipedia.org/wiki/Electronic_switch) electrical signals and [power](https://en.wikipedia.org/wiki/Electrical_power). It is one of the basic building blocks of modern [electronics](https://en.wikipedia.org/wiki/Electronics). It is composed of [semiconductor material](https://en.wikipedia.org/wiki/Semiconductor_material), usually with at least three [terminals](https://en.wikipedia.org/wiki/Terminal_%28electronics%29) for connection to an electronic circuit. A [voltage](https://en.wikipedia.org/wiki/Voltage) or [current](https://en.wikipedia.org/wiki/Electric_current) applied to one pair of the transistor's terminals controls the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. Some transistors are packaged individually, but many more in miniature form are found embedded in [integrated circuits](https://en.wikipedia.org/wiki/Integrated_circuit). Because transistors are the key active components in practically all modern [electronics](https://en.wikipedia.org/wiki/Electronics), many people consider them one of the 20th century's greatest inventions.

[Physicist](https://en.wikipedia.org/wiki/Physicist) [Julius Edgar Lilienfeld](https://en.wikipedia.org/wiki/Julius_Edgar_Lilienfeld) proposed the concept of a [field-effect transistor](https://en.wikipedia.org/wiki/Field-effect_transistor) (FET) in 1926, but it was not possible to construct a working device at that time. The first working device was a [point-contact transistor](https://en.wikipedia.org/wiki/Point-contact_transistor) invented in 1947 by physicists [John Bardeen](https://en.wikipedia.org/wiki/John_Bardeen), [Walter Brattain](https://en.wikipedia.org/wiki/Walter_Brattain), and [William Shockley](https://en.wikipedia.org/wiki/William_Shockley) at [Bell Labs](https://en.wikipedia.org/wiki/Bell_Labs); the three shared the 1956 [Nobel Prize in Physics](https://en.wikipedia.org/wiki/Nobel_Prize_in_Physics) for their achievement. The most widely used type of transistor is the [metal–oxide–semiconductor field-effect transistor](https://en.wikipedia.org/wiki/Metal%E2%80%93oxide%E2%80%93semiconductor_field-effect_transistor) (MOSFET), invented by [Mohamed Atalla](https://en.wikipedia.org/wiki/Mohamed_Atalla) and [Dawon Kahng](https://en.wikipedia.org/wiki/Dawon_Kahng) at Bell Labs in 1959. Transistors revolutionized the field of electronics and paved the way for smaller and cheaper [radios](https://en.wikipedia.org/wiki/Radio), [calculators](https://en.wikipedia.org/wiki/Calculator), [computers](https://en.wikipedia.org/wiki/Computer), and other electronic devices.

Most transistors are made from very pure [silicon](https://en.wikipedia.org/wiki/Silicon), and some from [germanium](https://en.wikipedia.org/wiki/Germanium), but certain other semiconductor materials are sometimes used. A transistor may have only one kind of charge carrier in a field-effect transistor, or may have two kinds of charge carriers in [bipolar junction transistor](https://en.wikipedia.org/wiki/Bipolar_junction_transistor) devices. Compared with the [vacuum tube](https://en.wikipedia.org/wiki/Vacuum_tube), transistors are generally smaller and require less power to operate. Certain vacuum tubes have advantages over transistors at very high operating frequencies or high operating voltages. Many types of transistors are made to standardized specifications by multiple manufacturers.

en.wikipedia.org/wiki/Transistor

Question:

Explain NOT, AND, OR gates circuits using transistor.

m3 = 0: NOT

m3 = 1: AND

m3 = 2: OR

A **transformer** is a [passive component](https://en.wikipedia.org/wiki/Passive_component) that transfers [electrical energy](https://en.wikipedia.org/wiki/Electrical_energy) from one electrical circuit to another circuit, or multiple [circuits](https://en.wikipedia.org/wiki/Electrical_network). A varying current in any coil of the transformer produces a varying [magnetic flux](https://en.wikipedia.org/wiki/Magnetic_flux) in the transformer's core, which induces a varying [electromotive force (EMF)](https://en.wikipedia.org/wiki/Electromotive_force) across any other coils wound around the same core. Electrical energy can be transferred between separate coils without a metallic (conductive) connection between the two circuits. [Faraday's law of induction](https://en.wikipedia.org/wiki/Faraday%27s_law_of_induction), discovered in 1831, describes the induced voltage effect in any coil due to a changing magnetic flux encircled by the coil.

