Task 1 in physics:

Instructions:

Write all your answers in this Word Document and email the Word Document with your answers to me.

Try to write only text. Try to avoid pictures, videos and other things, which make files big.

Write your name(s)

Write your student number(s)

s is your student number.

k = s mod 10000 = m10000

T = s mod 100 = m100

m = s mod 35 = m35

a = s mod 25 = m25

L = s mod 10 = m10

m9 = s mod 9

e = s mod 8 = m8

m7 = s mod 7

m6 = s mod 6

m5 = s mod 5

m4 = s mod 4.

m3 = s mod 3

m2 = s mod 2

Introduction to physics

What physics is

Physics is the most fundamental science, describing mechanical motion of solids and fluids, thermodynamics, electromagnetism, quantum mechanics, relativity theory, etc.

Question:

What do you want from this physics course?

Project

Your project can be about any topic in physics, which you like or interested in. You may present your project to the audience.

Question:

Describe your project.

Units of physics

There are 7 base units of physics.

Question:

What are the base units?

en.wikipedia.org/wiki/SI\_base\_unit

Question:

Express unit of force through the base units.

Use Second Law of Newton F = ma.

Question:

Show that ta has units of v.

t is time.

a is acceleration.

Accuracy and precision

Accuracy is average correctness of the results.

Precision is repeatability of the results.

Question:

Explain the example of:

m4 = 0: accurate and precise.

m4 = 1: accurate and NOT precise.

m4 = 2: NOT accurate and precise.

m4 = 3: NOT accurate and NOT precise.

en.wikipedia.org/wiki/Accuracy\_and\_precision

Significant figures

Significant figures are needed to use appropriate precision in numbers, describing measurements.

Use Atlantic rule and Pacific rule to determine number of significant figures.

Question:

How many significant figures are there in your T number?

Question:

Give the number of significant figures of the number for your T.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 1: 8778000 | 2: 0.000567 | 3: 80600 | 4: 0.00067900 | 5: 346000 |
| 6: 0.000673 | 7: 95328000 | 8: 943258000 | 9: 0.000774 | 10: 9900 |
| 11: 987890 | 12: 0.0000561 | 13: 94034600 | 14: 900653540 | 15: 0.005469 |
| 16: 4365600 | 17: 0.003268 | 18: 456700 | 19: 467000 | 20: 0.0000676 |
| 21: 36.00800 | 22: 65.00 | 23: 0.00000 | 24: 7890000 | 25: 0.0003 |
| 26: 65765700 | 27: 0.000500 | 28: 56456000 | 29: 0.00056 | 30: 6756700 |
| 31: 674670 | 32: 0.00654 | 33: 434500 | 34: 0.020450 | 35: 8760076 |
| 36: 0.0065400 | 37: 5689400 | 38: 0.000600 | 39: 5930300 | 40: 0.007700 |
| 41: 4920010 | 42: 4090330 | 43: 0.0750000 | 44: 490304457 | 45: 0.0060700 |
| 46: 4790650 | 47: 0.0006277 | 48: 50403460 | 49: 0.0060600 | 50: 490400600 |
| 51: 000000 | 52: 589500 | 53: 96400800 | 54: 0.0045045 | 55: 358000500 |
| 56: 0.00143 | 57: 32122000 | 58: 1258000 | 59: 0.001474 | 60: 51200 |
| 61: 187890 | 62: 0.000021 | 63: 94034100 | 64: 200653540 | 65: 0.005419 |
| 66: 4362600 | 67: 0.003268 | 68: 412700 | 69: 427000 | 70: 0.0000671 |
| 71: 174170 | 72: 0.00214 | 73: 434300 | 74: 0.020410 | 75: 8230021 |
| 76: 0.0012400 | 77: 2189400 | 78: 0.000200 | 79: 1930300 | 80: 0.003200 |
| 81: 1920010 | 82: 4020330 | 83: 0.0120000 | 84: 490304432 | 85: 0.0060300 |
| 86: 000000 | 87: 589100 | 88: 92400800 | 89: 0.0041045 | 90: 358000200 |

**Classical mechanics**

Classical mechanics is among the oldest branches of physics,

it is one of the most basic, it describes motion of the objects around us.

**Limits for use of classical mechanics**

Classical mechanics is used for speeds, which are much smaller than speed of light and distances, which are much larger than 1 nano-meter and much smaller than the size of our Galaxy, which is measured in light years (beyond this it is dealt with by relativity theory, quantum physics, astrophysics).

Classical mechanics is usually used for macro-objects (from 1 micro-meter to several kilometres) and for speeds between 0 and several speeds of sound).

Question:

Where can classical mechanics be used?

Definitions:

Distance is the total movement of object without regard to direction.

Displacement is distance moved in a particular direction.

Mass is the measure of resistance to change in motion (inertial mass).

Gravitational mass is measure of strength of gravitational force.

Speed is a scalar quantity that is equal to how far the object has moved divided by time taken.

Velocity is a quantity that designates how fast and in what direction a point is moving.

Momentum is product of mass of particle and its velocity.

Angular velocity is rotation rate, showing how fast object rotates.

Angular acceleration is the time rate of change of angular velocity.

Moment of inertia is resistance to angular acceleration. J = I = mR2

Angular momentum is moment of inertial times angular velocity.

Acceleration is the rate of change of the velocity of an object with respect to time.

Time is continued sequence of existence and events that occurs in irreversible succession from the part, through the present, into the future.

Torque is measure of force that can cause an object to rotate about an axis.

Question:

Define distance, displacement, time, speed, velocity, liner acceleration, linear momentum, angular velocity, angular acceleration, angular momentum, moment of inertia, force, torque.

Force

Force changes motion of body.

If physics, by nature, forces can be gravitational, electromagnetic, nuclear weak, nuclear strong.

By way of application, forces can be surface forces (friction) and volume forces (gravity, electromagnetism).

Surface force acts across surface element of body.

Volume force acts on all particles of given body.

**Material point**

Material point is infinitely small, we neglect its sizes.

It is often possible with high accuracy and precision.

Examples of material points in physics can be bullet,

cannon ball, tennis ball, etc.

if we compare their sizes to much bigger objects,

such as Earth, Galaxy, etc.