Transformers are used to change [AC](https://en.wikipedia.org/wiki/Alternating_current) voltage levels, such transformers being termed step-up or step-down type to increase or decrease voltage level, respectively. Transformers can also be used to provide [galvanic isolation](https://en.wikipedia.org/wiki/Galvanic_isolation) between circuits as well as to couple stages of signal-processing circuits. Since the invention of the first [constant-potential transformer](https://en.wikipedia.org/wiki/Constant-potential_transformer) in 1885, transformers have become essential for the [transmission](https://en.wikipedia.org/wiki/Electric_power_transmission), [distribution](https://en.wikipedia.org/wiki/Electric_power_distribution), and utilization of alternating current electric power. A wide range of transformer designs is encountered in electronic and electric power applications. Transformers range in size from [RF](https://en.wikipedia.org/wiki/Radio_Frequency) transformers less than a cubic centimeter in volume, to units weighing hundreds of tons used to interconnect the [power grid](https://en.wikipedia.org/wiki/Power_grid).

en.wikipedia.org/wiki/Transformer

Question:

Find V1 for the transformer if V2 = T volts, N1 = k and N2 = s.

n = 15107096

k = n Mod 10000

T = n Mod 100

V2 = T

N1 = k

N2 = n

V1 = -V2 \* N1 / N2

MsgBox V1

http://physics16.weebly.com/uploads/5/9/8/5/59854633/transformer.txt

Question:

T kilowatts of electric power is sent to a town from a power plant. The transmission lines have the total resistance of 0.1T Ohms. Calculate the power loss if the power is transmitted at:

(a) 0.03k Volts (b) s Volts

n = 15108097

k = n Mod 10000

T = n Mod 100

power = T \* 10 ^ 3

resistance = 0.1 \* T

voltage = 0.03 \* k

voltage = n

current = power / voltage

Losses = resistance \* current ^ 2

MsgBox Losses

http://physics16.weebly.com/uploads/5/9/8/5/59854633/losses4transmitting4power.txt

physics16.weebly.com/uploads/5/9/8/5/59854633/2054\_ch21a.pdf

An **electric motor** is an [electrical machine](https://en.wikipedia.org/wiki/Electric_machine) that converts [electrical energy](https://en.wikipedia.org/wiki/Electrical_energy) into [mechanical energy](https://en.wikipedia.org/wiki/Mechanical_energy). Most electric motors operate through the interaction between the motor's [magnetic field](https://en.wikipedia.org/wiki/Magnetic_field) and [electric current](https://en.wikipedia.org/wiki/Electric_current) in a [wire winding](https://en.wikipedia.org/wiki/Electromagnetic_coil) to generate force in the form of [torque](https://en.wikipedia.org/wiki/Torque) applied on the motor's shaft. An [electric generator](https://en.wikipedia.org/wiki/Electric_generator) is mechanically identical to an electric motor, but operates in reverse, converting mechanical energy into electrical energy.

Electric motors can be powered by [direct current](https://en.wikipedia.org/wiki/Direct_current) (DC) sources, such as from batteries or [rectifiers](https://en.wikipedia.org/wiki/Rectifiers), or by [alternating current](https://en.wikipedia.org/wiki/Alternating_current) (AC) sources, such as a power grid, [inverters](https://en.wikipedia.org/wiki/Inverter_%28electrical%29) or electrical generators.

Electric motors may be classified by considerations such as power source type, construction, application and type of motion output. They can be [brushed](https://en.wikipedia.org/wiki/Brushed_motor) or [brushless](https://en.wikipedia.org/wiki/Brushless_motor), [single-phase](https://en.wikipedia.org/wiki/Single-phase_electric_power), [two-phase](https://en.wikipedia.org/wiki/Two-phase_electric_power), or [three-phase](https://en.wikipedia.org/wiki/Three-phase_electric_power), [axial](https://en.wikipedia.org/wiki/Axial_flux_motor) or radial flux, and may be air-cooled or liquid-cooled.

Standardized motors provide power for industrial use. The largest are used for ship propulsion, pipeline compression and [pumped-storage](https://en.wikipedia.org/wiki/Pumped-storage_hydroelectricity) applications, with output exceeding 100 [megawatts](https://en.wikipedia.org/wiki/Watt).

Applications include industrial fans, blowers and pumps, machine tools, household appliances, power tools, vehicles, and disk drives. Small motors may be found in electric watches. In certain applications, such as in [regenerative braking](https://en.wikipedia.org/wiki/Regenerative_braking) with [traction motors](https://en.wikipedia.org/wiki/Traction_motor), electric motors can be used in reverse as generators to recover energy that might otherwise be lost as heat and friction.