If object is big enough then we can often consider it as material point,

located in the centre of mass.

**Kinematics**

To find equations of velocity and acceleration using the equation of displacement, differentiate the equation once to find the velocity, differentiate the equation of displacement twice or equation of velocity once to get the equation of acceleration, differentiate with respect to time t.

Question:

Find velocity and acceleration for one-dimensional motion with the equation x = -k + Lt + Tt2.

Momentum:

Linear momentum:

**p** = m**v** (1)

. (2)

(1) is the expression of linear momentum for one material point.

(2) is the expression of linear momentum for the mechanical system of n material points.

**Collisions**:

We consider one-dimensional motion of material points.

Inelastic collisions or perfectly inelastic collisions:

Two balls (material points) collide without external forces (without friction, etc.) along the straight line (one-dimensional motion), after the inelastic collision both balls move with the same velocity being stick to each other.

Before the collision the masses and the velocities of the balls are m1 and m2, v1 and v2, respectively.

After the collision the balls move together with the same velocity v.

Momentum is conserved: momentum before the collision is equal to momentum after the collision.

m1v1 + m2v2 = (m1 + m2)v (3)

 (4)

**Elastic collisions or perfectly elastic collisions**:

This is more complex problem because instead of one unknown v there two unknowns V1 and V2.

This time we use the law of conservation of kinetic energy in addition to the law of conservation of momentum.

There two simultaneous equations to solve in this case for V1 and V2.

m1v1 + m2v2 = m1V1 + m2V2 (5)

 (6)

These simultaneous equations are quadratic; there will be two solutions for V1 and two solutions for V2.

We must choose the correct solutions based on the physical conditions.

We solve the quadratic simultaneous equations by substitution, expressing V2 through V1 from the first equation and substituting the expression into the second equation.

 (7)

Substituting (7) to (6), we get the single quadratic equation for V1. By solving the single quadratic equation and finding two values of V1, we must decide with of the two answers is the correct physical value for V1.

V2 can be found through V1 using (7).

Conservation of momentum

Momentum is conserved only for absolutely inelastic collision and absolutely elastic collision.

Describing the inelastic collision, we assume that the momentum is conserved. The material points stick together after collision and move with the same velocity. We consider one-dimensional motion.

Question:

Calculate the final speed after absolutely inelastic collision of two balls of masses L kg and T kg, moving with velocities s meters per second and k metres per second respectively.

s = 22123456

k = s mod 10000

T = s mod 100

L = s mod 10

u1 = s

u2 = k

m1 = L

m2 = T

v = (m1 \* u1 + m2 \* u2) / (m1 + m2)

MsgBox v

MsgBox “Velocity is measured in meters per second.”

MsgBox “Maximum number of significant figures is 1.”

http://physics16.weebly.com/uploads/5/9/8/5/59854633/inelastic4collision.txt

Absolutely elastic collision has 2 equations: conservation of momentum and conservation of kinetic energy

We neglect resistance to motion.

Question:

Solve the elastic collision problem for u1 = k, u2 = k/2, m1 = k, m2 = 2k.

s = 22123456

k = s mod 10000

T = s mod 100

L = s mod 10

u1 = k

u2 = k/2

m1 = k

m2 = 2\* k

'

v1 = ((m1 - m2) \* u1 + 2 \* m2 \* u2) / (m1 + m2)

v2 = v1 + u1 - u2

'

MsgBox v1

MsgBox v2

MsgBox “Velocity is measured in meters per second.”

MsgBox “Maximum number of significant figures is 4.”

http://physics16.weebly.com/uploads/5/9/8/5/59854633/linear2elastic4collision.txt

**Acceleration kinematics**

x = x0 + tV0 + 0.5at2

V = V0 + at

V2 = +2a(x – x0)

Question:

Prove that V2 = +2a(x – x0).

**Dynamics**

Dynamics studies motion of bodies under the influence of forces.

**Mechanical system**

Mechanical system consists of many material points.

Centre of mass of discrete mechanical system is weighted average.

Centre of mass of continuous mechanical system is weighted average,

expressed through integrals.

**Centre of mass**

Only external force can change location of centre of mass of mechanical system.

Internal force cannot change location of centre of mass of mechanical system.

Equation for centre of mass for 2 material points is weighted average:

The equation for any number of material points is similar, the difference is in the number of terms: 3 terms for 3 points, etc.

Centre of gravity may be different from centre of mass.

Question:

Find the centre of mass of 2 equal masses k meters apart.

s = 22123456

k = s Mod 10000

centerOfMass = k / 2

MsgBox centerOfMass

MsgBox “Location of centre of mass is measured in meters”

MsgBox “Maximum 4 significant figures”

https://physics15.weebly.com/uploads/3/0/2/7/30272185/centerofmass23sept.txt

**Internal forces and external forces**

I cannot pull myself out of mud because my force is internal force for the mechanical system.

I can only get out of mud if I use external friction force or get help from other people.

Question:

Can I pull myself out of mud? Why?

**Momentum**

Momentum of material point is mv.

Here m is mass of material point and V is velocity of material point.

**Kinetic energy**

Kinetic energy of material point is mv2/2

Note that derivative of kinetic energy with respect to velocity is equal to momentum.

Question:

Prove that derivative of kinetic energy with respect to velocity is equal to momentum.

**Potential energy** is mgh

m is mass.

g is gravity acceleration.

h is height.

**Laws of Newton**

Laws of Newton describe motion or stationary states of bodies under the influence of forces

First Law of Newton says that there is no acceleration without force, it follows from Second Law of Newton.

Second Law of Newton: F = ma

Third Law of Newton says that action is equal to reaction: F1 = - F2.

**Mass**

Mass is the measure of inertial of body, measure of how much body resists acceleration.

There is also gravitational mass, which shows how much body is attracted by other bodies due to gravitational force.

Question:

What is mass?

**Weight**

Weight is the force that object exerts on ground due to gravitational attraction to Earth or another similar object.

weight = mg

Question:

What is your weight?

MyMass = 75

g = 10

MyWeight = MyMass \* g

MsgBox MyWeight

MsgBox “Weight is measured in Newtons.”

MsgBox “1 significant figure.”

https://physics15.weebly.com/uploads/3/0/2/7/30272185/weightonearththroughmass23sept.txt

**Projectile**

Projectile is particular case of motion with constant acceleration a = -g.

g is gravity acceleration.

Projectile is a material point, moving under the influence of gravity in two-dimensions. We solved differential equations of Second Law of Newton, using the initial conditions to determine the integration constants.

Projectile is described by Second Law of Newton in 2 dimensions.

We solve ordinary differential equations of second order.

x: Fx = 0, therefore no acceleration along x, there will be constant velocity along x.

y: Fy = -mg = ma, therefore there is constant acceleration along y.

To get the velocity, we must integrate differential equation of Second Law of Newton once.

Velocity of the projectile is:

Vx = V0cosA

Vy = V0sinA – gt

Here we used initial conditions for time t = 0

Vx(0) = V0cosA

Vy(0) = V0sinA

Using the fact that Vy = 0 at maximum height and symmetry of trajectory:

Total time is: 2(V0sinA)/g

Time for maximum height is: (V0sinA)/g

To find distance, we must integrate differential equations of Second Law of Newton twice.

x = x0 + tV0cosA

y = y0 + tV0sinA – 0.5gt2

Here we used initial conditions for time t = 0

x(0) = x0

y(0) = y0

y as a function of x:

y = xtanA – (1 + (tanA)2)gx2/(2(V0)2)

tanA = sinA/cosA

You can find minimum initial velocity and corresponding angle of release to hit any point in space.

Question:

Find Maximum x, Maximum y; find x and y at time = T seconds, for angle of release A = T degrees, initial velocity V0 = T meters per second, x0 = y0 = 0 meters for projectile.

s = 22123456

T = s Mod 100

v0 = T

g = 10

Pi = 4 \* Atn(1)

A = T \* Pi / 180

x0 = 0

y0 = 0

x = x0 + T \* v0 \* Cos(A)

y = y0 + T \* v0 \* Sin(A) - g \* T / 2

MsgBox x

MsgBox y

xmax = v0 ^ 2 \* Sin(2 \* A) / g

ymax = v0 ^ 2 \* (Sin(A)) ^ 2 / (2 \* g)

MsgBox xmax

MsgBox ymax

MsgBox “Distance is measured in meters.”

MsgBox “1 or 2 significant figures for x”

MsgBox ”1 significant figure for y, xmax, ymax.”

physics16.weebly.com/uploads/5/9/8/5/59854633/projectile309task2019.txt

Question:

Find the velocity at time = T seconds, for angle of release A = T degrees, initial velocity V0 = T meters per second, x0 = y0 = 0 meters for projectile.

s = 22123456

T = s Mod 100

v0 = T

g = 10

Pi = 4 \* Atn(1)

A = T \* Pi / 180

x0 = 0

y0 = 0

Vx = v0 \* Cos(A)

Vy = v0 \* Sin(A) - g \* T

MsgBox Vx

MsgBox Vy

MsgBox “Velocity is measured in meters per second.”

MsgBox “1 significant figure.”

https://physics15.weebly.com/uploads/3/0/2/7/30272185/velocityofprojectile23sept.txt

Question:

Calculate total time of the motion and time for maximum height for angle of release A = T degrees, initial velocity V0 = T meters per second, x0 = y0 = 0 meters for projectile.

s = 22123456

T = s Mod 100

v0 = T

g = 10

Pi = 4 \* Atn(1)

A = T \* Pi / 180

x0 = 0

y0 = 0

totalTime = 2 \* v0 \* Sin(A) / g

time4maximumHeight = totalTime / 2

MsgBox totalTime

MsgBox time4maximumHeight

MsgBox “Time is measured in seconds.”

MsgBox “1 significant figure”

https://physics15.weebly.com/uploads/3/0/2/7/30272185/timeofprojectile23sept.txt

Question:

Find minimum velocity and corresponding angle of release of projectile to hit the point (s, T).

https://calculus12s.weebly.com/uploads/2/5/3/9/25393482/projectile16.docx

' minimum velocity for projectile

x = 11

y = 2.5

'

g = 10

'

T1 = (y + Sqr(x \* x + y \* y)) / x

T2 = (y - Sqr(x \* x + y \* y)) / x

'MsgBox T1

'MsgBox T2

'

v1 = Sqr(g \* x ^ 2 \* (1 + T1 ^ 2) / (2 \* (x \* T1 - y)))

MsgBox v1

'v2 = Sqr(g \* x ^ 2 \* (1 + T2 ^ 2) / (2 \* (x \* T2 - y)))

'MsgBox v2

MsgBox Atn(T1) \* 180 / (4 \* Atn(1))

'MsgBox Atn(T2) \* 180 / (4 \* Atn(1))

MsgBox “Velocity is measured in meters per second.”

MsgBox “Angle is measured in degrees.”

MsgBox “1 significant figure”

calculus12s.weebly.com/uploads/2/5/3/9/25393482/velocity4minimum4projectile.txt

Question:

Check correctness of minimum velocity calculation by using x = 0.000000001 and y = 20.

Question:

Calculate minimum velocity for tanA = y/x +1/s

s = 22123456

x = 1

y = 1

g = 10

T1 = 1 / s + y / x

v1 = Sqr(g \* x ^ 2 \* (1 + T1 ^ 2) / (2 \* (x \* T1 - y)))

MsgBox v1

Question:

Find all projectile solutions for V0 = V0mimimum + 1/T.

Quadratic equation for T:

Here V = V0.

s = 22123456

T = s Mod 100

x = 1

y = 1

g = 10

T1 = (2 \* y - x + Sqr((x - 2 \* y) ^ 2 + 4 \* x \* (x + y))) / (2 \* x)

T2 = (2 \* y - x - Sqr((x - 2 \* y) ^ 2 + 4 \* x \* (x + y))) / (2 \* x)

v1 = Sqr(g \* x ^ 2 \* (1 + T1 ^ 2) / (2 \* (x \* T1 - y)))

'v2 = Sqr(g \* x ^ 2 \* (1 + T2 ^ 2) / (2 \* (x \* T2 - y)))

v = v1 + 1 / T

T1 = v \* v \* (x + Sqr(x \* x - 4 \* g \* x \* x \* (y + g \* x \* x / (2 \* v \* v)) / (2 \* v \* v))) / (g \* x \* x)

T2 = v \* v \* (x - Sqr(x \* x - 4 \* g \* x \* x \* (y + g \* x \* x / (2 \* v \* v)) / (2 \* v \* v))) / (g \* x \* x)

MsgBox Atn(T1) \* 180 / (4 \* Atn(1))

MsgBox Atn(T2) \* 180 / (4 \* Atn(1))

MsgBox “Angle is measured in degrees.”