Electric motors produce linear or rotary force ([torque](https://en.wikipedia.org/wiki/Torque)) intended to propel some external mechanism. They are generally designed for continuous rotation, or for linear movement over a significant distance compared to its size. [Solenoids](https://en.wikipedia.org/wiki/Solenoid) also convert electrical power to mechanical motion, but over only a limited distance.

en.wikipedia.org/wiki/Electric\_motor

Question:

A circular coil of wire has a diameter of 0.002k cm and contains 10 loops. The current in each loop is 3A, and the coil is placed into 2TESLA external magnetic field. Determine the maximum and minimum torque exerted on the coil by the field.

n = 15107086

k = n Mod 10000

T = n Mod 100

diameter = 0.002 \* k \* 0.01

area = 4 \* Atn(1) \* diameter ^ 2 / 4

number4loops = 10

current = 3

magneticflied = 2

torque = area \* number4loops \* current \* magneticflied

MsgBox "maximum torque is equal to"

MsgBox torque

MsgBox "minimum torque is equal to zero"

http://physics16.weebly.com/uploads/5/9/8/5/59854633/torque.txt

In [physics](https://en.wikipedia.org/wiki/Physics), **electromagnetic radiation** (**EMR**) consists of [waves](https://en.wikipedia.org/wiki/Wave) of the [electromagnetic (EM) field](https://en.wikipedia.org/wiki/Electromagnetic_field), which propagate through [space](https://en.wikipedia.org/wiki/Space) and carry [momentum](https://en.wikipedia.org/wiki/Momentum) and electromagnetic [radiant energy](https://en.wikipedia.org/wiki/Radiant_energy). Types of EMR include [radio waves](https://en.wikipedia.org/wiki/Radio_wave), [microwaves](https://en.wikipedia.org/wiki/Microwave), [infrared](https://en.wikipedia.org/wiki/Infrared), [(visible) light](https://en.wikipedia.org/wiki/Light), [ultraviolet](https://en.wikipedia.org/wiki/Ultraviolet), [X-rays](https://en.wikipedia.org/wiki/X-ray), and [gamma rays](https://en.wikipedia.org/wiki/Gamma_ray), all of which are part of the [electromagnetic spectrum](https://en.wikipedia.org/wiki/Electromagnetic_spectrum).

[Classically](https://en.wikipedia.org/wiki/Classical_electromagnetism), electromagnetic radiation consists of **electromagnetic waves**, which are synchronized [oscillations](https://en.wikipedia.org/wiki/Oscillation) of [electric](https://en.wikipedia.org/wiki/Electric_field) and [magnetic fields](https://en.wikipedia.org/wiki/Magnetic_field). Depending on the frequency of oscillation, different wavelengths of electromagnetic spectrum are produced. In a vacuum, electromagnetic waves travel at the [speed of light](https://en.wikipedia.org/wiki/Speed_of_light), commonly denoted *c*. In homogeneous, isotropic media, the oscillations of the two fields are perpendicular to each other and perpendicular to the direction of energy and wave propagation, forming a [transverse wave](https://en.wikipedia.org/wiki/Transverse_wave). The position of an electromagnetic wave within the [electromagnetic spectrum](https://en.wikipedia.org/wiki/Electromagnetic_spectrum) can be characterized by either its [frequency](https://en.wikipedia.org/wiki/Frequency) of oscillation or its [wavelength](https://en.wikipedia.org/wiki/Wavelength). Electromagnetic waves of different frequency are called by different names since they have different sources and effects on matter. In order of increasing frequency and decreasing wavelength these are: radio waves, microwaves, infrared radiation, visible light, ultraviolet radiation, X-rays and gamma rays.

Electromagnetic waves are emitted by electrically [charged particles](https://en.wikipedia.org/wiki/Charged_particle) undergoing acceleration, and these waves can subsequently interact with other charged particles, exerting force on them. EM waves carry energy, [momentum](https://en.wikipedia.org/wiki/Momentum) and [angular momentum](https://en.wikipedia.org/wiki/Angular_momentum) away from their source particle and can impart those quantities to [matter](https://en.wikipedia.org/wiki/Matter) with which they interact. Electromagnetic radiation is associated with those EM waves that are free to propagate themselves ("radiate") without the continuing influence of the moving charges that produced them, because they have achieved sufficient distance from those charges. Thus, EMR is sometimes referred to as the [far field](https://en.wikipedia.org/wiki/Near_and_far_field). In this language, the [near field](https://en.wikipedia.org/wiki/Near_and_far_field) refers to EM fields near the charges and current that directly produced them, specifically [electromagnetic induction](https://en.wikipedia.org/wiki/Electromagnetic_induction) and [electrostatic induction](https://en.wikipedia.org/wiki/Electrostatic_induction) phenomena.