MsgBox “1 significant figure”

https://physics15.weebly.com/uploads/3/0/2/7/30272185/2anglesof1initialvelocity1projectile23sept.txt

To hit the target as quickly as possible, we need to calculate minimum velocity, provide maximum initial velocity, which must be bigger than minimum velocity, chose the smallest angle of release for the maximum initial velocity.

Question:

How can I hit a target as quickly as possible, using projectile?

Question:

Prove that for the projectile

**Truck and trolley**

Torque is applied to wheels of truck, which in more efficient than trolley, which is pushed or pulled.

Question:

Compare efficiency of truck and trolley.

Use what we discussed in our class about pulling trolley and rotating wheels of truck.

**Collided eggs**

Your own speed is the most dangerous for you.

Question:

Is moving or stationary egg more likely to crack after the collision?

Big foot vs small foot

Small foot is more likely to be more accurate and more precise, give less random error and systematic error because small foot can kick more accurately and precisely with respect to centre of mass of soccer ball.

Because of that, Messi is smaller and better than Ronaldo, who is bigger but, in real life, Ronaldo can kick the ball very accurately and precisely. In this case, physics fails but just a little bit.

Question:

Is big or small foot better for more accurate and precise kick of soccer ball?

Is Ronaldo or Messi better for that?

**Volume**:

Question:

Air purifier purifies 5 cubic meters of air. How many such air purifiers are needed for a room 5×5×10meters?

OneAirPurifier = 5

AllAir = 5 \* 5 \* 10

MsgBox AllAir / OneAirPurifier

MsgBox “Number of air purifiers has no units.”

https://physics15.weebly.com/uploads/3/0/2/7/30272185/volumeforairpurifier23sept.txt

**Pulley problem**

Pulley problem is solved by projecting all forces to the cord.

Is there are two non-zero different masses, acceleration is not g and not -g, then there will be acceleration a of the masses and tension in the cord.

We neglect the resistance. We assume cord to be massless.

Tension is internal force.

Difference in weights is external force.

If the masses are the same, then there will be no acceleration but there will be tension.

If both masses are zero, then there will be no acceleration and no tension.

If one mass is zero, then there will be acceleration but no tension.

If acceleration is g, then there will be no tension (free fall).

We choose coordinate axis down, along the motion of bigger mass.

Second Law of Newton for two masses: Mg – mg = (M+m)a

T is tension in rope. T is internal force, which can break the rope.

Using free-body diagram for mass M, we will get: Mg – T = Ma

T = M(g - a)

Using free-body diagram for mass m, we will get: T – mg = ma

T = m(g + a)

Question:

Find the acceleration of a simple pulley and tension in the rope for two masses: L kg and T kg.

s = 22123456

k = s Mod 10000

T = s Mod 100

L = s mod 10

g = 10

m1 = L

m2 = T

a = (m2 - m1) \* g / (m1 + m2)

tt = m1 \* (g + a)

tt = m2 \* (g - a)

MsgBox a

MsgBox “Acceleration is measured in meters per second squared.”

MsgBox tt

MsgBox “Tension is measured in Newtons.”

MsgBox “1 significant figure”

http://physics16.weebly.com/uploads/5/9/8/5/59854633/problem4pulleys.txt

youtube.com/watch?v=kvCnjVSpuv0

**Friction**

Friction force is resistance to motion.

We often consider sliding friction, for which friction force F = μN.

μ is coefficient of friction.

N is normal reaction.

Question:

Calculate friction force F = μN. μ = 1/T. N = k.

s = 22123456

T = s Mod 100

k = s Mod 10000

mu = 1 / T

N = k

F = mu \* N

MsgBox F

MsgBox “Force is measured in Newtons”

MsgBox “1 or 2 significant figures”

https://en.wikipedia.org/wiki/Friction

https://physics15.weebly.com/uploads/3/0/2/7/30272185/frictionforce23sept.txt

**mv = Ft**

mv = Ft is simplified mechanical equation, which says that change in momentum is equal to impulse of force.

This equation is a particular case of the equation , d(mv) = Fdt,

Question:

A dust particle with mass of 0.00001kg and speed of 5 m/s is subjected to a force of 0.00001N of the filter. How much time will it take to stop the particle?

Use the equations mv = Ft and t = mv/F

mass = 0.00001

speed = 5

force = 0.00001

tTime = mass \* speed / force

MsgBox tTime

MsgBox “Time is measured in seconds.”

MsgBox “1 significant figure.”

https://physics15.weebly.com/uploads/3/0/2/7/30272185/airpurifierproblem23sept.txt

Question:

Biker of mass T kg starts moving from rest. Friction coefficient μ = 1/T. What is the maximum velocity after T seconds?

Use the equations mv = Ft and v = Ft/m

s = 22123456

T = s Mod 100

k = s Mod 10000

mu = 1 / T

m = T

g = 10

N = m \* g

F = mu \* N

v = F \* T / m

MsgBox v

MsgBox “Velocity is measured in meters per second.”

MsgBox “1 significant figure”

https://physics15.weebly.com/uploads/3/0/2/7/30272185/bikerfrictionmaxspeed23sept.txt

**Rotational motion**

Rotational motion is possible for systems of material points or solids.

Rotation of satellite around planet is often considered as rotation one material point around the other.

Not only satellite is substituted by its centre of mass, but also planet is substituted by its centre of mass.

Period = 1/frequency

Liner acceleration for rotational motion is a = = Rω2

ω is angular velocity, ω = A/t

A is Angle.

t is time.

Linear velocity of rotational motion is: V = Rω.

Question:

Find linear accretion due to rotation for a person on planet with period of rotation of 24 hours and radius s millimetres.

s = 22123456

R = s / 1000

Pi = 4 \* Atn(1)

omega = 2 \* Pi / (24 \* 60)

a = R \* omega \* omega

MsgBox a

MsgBox “Angular velocity is measured in radians per minute.”