In [quantum mechanics](https://en.wikipedia.org/wiki/Quantum_mechanics), an alternate way of viewing EMR is that it consists of [photons](https://en.wikipedia.org/wiki/Photon), uncharged [elementary particles](https://en.wikipedia.org/wiki/Elementary_particle) with zero [rest mass](https://en.wikipedia.org/wiki/Rest_mass) which are the [quanta](https://en.wikipedia.org/wiki/Quantum) of the [electromagnetic field](https://en.wikipedia.org/wiki/Electromagnetic_field), responsible for all electromagnetic interactions. [Quantum electrodynamics](https://en.wikipedia.org/wiki/Quantum_electrodynamics) is the theory of how EMR interacts with matter on an atomic level. Quantum effects provide additional sources of EMR, such as the [transition of electrons](https://en.wikipedia.org/wiki/Atomic_electron_transition) to lower [energy levels](https://en.wikipedia.org/wiki/Energy_level) in an atom and [black-body radiation](https://en.wikipedia.org/wiki/Black-body_radiation). The energy of an individual photon is [quantized](https://en.wikipedia.org/wiki/Quantization_%28physics%29) and is greater for photons of higher frequency. This relationship is given by [Planck's equation](https://en.wikipedia.org/wiki/Planck%E2%80%93Einstein_relation) *E* = *hf*, where *E* is the energy per photon, *f* is the frequency of the photon, and *h* is the [Planck constant](https://en.wikipedia.org/wiki/Planck_constant). A single gamma ray photon, for example, might carry ~100,000 times the energy of a single photon of visible light.

The effects of EMR upon chemical compounds and biological organisms depend both upon the radiation's [power](https://en.wikipedia.org/wiki/Power_%28physics%29) and its frequency. EMR of visible or lower frequencies (i.e., visible light, infrared, microwaves, and radio waves) is called [*non-ionizing radiation*](https://en.wikipedia.org/wiki/Non-ionizing_radiation), because its photons do not individually have enough energy to [ionize](https://en.wikipedia.org/wiki/Ionization) atoms or molecules, or break [chemical bonds](https://en.wikipedia.org/wiki/Chemical_bond). The effects of these radiations on chemical systems and living tissue are caused primarily by heating effects from the combined energy transfer of many photons. In contrast, high frequency ultraviolet, X-rays and gamma rays are called [*ionizing radiation*](https://en.wikipedia.org/wiki/Ionizing_radiation), since individual photons of such high frequency have enough energy to [ionize](https://en.wikipedia.org/wiki/Ionization) molecules or break [chemical bonds](https://en.wikipedia.org/wiki/Chemical_bond). These radiations have the ability to cause [chemical reactions](https://en.wikipedia.org/wiki/Chemical_reaction) and damage living cells beyond that resulting from simple heating, and can be a health hazard.

en.wikipedia.org/wiki/Electromagnetic\_radiation

Question:

T Watts lamp emits electromagnetic radiation in all directions. Assuming a lamp to be a point source, calculate the intensity of the radiation:

a. at distance of 1 m from the lamp.

b. at distance of 2 m from the lamp.

S = 4πR2.

I = T/S.

s = 19107012

L = s Mod 10

T = s Mod 100

k = s Mod 10000

Pi = 4 \* Atn(1)

S1 = 4 \* Pi \* 1 ^ 2

S2 = 4 \* Pi \* 2 ^ 2

I1 = T / S1

I2 = T / S2

MsgBox I1

MsgBox I2

https://physics16.weebly.com/uploads/5/9/8/5/59854633/intensity4radius2019nov.txt

Question:

Waves from a source have an amplitude of 5 cm and an intensity of T Wm-2.

a. The amplitude of the waves is increased to 10 cm. What is their intensity now?

b. The intensity of the waves is increased to 100 Wm-2. What is their amplitude?

I = CA2.

C = I/A2.