MsgBox “1 significant figure.”

https://physics15.weebly.com/uploads/3/0/2/7/30272185/rotationallinearacceleration23sept.txt

**Breaking rope during rotation of the mass**

If the mass rotates on rope and rope breaks, then the mass will move along the tangent to the circumference of rotation at the point of breaking the rope because there is no force (First Law of Newton), which means that velocity must be the same and velocity during rotational motion is along tangent line to circumference of rotation.

Question:

If the mass rotates on rope and rope breaks, what will be velocity of the mass?

**Rotation vs translation**

Angle A for rotation, distance D for translation

Angular velocity ω for rotation, liner velocity V for translation

Moment of inertia J for rotation, mass m for translation

Angular momentum Jω for rotation, liner momentum mV for translation

Kinetic energy for rotation 0.5Jω2, kinetic energy for translation 0.5mV2

Torque M for rotation, force F for translation

Translation is rotation with infinitely far centre of rotation.

Vectors of angular velocity, angular acceleration, torque are perpendicular to the plain in which there is rotation.

Question:

Compare rotation and translation.

**Energy, work and power**

Energy is the ability to do work.

Work is not always W = DF but sometimes dot-product W = **DF** or curvilinear integral W =

Power is not always P = W/t but sometimes P =

P = FV

W is work

D is distance

F is force

P is power

t is time

V is velocity

Question:

Explain energy, work and power.

**Conservation laws**

Energy is conserved if no work is done by external forces, all work is done by internal forces.

Energy is conserved when force is derivative of some function, for example, for gravity force

Momentum is conserved when there are no external forces.

Conservation laws are the result of symmetry of space and time.

Question:

Explain conservation laws.

**Gravity force of Newton**

Gravity force of Newton is expressed by equation similar to Law of Colomb

F = G\*m1\*m2/R2

G is gravity constant

m1 and m2 are masses of bodies between which this force is.

R is the distance between centres of masses of the bodies.

Question:

Calculate the difference in weight on the pole and on the equator of the Earth. Take the difference in the distance from the centre of the Earth as 21km.

GG = 6.6740831 \* 10 ^ (-11)

M = 5.9722 \* 10 ^ 24

R1 = 6.378 \* 10 ^ 6

m2 = 1

F1 = GG \* M \* m2 / R1 ^ 2

MsgBox F1

R2 = R1 + 21000

F2 = GG \* M \* m2 / R2 ^ 2

MsgBox F2

differenceInWeights = Abs(F1 - F2)

MsgBox differenceInWeights

MsgBox “Weight is measured in Newtons.”

MsgBox “1 significant figure”

https://physics15.weebly.com/uploads/3/0/2/7/30272185/differenceingravityforceduetodistance23sept.txt

**Escape velocity, orbital velocity and gravity acceleration**

Escape velocity is velocity of a body falling on a planet from the infinity.

Escape velocity can be found from equation of energy conservation mgh = 0.5m

Orbital velocity is such velocity of projectile for which it will never fall on planet and will become its satellite.

Orbital velocity is found from equation of g = centripetal acceleration: g = /R.

Gravity acceleration can be found, using mass of planet M and its radius R.

We use law of gravity of Newton: F = Gm1m2/R2.

F is gravitational force of Newton.

G is gravitational constant of Newton.

m1 is mass of first body.

m2 is mass of second body.

R is distance between centres of masses of bodies.

Question:

Find gravity acceleration g, orbital velocity Vo and escape velocity Ve for planet with mass s billion tons and radius s millimetres.

s = 22123456

GG = 6.6740831 \* 10 ^ (-11)

M = 10 ^ 12 \* s

R = s / 1000

g = GG \* M / R ^ 2

MsgBox g

MsgBox “Acceleration g is measured in meters per second squared.”

Vo = Sqr(g \* R)

MsgBox Vo

Ve = Sqr(2 \* g \* R)

MsgBox Ve

MsgBox “Velocity is measured in meters per second.”

MsgBox “7 or 8 significant figures”

https://physics18.weebly.com/uploads/5/9/8/5/59854633/g1orbital1velocity1escape1velocity13oct2017.txt

**Work-energy theorem**

Change in kinetic energy of mechanical system is equal to work of all external forces and all internal forces.

This theorem solves almost all problems of classical mechanics.

We can illustrate this theorem using V2 = +2a(x – x0) but we can also use this theorem for any number of dimensions.

**Solid mechanics**

Solid mechanics considers motion of rigid bodies (they cannot be deformed).

For rigid body can be subjected to torque M = DF or, for more general case, using cross-product ×,

**M** = **D×F**.

D is the distance to pivot from the direction of force.

F is force.

M is torque.

It is not possible to apply torque to material point where distance = 0.

Solid has moments of inertia with respect to different axes of rotation.

For solids there is rotational equivalent to Second Law of Newton: **M** = J**ε**

J is tensor of moments of inertia.

ε is angular acceleration.

Bold letters mean vectors.

Sliding vector of force must be directed only along one straight line, otherwise, parallel force will cause additional torque.

Free vectors of torque, velocity, angular velocity, momentum, angular momentum can be applied along any parallel straight line.

**Free-body diagram**

Free-body diagram shows all forces, which are acting on a body.

Question:

Explain free-body diagram.

**Inclined plane**

Inclined plane problem requires adding up all forces as vectors, finding the resulting force.

It includes weight, normal reaction and friction force.

For no friction:

sinAmg = ma

sinAg = a

For static friction:

F ≤ Nµstatic

For sliding friction:

µ < µstatic

µ is sliding friction coefficient.

We use free-body diagram, identifying all forces acting on mass.

x: sinAmg – µN = ma

y: N – cosAmg = 0

N = cosAmg

sinAmg – µ cosAmg = ma

(sinA – µ cosA)g = a

Question:

Find acceleration of a mass at the inclined plane with

A = T degrees and the friction coefficient μ = 1/T.

s = 22123456

T = s Mod 100

Angle = 4 \* Atn(1) \* T / 180

g = 10

mu = 1 / T

acceleration = g \* (Sin(Angle) - mu \* Cos(Angle))

MsgBox acceleration

MsgBox “Acceleration is measured in meters per second squared.”

MsgBox “1 significant figure”

youtube.com/watch?v=8xOU25PWx8M

https://physics15.weebly.com/uploads/3/0/2/7/30272185/sept23rampinclinedplane.txt

https://physics16.weebly.com/uploads/5/9/8/5/59854633/ramp4inclined4plane2019oct.txt

http://physics16.weebly.com/uploads/5/9/8/5/59854633/inclined4plane.txt

**Centre of gravity** is the centre of parallel forces.

Centre of gravity is not always the same as centre of mass.

**Blocks stacking problem**

Blocks stacking problem finds locations of blocs to make maximum hangover, which follows harmonic series 1/n, which diverges, which means that hangover can be infinitely big.

We use equations of static equilibrium to solve the problem.

This is logistical problem for computer programmers to solve.

Question:

Find the hangover for the s blocks in the blocks stacking problem.

s = 22123456

h = 0

For k = 1 To s

h = h + 1 / k

Next k

ho = h / 2

MsgBox ho

MsgBox “Hangover is measured in meters.”

MsgBox “7 or 8 significant figures.”

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

youtube.com/watch?v=Gaua\_V9Fse4

**Angular acceleration, torque, force**

Question:

Find F = ma, M = Jε, for m = a = J = ε = T.

s = 22123456

T = s Mod 100

m = T

a = T

J = T

epsilon = T

F = m \* a

MomentOfForce = J \* epsilon

MsgBox F

MsgBox MomentOfForce

MsgBox “Moment of force is measured in Newtons times meters.”

MsgBox “1 or 2 significant figures”

https://physics15.weebly.com/uploads/3/0/2/7/30272185/forceandmomentofforce23sept.txt

Angular velocity and linear acceleration

Question:

Find angular velocity and linear acceleration for v = T meters per second and R = k meters.

s = 22123456

L = s Mod 10

T = s Mod 100

k = s Mod 10000

v = T

R = k

omega = v / R

a = R \* omega ^ 2

MsgBox omega

MsgBox “Angular velocity is measured in radians per second.”

MsgBox a

MsgBox “Linear acceleration is measured in meters per second squared.”

MsgBox “Maximum 2 significant figures.”

https://physics16.weebly.com/uploads/5/9/8/5/59854633/angular\_velocity\_linear\_acceleration2019nov.txt

Question:

Find velocity and acceleration at T degrees latitude. Earth Radius = 6371.009km.

s = 22123456

T = s Mod 100

RE = 6371.009

Pi = 4 \* Atn(1)

omegaE = 2 \* Pi / 24

Angle = T \* Pi / 180

R = RE \* Cos(Angle)

v = R \* omegaE

a = R \* omegaE ^ 2

MsgBox v

MsgBox “Velocity is measured in meters per second”

MsgBox a

MsgBox “Acceleration is measured in meters per second squared.”

MsgBox “Maximum 2 significant figures.”

https://physics16.weebly.com/uploads/5/9/8/5/59854633/latitude4velocity4acceleration2019nov.txt

Question:

Find the angular speed and total acceleration for the rotational motion of the material point around the circumference with radius of T meters and constant linear speed of s meters per second.

s = 22123456

T = s Mod 100

R = T

v = s

omega = v / R

MsgBox omega

MsgBox “Angular velocity is measured in radians per second.”

a = R \* omega ^ 2

MsgBox a

MsgBox “Acceleration is measured in meters per second squared.”

MsgBox “Maximum 2 significant figures.”

https://physics16.weebly.com/uploads/5/9/8/5/59854633/omega\_acceleration309task2019.txt

Potential energy

Question:

Find potential energy E = mgh. h = T.

https://en.wikipedia.org/wiki/Potential\_energy

s = 22123456

m = s Mod 35

T = s Mod 100

g = 10

h = T

E = m \* g \* h

MsgBox E

MsgBox “Energy is measured in Joules.”

MsgBox “1 significant figure.”

Kinetic energy

Question:

Give kinetic energy . v = T.

https://en.wikipedia.org/wiki/Kinetic\_energy

s = 22123456

m = s Mod 35

T = s Mod 100

v = T

E = m \* v ^ 2 / 2

MsgBox E

MsgBox “Energy is measured in Joules.”

MsgBox “Maximum 2 significant figures.”

Static equilibrium

Static equilibrium for material point is when all forces are 0.

Static equilibrium for mechanical system is when all forces are 0 and all torques are 0.

Question

Solve the pulley problem for the case of static equilibrium.

M = m

Black hole

Black hole is cosmic body with extremely intense gravity, from which even light cannot escape.

Question

Calculate the Schwarzschild radius for the k grams desk.

s = 22123456

k = s Mod 10000

T = s Mod 100

c = 2.99792458 \* 10 ^ 8

G = 6.67408 \* 10 ^ (-11)

M = k \* 10 ^ (-3)

Rs = 2 \* G \* M / c ^ 2

MsgBox Rs

MsgBox “Radius is measured in meters.”

MsgBox “Maximum 2 significant figures.”

http://physics16.weebly.com/uploads/5/9/8/5/59854633/radius4schwarzschild.txt

Question

Prove Schwarzschild radius formula from escape velocity expression

R is radius of black hole of Schwarzschild

G is gravity constant

g is gravity acceleration

M is mass of the object, which is compressed to the size of black hole

Ve is escape velocity

c is the speed of light

Special relativity

Question:

Assess the time, size, mass when you move with c/1000000, c/1000, c/100, c/10, c/2, 0.8c, 0.9c.

c = 300000000

v = c / 1000000

v = c / 1000

v = c / 100

v = c / 10

v = c / 2

v = 0.8 \* c

v = 0.9 \* c

MsgBox Sqr(1 - v \* v / (c \* c))

MsgBox “This square root is dimensionless.”

MsgBox “1 significant figure.”

Chaos in classical mechanics

Double pendulum is chaotic.

en.wikipedia.org/wiki/Double\_pendulum

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

Moment of inertia is measure of resistance to change of angular velocity.

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:

m = 1, 2, 3.

We use Cramer Rule

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

= 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 must not be zero.

Question:

Find torque for given tensor of inertia and angular acceleration.

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

s = 22123456

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

MsgBox “Torque is measured in Newtons times meters.”