I = Intensity

A = Amplitude

C = Constant

s = 19107012

L = s Mod 10

T = s Mod 100

k = s Mod 10000

I = T

A = 5 \* 10 ^ (-2)

C = I / A ^ 2

A = 10 \* 10 ^ (-2)

I = C \* A ^ 2

MsgBox I

I = 100

A = Sqr(I / C)

MsgBox A

https://physics16.weebly.com/uploads/5/9/8/5/59854633/amplitude4intensity2019nov.txt

In [physics](https://en.wikipedia.org/wiki/Physics), **refraction** is the redirection of a [wave](https://en.wikipedia.org/wiki/Wave) as it passes from one [medium](https://en.wikipedia.org/wiki/Transmission_medium) to another. The redirection can be caused by the wave's change in speed or by a change in the medium. Refraction of [light](https://en.wikipedia.org/wiki/Light) is the most commonly observed phenomenon, but other waves such as [sound waves](https://en.wikipedia.org/wiki/Sound_wave) and [water waves](https://en.wikipedia.org/wiki/Wind_wave) also experience refraction. How much a wave is refracted is determined by the change in wave speed and the initial direction of wave propagation relative to the direction of change in speed.

en.wikipedia.org/wiki/Refraction

Snell law:

$$n\_{1}\sin(\left(A\_{1}\right))=n\_{2}\sin(\left(A\_{2}\right))$$

$$\frac{n\_{1}}{n\_{2}}=\frac{\sin(\left(A\_{2}\right))}{\sin(\left(A\_{1}\right))}$$

Index of refraction:

$$n=\frac{c}{v}$$

c is speed of light in vacuum

v is speed of light in the medium (glass, etc.)

Question:

Light of wavelength T nm in a vacuum, travels into glass, where its speed decreases to 2×108ms-1. Determine:

a. the frequency of the light in vacuum

b. its frequency and wavelength in glass.

Frequency is the same in all media.

c = 3\*108 m/s in vacuum.

s = 19107012

L = s Mod 10

T = s Mod 100

k = s Mod 10000

c = 3 \* 10 ^ 8

lambdainvacuum = T \* 10 ^ (-9)

frequencyinvacuum = c / lambdainvacuum

MsgBox frequencyinvacuum

velocityinglass = 2 \* 10 ^ 8

lambdainglass = velocityinglass / frequencyinvacuum

MsgBox lambdainglass

https://physics16.weebly.com/uploads/5/9/8/5/59854633/wavelength4frequency4refraction2019nov.txt

Question:

An astronomer observes light from a distant star. A particular line in its spectrum has a wavelength of T nm. When measures in the laboratory, the same spectral line has a wavelength of L nm. Determine:

a. the change in the wavelength of the spectral line

b. the speed of the star

c. the direction of the movement of the star (towards or away from the observer).

f = c/T

F = c/L

f = Fc/(c+v)

v = -c + Fc/f

s = 19107012

L = s Mod 10

T = s Mod 100

k = s Mod 10000

c = 3 \* 10 ^ 8

f\_small = c / (T \* 10 ^ (-9))

F\_BIG = c / (L \* 10 ^ (-9))

wavelebgthchange = T \* 10 ^ (-9) - L \* 10 ^ (-9)

MsgBox wavelebgthchange

v = -c + c \* F\_BIG / f\_small

MsgBox v

https://physics16.weebly.com/uploads/5/9/8/5/59854633/doppler4effect2019nov.txt

In [modern physics](https://en.wikipedia.org/wiki/Modern_physics), the **double-slit experiment** demonstrates that light and matter can satisfy the seemingly-incongruous classical definitions for both waves *and* particles, which is considered evidence for the fundamentally probabilistic nature of [quantum mechanics](https://en.wikipedia.org/wiki/Quantum_mechanics). This type of experiment was first performed by [Thomas Young](https://en.wikipedia.org/wiki/Thomas_Young_%28scientist%29) in 1801, as a demonstration of the wave behavior of visible light. At that time it was thought that light consisted of *either* waves *or* particles. With the beginning of modern physics, about a hundred years later, it was realized that light could in fact show *both* wave *and* particle characteristics. In 1927, [Davisson and Germer](https://en.wikipedia.org/wiki/Davisson%E2%80%93Germer_experiment) and, independently [George Paget Thomson](https://en.wikipedia.org/wiki/George_Paget_Thomson) and Alexander Reid demonstrated that electrons show the same behavior, which was later extended to atoms and molecules. Thomas Young's experiment with light was part of [classical physics](https://en.wikipedia.org/wiki/Classical_physics) long before the development of quantum mechanics and the concept of [wave–particle duality](https://en.wikipedia.org/wiki/Wave%E2%80%93particle_duality). He believed it demonstrated that [Christiaan Huygens'](https://en.wikipedia.org/wiki/Christiaan_Huygens) [wave theory of light](https://en.wikipedia.org/wiki/Wave_theory_of_light) was correct, and his experiment is sometimes referred to as [Young's experiment](https://en.wikipedia.org/wiki/Young%27s_interference_experiment) or Young's slits.