MsgBox “1 or 2 significant figures”

Question:

Calculate angular acceleration for given tensor of inertia and torque.

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

s = 22123456

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)

MsgBox “1 or 2 significant figures”

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)

MsgBox “1 or 2 significant figures”

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)

MsgBox “1 or 2 significant figures”

MsgBox “Acceleration is measured in meters per second squared.”

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

**Oscillation**

Pendulum is used for many useful things: counting time, monitoring rotation of Earth, etc.

Oscillation is periodic motion.

We solve ordinary differential equation to describe oscillation.

We can describe oscillation of mass, attached to spring.

**Resonance** is when amplitude of oscillation becomes infinite because frequencies of external force and natural frequency of the oscillator are the same.

Question:

Give period of spring oscillator . m = m35. k = m10000.

s = 22123456

m = s Mod 35

k = s Mod 10000

Pi = 4 \* Atn(1)

T = 2 \* Pi \* Sqr(m / k)

MsgBox T

MsgBox “Period is measured in seconds.”

MsgBox “1 or 2 significant figures.”

https://physics16.weebly.com/uploads/5/9/8/5/59854633/spring4oscillator2019nov.txt

Question:

Find period of pendulum . L = m10.

s = 22123456

L = s Mod 10

g = 10

Pi = 4 \* Atn(1)

T = 2 \* Pi \* Sqr(L / g)

MsgBox T

MsgBox “Period is measured in seconds.”

MsgBox “1 significant figure.”

https://physics16.weebly.com/uploads/5/9/8/5/59854633/pendulum4period2019nov.txt

Question:

Find the displacement of a harmonic oscillator after s seconds with amplitude k, frequency k and initial phase k/2.

s = 22123456

k = s Mod 10000

D = k \* Sin(s \* k + k / 2)

MsgBox D

MsgBox “Displacement is measured in meters.”

MsgBox “3 or 4 significant figures.”

http://physics16.weebly.com/uploads/5/9/8/5/59854633/harmonic4oscillator.txt

Question:

Solve oscillation problem y'' + yT2 = 0.

https://www.wolframalpha.com

y is measured in meters.

Question:

Ty'' + Ly = sin(ωx)

Find resonant ω.

s = 22123456

L = s Mod 10

T = s Mod 100

omega = Sqr(L / T)

MsgBox omega

MsgBox “Angular frequency omega is measured in radians per second.”

MsgBox “1 significant figure.”

https://physics16.weebly.com/uploads/5/9/8/5/59854633/resonant4frequency2019nov.txt

Question:

Forced vibration with damping:

Ty'' + my' + Ly = sin(Tx)

Is there resonance?

m = m35

L = m10

y is measured in meters.

http://www.wolframalpha.com

**Waves**

Wave is spread of oscillation in space.

Waves have properties of interference and diffraction.

Interference is when waves of the seme frequency interact creating picture of maxima and minima.

Diffraction is when wave goes around the obstacle.

Question:

Solve the string oscillatory equation for v = T, frequency = L = m10, Amplitude = T.

Find the displacement after s seconds at m meters.

s = 22123456

Ttt = s Mod 100

m = s Mod 35

L = s Mod 10

omega = L

A = Ttt

t = s

x = m

v = Ttt

y = A \* Sin(omega \* (t - x / v))

MsgBox y

MsgBox “y is measured in meters.”

MsgBox “1 significant figure.”

https://physics18.weebly.com/uploads/5/9/8/5/59854633/string1wave1oscillation22oct2017.txt

**Interference**:

sin(ω(t – x/v)) + sin(L + ω(t – x/v)) = 2sin(0.5L + ω(t – x/v))cos(0.5L)

Question:

Give interference equation for sin(ω(t – x/v)) and sin(L + ω(t – x/v)). L = m10. ω = T. t = T.

s = 22123456

L = s Mod 10

T = s Mod 100

k = s Mod 10000

omega = T

x = k

v = s

A1 = omega \* (T - x / v)

A2 = L + omega \* (T - x / v)

oscillatingvalue = 2 \* Sin((A1 + A2) / 2) \* Cos((A1 - A2) / 2)

MsgBox oscillatingvalue

MsgBox “oscillatingvalue can be measured in meters, Volts per meter, Pa”

MsgBox “1 significant figure.”

https://physics16.weebly.com/uploads/5/9/8/5/59854633/interference2019nov.txt

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

MsgBox “Velocity is measured in meters per second.”

MsgBox “2 significant figures.”

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

Elasticity

**Spring force** F = -kx

k is property of spring

x is displacement

Hooks Law

F = kx

Elastic energy: E = 0.5kx2.

The most general case of elastic body deformation and stress:

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

 is tensor of stress, stress is pressure.

 is tensor of deformation, deformation is relative extension.

 is tensor of elastic constants.

Plasticity

Plastic deformation is irreversible deformation.

Fracture

Question:

What must the masses in the simple pulley problem to break the rope if the breaking point of the rope is T Newtons?

Electromagnetic nature of friction, elasticity, plasticity, fracture

Elasticity, friction, plasticity, fracture of solids in classical mechanic have electromagnetic causes.

Fluid

Pressure = Force/Area

Pressure of fluid at depth h is

h is height or depth

ρ is density

g is gravity acceleration

A is area

V is volume

Proof: Pressure is F/A, pressure = mg/A, m = ρV, V = Ah, ρAhg/A = ρgh

Question:

Prove that pressure of fluid at depth h is

Question:

Calculate fluid pressure p = ρgh. ρ = a; h = T.

https://en.wikipedia.org/wiki/Pressure#Fluid\_pressure

s = 22123456

a = s Mod 25

T = s Mod 100

ro = a

g = 10

h = T

p = ro \* g \* h

MsgBox p

MsgBox “Pressure is measured in Pascals or in Newtons per meter squared.”

MsgBox “1 significant figure.”

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 = 22123456

ro = 1000

g = 10

V = s

F = ro \* g \* V

MsgBox F

MsgBox “Force is measured in Newtons.”

MsgBox “1 significant figure.”

Bernoulli principle

Magnus effect is when, for example, ball curves its trajectory because of rotation of the ball, fluid sticking to the ball because of viscosity, then Bernoulli principle explains why the ball curves its trajectory in soccer, tennis, etc.