The experiment belongs to a general class of "double path" experiments, in which a wave is split into two separate waves (the wave is typically made of many photons and better referred to as a wave front, not to be confused with the wave properties of the individual photon) that later combine into a single wave. Changes in the path-lengths of both waves result in a [phase shift](https://en.wikipedia.org/wiki/Phase_shift), creating an [interference pattern](https://en.wikipedia.org/wiki/Interference_pattern). Another version is the [Mach–Zehnder interferometer](https://en.wikipedia.org/wiki/Mach%E2%80%93Zehnder_interferometer), which splits the beam with a [beam splitter](https://en.wikipedia.org/wiki/Beam_splitter).

en.wikipedia.org/wiki/Double-slit\_experiment

Question:

Find x. λD = ax Young double-slit experiment (waves). D = d2. a = m25. λ = L = m10.

λ is the wavelength.

D is distance between double slits and screen.

a is the distance between slits.

x is the distance between fringes.

physics18.weebly.com/uploads/5/9/8/5/59854633/5c14img\_2290p5.jpg

s = 19107012

L = s Mod 10

T = s Mod 100

k = s Mod 10000

E = s Mod 8

q = s Mod 17

a = s Mod 25

d = (T - L) / 10

Lambda = L

x = Lambda \* d / a

MsgBox x

https://physics16.weebly.com/uploads/5/9/8/5/59854633/young4double4slit4experiment2019nov.txt

In [optics](https://en.wikipedia.org/wiki/Optics), a **diffraction grating** is an optical [grating](https://en.wikipedia.org/wiki/Grating) with a periodic structure that [diffracts](https://en.wikipedia.org/wiki/Diffraction) light into several beams traveling in different directions (i.e., different diffraction angles). The emerging coloration is a form of [structural coloration](https://en.wikipedia.org/wiki/Structural_coloration). The directions or diffraction angles of these beams depend on the wave (light) incident angle to the diffraction grating, the spacing or distance between adjacent diffracting elements (e.g., parallel slits for a transmission grating) on the grating, and the wavelength of the incident light. The grating acts as a [dispersive](https://en.wikipedia.org/wiki/Dispersion_%28optics%29) element. Because of this, diffraction gratings are commonly used in [monochromators](https://en.wikipedia.org/wiki/Monochromator) and [spectrometers](https://en.wikipedia.org/wiki/Spectrometer), but other applications are also possible such as optical encoders for high-precision motion control and wavefront measurement.

For typical applications, a [reflective](https://en.wikipedia.org/wiki/Reflection_%28optics%29) grating has ridges or *rulings* on its surface while a transmissive grating has transmissive or hollow slits on its surface. Such a grating modulates the amplitude of an incident wave to create a diffraction pattern. Some gratings modulate the phases of incident waves rather than the amplitude, and these types of gratings can be produced frequently by using [holography](https://en.wikipedia.org/wiki/Holography).

[James Gregory](https://en.wikipedia.org/wiki/James_Gregory_%28astronomer_and_mathematician%29) (1638–1675) observed the diffraction patterns caused by a bird feather, which was effectively the first diffraction grating (in a natural form) to be discovered, about a year after [Isaac Newton](https://en.wikipedia.org/wiki/Isaac_Newton)'s prism experiments. The first man-made diffraction grating was made around [1785](https://en.wikipedia.org/wiki/1785_in_science) by [Philadelphia](https://en.wikipedia.org/wiki/Philadelphia) inventor [David Rittenhouse](https://en.wikipedia.org/wiki/David_Rittenhouse), who strung hairs between two finely threaded screws. This was similar to notable German physicist [Joseph von Fraunhofer](https://en.wikipedia.org/wiki/Joseph_von_Fraunhofer)'s wire diffraction grating in [1821](https://en.wikipedia.org/wiki/1821_in_science). The principles of diffraction were discovered by [Thomas Young](https://en.wikipedia.org/wiki/Thomas_Young_%28scientist%29) and [Augustin-Jean Fresnel](https://en.wikipedia.org/wiki/Augustin-Jean_Fresnel). Using these principles, Fraunhofer was the first to use a diffraction grating to obtain line spectra and the first to measure the wavelengths of spectral lines with a diffraction grating.

Gratings with the lowest line distance (d) were created, in the 1860s, by [Friedrich Adolph Nobert](https://en.wikipedia.org/wiki/Friedrich_Adolph_Nobert) (1806–1881) in Greifswald; then the two Americans Lewis Morris Rutherfurd (1816–1892) and William B. Rogers (1804–1882) took over the lead; and, by the end of the 19th century, the concave gratings of [Henry Augustus Rowland](https://en.wikipedia.org/wiki/Henry_Augustus_Rowland) (1848–1901) were the best available.