Question:

Explain Magnus effect.

Thermodynamics

Similarly to mechanics, in thermodynamics system tries to reduce its potential energy.

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.

s = 22123456

k = s Mod 10000

T = s mod 100

L = s mod 35

a = 1 / k

d = T \* L \* a

MsgBox d

MsgBox “Change in distance d is measured in meters”

MsgBox “1 significant figure for length change”

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

MsgBox V

MsgBox “Change in volume V is measured in cubic meters”

MsgBox “1 or 2 significant figures for volume change”

 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

s = 22123456

k = s 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

MsgBox “Temperature is measured in Kelvins.”

MsgBox “3 or 4 significant figures.”

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.

Google.com

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 = 22123456

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

MsgBox “Pressure is measured in Pascals.”

MsgBox “1 significant figure.”

Real gas

In real gas particles interact and are finite in size.

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

a = m25

b = m9

Vm = s

R = m8

T = m100

s = 22123456

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

MsgBox “Pressure is measured in Pascals.”

MsgBox “1 significant figure.”

Question:

Prove the solution to the heat transfer equation.

Heat H transfers in time in one dimension x.

 (equation)

 (boundary condition)

 (solution)

D is transferring constant

π = 3.14…..

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.

Electrostatics

Coulombs law in electrostatics is similar to Newton law of gravity, the difference is that gravity can only attract and 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 = 22123456

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

MsgBox “Force is measured in Newtons.”

MsgBox “1 significant figure.”

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

Question:

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

s = 22123456

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

MsgBox “Voltage is measured in Volts.”

MsgBox “1 significant figure.”

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

Question:

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

s = 22123456

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

MsgBox “Force is measured in Newtons.”

MsgBox “1 significant figure.”

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 = 22123456

T = s Mod 100

L = s Mod 10

I = T

R = L

V = I \* R

MsgBox V

MsgBox “Voltage is measured in Volts.”

MsgBox “1 significant figure.”

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

Question:

Find A = m25. ρ = m17. L = m10.

s = 22123456

L = s Mod 10

ro = s Mod 17

A = s Mod 25

R = L \* ro / A

MsgBox R

MsgBox “Resistance is measured in Ohms.”

MsgBox “1 significant figure.”

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

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 = 22123456

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

MsgBox “Voltage is measured in Volts.”

' For parallel circuit:

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

MsgBox R

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

MsgBox “Current is measured in Ampers.”

MsgBox “1 significant figure”

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

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.

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

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

derivative-calculator.net

R = r for maximum waste (loss).

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

Question:

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

s = 22123456

k = s Mod 10000

T = s Mod 100

L = k \* 10 ^ (-6)

C = T \* 10 ^ (-6)

omega0 = 1 / Sqr(L \* C)

MsgBox omega0

MsgBox “Angular frequency omega0 is measured in radians per second.”

MsgBox “1 or 2 significant figures”

pi = 4 \* Atn(1)

period = 2 \* pi / omega0

MsgBox period

MsgBox “Period is measured in seconds.”

MsgBox “1 or 2 significant figures”

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

Question:

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

Question:

Explain NOT, AND, OR gates circuits using transistor.

m3 = 0: NOT

m3 = 1: AND

m3 = 2: OR

Question:

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

s = 22123456

k = s Mod 10000

T = s Mod 100

V2 = T

N1 = k

N2 = s

V1 = -V2 \* N1 / N2

MsgBox V1

MsgBox “Voltage is measured in Volts.”

MsgBox “1 or 2 significant figures”

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

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

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

s = 22123456

k = s Mod 10000

T = s Mod 100

power = T \* 10 ^ 3

resistance = 0.1 \* T

voltage = 0.03 \* k

voltage = s

current = power / voltage

Losses = resistance \* current ^ 2

MsgBox Losses

MsgBox “Losses are measured in Watts.”

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

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

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.

s = 23123456

k = s Mod 10000

T = s 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"

MsgBox “Torque is measured in Newtons times meter.”

MsgBox “1 significant figure”

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

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 = 23123456

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

MsgBox “Intensity is measured in Watts divided by meter squared.”

MsgBox “1 or 2 significant figures”

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 = 23123456

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

MsgBox “Amplitude is measured in Volts per meter for electric field.”

MsgBox “1 significant figure”

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

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.

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

s = 23123456

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

MsgBox “Wavelength is measured in meters.”

MsgBox “1 significant figure”

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 = 23123456

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

MsgBox “Velocity is measured in meters per second.”

MsgBox “1 significant figure”

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

Question:

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

s = 23123456

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

MsgBox “x here is measured in metres.”

MsgBox “1 significant figure”

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

Question:

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

s = 23123456

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

MsgBox “n here is dimensionless.”

MsgBox “No need for significant figures here”

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

Question:

Solve the simplified Maxwell Equations for c = 300000000-s, red light. Take amplitude 1 V/m. Find the intensity of electric field after s seconds at m meters.

s = 23123456

Ttt = s Mod 100

m = s Mod 35

L = s Mod 10

t = s

x = m

c = 3 \* 10 ^ 8 – s

Amplitude=1

E = Amplitude\*Sin(x - c \* t)

MsgBox E

MsgBox “Units of electric field intensity are Volts/meter”

MsgBox “1 significant figure”

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?

s = 23123456

k = s Mod 10000

b = 3 \* 10 ^ (-3)

t = 4 \* k

Lambda\_max = b / t

MsgBox Lambda\_max

MsgBox “Wavelength is measured in meters.”

MsgBox “1 significant figure”

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

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?

s = 23123456

k = s Mod 10000

T = s 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

MsgBox “Length is measured in meters.”

MsgBox “1 significant figure”

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

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 = 23123456

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

MsgBox “Distance is measured in meters.”

m = -di / doo

MsgBox m

MsgBox “Magnification is dimensionless.”

MsgBox “1 significant figure”

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.

s = 23123456

k = s Mod 10000

T = s Mod 100

Lambda = 550 \* 10 ^ (-9)

A = 0.03 / 100000

Lambda = k \* 10 ^ (-10)

A = T \* 0.01 / s

D = 1.22 \* Lambda / A

MsgBox D

MsgBox “Diameter is measured in meters.”

MsgBox “1 significant figure”

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