A diffraction grating can create "rainbow" colors when it is illuminated by a wide-spectrum (e.g., continuous) light source. Rainbow-like colors from closely spaced narrow tracks on optical data storage disks such as [CDs](https://en.wikipedia.org/wiki/CD) or [DVDs](https://en.wikipedia.org/wiki/DVD) are an example of light [diffraction](https://en.wikipedia.org/wiki/Diffraction) caused by diffraction gratings. A usual diffraction grating has parallel lines (It is true for 1-dimensional gratings, but 2 or 3-dimensional gratings are also possible and they have their applications such as wavefront measurement), while a CD has a spiral of finely spaced data tracks. Diffraction colors also appear when one looks at a bright point source through a translucent fine-pitch umbrella fabric covering. Decorative patterned plastic films based on reflective grating patches are inexpensive and commonplace.

en.wikipedia.org/wiki/Diffraction\_grating

Question:

Give n. d sinA = nλ diffraction grating (waves). d = d2. A = m25. λ = L = m10.

s = 19107012

L = s Mod 10

T = s Mod 100

k = s Mod 10000

E = s Mod 8

q = s Mod 17

A = s Mod 25

d = (T - L) / 10

Pi = 4 \* Atn(1)

A = A \* Pi / 180

Lambda = L

n = d \* Sin(A) / Lambda

n = Round(n)

MsgBox n

https://physics16.weebly.com/uploads/5/9/8/5/59854633/diffraction4grating2019nov.txt

**Maxwell's equations**, or **Maxwell–Heaviside equations**, are a set of coupled [partial differential equations](https://en.wikipedia.org/wiki/Partial_differential_equation) that, together with the [Lorentz force](https://en.wikipedia.org/wiki/Lorentz_force) law, form the foundation of [classical electromagnetism](https://en.wikipedia.org/wiki/Classical_electromagnetism), classical [optics](https://en.wikipedia.org/wiki/Optics), and [electric circuits](https://en.wikipedia.org/wiki/Electric_circuit). The equations provide a mathematical model for electric, optical, and radio technologies, such as power generation, electric motors, [wireless](https://en.wikipedia.org/wiki/Wireless) communication, lenses, radar, etc. They describe how [electric](https://en.wikipedia.org/wiki/Electric_field) and [magnetic fields](https://en.wikipedia.org/wiki/Magnetic_field) are generated by [charges](https://en.wikipedia.org/wiki/Electric_charge), [currents](https://en.wikipedia.org/wiki/Electric_current), and changes of the fields. The equations are named after the physicist and mathematician [James Clerk Maxwell](https://en.wikipedia.org/wiki/James_Clerk_Maxwell), who, in 1861 and 1862, published an early form of the equations that included the Lorentz force law. Maxwell first used the equations to propose that light is an electromagnetic phenomenon. The modern form of the equations in their most common formulation is credited to [Oliver Heaviside](https://en.wikipedia.org/wiki/Oliver_Heaviside).

en.wikipedia.org/wiki/Maxwell%27s\_equations

Question:

Solve the simplified Maxwell Equations $c^{2}\frac{∂^{2}E}{∂x^{2}}=\frac{∂^{2}E}{∂t^{2}}$ for c = 300000000-s, red light. Take amplitude 1 V/m.

Find the intensity of electric field after s seconds at m meters.

s = 16108088

Ttt = s Mod 100

m = s Mod 35

L = s Mod 10

t = s

x = m

c = 3 \* 10 ^ 8 - s

E = Sin(x - c \* t)

MsgBox E

http://physics16.weebly.com/uploads/5/9/8/5/59854633/maxwell\_equations\_solution.txt

Question:

Suppose a star has a surface temperature of 4k degrees. What are the wavelength and the color this star appears?

n = 15108097

k = n Mod 10000

b = 3 \* 10 ^ (-3)

t = 4 \* k

Lambda\_max = b / t

MsgBox Lambda\_max

http://physics16.weebly.com/uploads/5/9/8/5/59854633/color4black4body.txt

**Reflection** is the change in direction of a [wavefront](https://en.wikipedia.org/wiki/Wavefront) at an [interface](https://en.wikipedia.org/wiki/Interface_%28matter%29) between two different [media](https://en.wikipedia.org/wiki/Medium_%28optics%29) so that the wavefront returns into the medium from which it originated. Common examples include the reflection of [light](https://en.wikipedia.org/wiki/Light), [sound](https://en.wikipedia.org/wiki/Sound) and [water waves](https://en.wikipedia.org/wiki/Water_wave). The *law of reflection* says that for [specular reflection](https://en.wikipedia.org/wiki/Specular_reflection) (for example at a [mirror](https://en.wikipedia.org/wiki/Mirror)) the angle at which the wave is incident on the surface equals the angle at which it is reflected.

In [acoustics](https://en.wikipedia.org/wiki/Acoustics), reflection causes [echoes](https://en.wikipedia.org/wiki/Echo_%28phenomenon%29) and is used in [sonar](https://en.wikipedia.org/wiki/Sonar). In geology, it is important in the study of [seismic waves](https://en.wikipedia.org/wiki/Seismic_wave). Reflection is observed with [surface waves](https://en.wikipedia.org/wiki/Surface_wave) in bodies of water. Reflection is observed with many types of [electromagnetic wave](https://en.wikipedia.org/wiki/Electromagnetic_wave), besides [visible light](https://en.wikipedia.org/wiki/Visible_light). Reflection of [VHF](https://en.wikipedia.org/wiki/Very_high_frequency) and higher frequencies is important for [radio](https://en.wikipedia.org/wiki/Radio) transmission and for [radar](https://en.wikipedia.org/wiki/Radar). Even [hard X-rays](https://en.wikipedia.org/wiki/Hard_X-ray) and [gamma rays](https://en.wikipedia.org/wiki/Gamma_ray) can be reflected at shallow angles with special "grazing" mirrors.

en.wikipedia.org/wiki/Reflection\_(physics)

Angle of incidence is equal to angle of reflection.

Question:

A man 0.25k mm tall stands in front of a vertical plane mirror. His eyes are 10 cm bellow the top of his head. What are the sizes and the best location of the smallest possible mirror so that he can see his entire body?

n = 15107096

k = n Mod 10000

T = n Mod 100

Height\_of\_man = 0.25 \* k \* 10 ^ (-3)

d = 10 \* 10 ^ (-2)

Top\_of\_mirror = Height\_of\_man - d / 2

Mirror\_Length = Height\_of\_man / 2

MsgBox Top\_of\_mirror

MsgBox Mirror\_Length

http://physics16.weebly.com/uploads/5/9/8/5/59854633/height4mirror.txt

A **convex mirror** or **diverging mirror** is a curved mirror in which the reflective surface bulges towards the light source. Convex mirrors reflect light outwards, therefore they are not used to focus light. Such mirrors always form a [virtual image](https://en.wikipedia.org/wiki/Virtual_image), since the [focal point](https://en.wikipedia.org/wiki/Focus_%28optics%29) (*F*) and the centre of curvature (*2F*) are both imaginary points "inside" the mirror, that cannot be reached. As a result, images formed by these mirrors cannot be projected on a screen, since the image is inside the mirror. The image is smaller than the object, but gets larger as the object approaches the mirror.

A [collimated](https://en.wikipedia.org/wiki/Collimated_light) (parallel) beam of light diverges (spreads out) after reflection from a convex mirror, since the [normal](https://en.wikipedia.org/wiki/Surface_normal) to the surface differs at each spot on the mirror.

en.wikipedia.org/wiki/Curved\_mirror#Convex\_mirrors

teachoo.com/10830/3118/Mirror-Formula/category/Concepts/

$$\frac{1}{di}+\frac{1}{doo}=\frac{1}{f}$$

f =0.5R

R is radius of curvature of the mirror

f is a focal distance of the mirror

$$m=-\frac{di}{doo}$$

di is distance to the image

doo is distance to the object

m is magnification

Question:

For convex mirror with a radius of curvature of 0.002k meters, determine the location of the image and its magnification for an object 0.0012k meters from the mirror.

n = 15108097

k = n Mod 10000

r = 16

doo = 10

r = 0.002 \* k

doo = 0.0012 \* k

f = -r / 2

di = 1 / (1 / f - 1 / doo)

MsgBox di

m = -di / doo

MsgBox m

http://physics16.weebly.com/uploads/5/9/8/5/59854633/mirror.txt

Question:

A spy satellite camera can recognize T cm objects from the altitude of n meters. If diffraction was the only limitation (the wave length Lambda = 0.1k nanometers), determine what diameter lens the camera has.

n = 15108097

k = n Mod 10000

T = n Mod 100

Lambda = 550 \* 10 ^ (-9)

A = 0.03 / 100000

Lambda = k \* 10 ^ (-10)

A = T \* 0.01 / n

D = 1.22 \* Lambda / A

MsgBox D

http://physics16.weebly.com/uploads/5/9/8/5/59854633/satellite4spying.txt