```
%% Roshan Jaiswal-Ferri
%Section - 01
%Aero 356 Midterm 2: 5/22/25

%% Workspace Prep

%warning off
format long     %Allows for more accurate decimals
close all;      %Clears all
clear all;      %Clears Workspace
clc;            %Clears Command Window
```

Assumptions:

Assume sigma = 5.67e-8 W/m2, Radius of the earth = 6378 km, Solar Output is 1366 W/m2.

Question 1:

Determine the mean penetration depth in Silicon of 2MeV electrons, 2MeV protons, and 2MeV alpha particles (Helium Ions), assuming no non-local energy losses.

Use a silicon density of 2.3 g/cm3 and total stopping power values given by NIST when performing your calculations. https://www.nist.gov/pml/stopping-power-range-tables-electrons-protons-and-helium-ions

Links to an external site.

Scroll down to "Access the Data" to select Electron, Proton & Helium Ion links.

Give the answer for electrons here and then protons and ions in the next two answer boxes. Give result in cm with X.XXX accuracy.

```
Ke = 2; %MeV
totalStop = 1.567; %MeV cm^2/g
rho = 2.3; %g/cm^3

R = (1/rho)*(Ke/totalStop);
disp(num2str(R))
```

```
0.55492
```

Question 2

Penetration depth for protons? Given in cm to this accuracy X.XXX

```
Ke = 2; %MeV
totalStop = 1.118e2; %MeV cm^2/g
rho = 2.3; %g/cm^3

R = (1/rho)*(Ke/totalStop);
disp(num2str(R))
```

```
0.0077779
```

Question 3

Penetration depth for ions? Given in cm to this accuracy X.XXX

```
Ke = 2; %MeV
totalStop = 1.024e3; %MeV cm^2/g
rho = 2.3; %g/cm^3

R = (1/rho)*(Ke/totalStop);
disp(num2str(R))
```

```
0.00084918
```

Question 5

(b) Repeat (a) for Aluminum and Graphite. Use an Aluminum density of 2.7 g/cm3, and a graphite density of 1.7 g/cm3

Which of the three materials would you use for radiation shielding if material thickness is the driving requirement?

```
Alrho = 2.7;
grarho = 1.7;

AlStop = [1.518,1.095e2,9.859e2];
graStop = [1.619,1.409e2,1.401e3];

RAl = penDepth(Alrho,Ke,AlStop)
```

```
RAl = 1×3
   0.487971502464256   0.006764755623203   0.000751334558009
```

```
RGR = penDepth(grarho,Ke,graStop)
```

```
RGR = 1×3
   0.726664971115067   0.008349684799399   0.000839736322795
```

Question 7:

A 45-year old female astronaut is being considered for a 3-year space mission to the ISS (January 2032 to December 2034). The astronaut is anticipated to be exposed to various radiation types and levels over the entire body every month. Simulations anticipate the absorbed dose measurements to be:

- A constant photon background of 6mGy per month
- A constant electron background of 5mGy per month
- A constant proton background of 5mGy per month
- In May 2032, a CME increases radiation to 18mGy of photons, 15mGy of electrons, 8mGy of protons for the month

- In December 2032, a CME increases radiation to 21mGy of photons, 19mGy of electrons, 9mGy of protons for the month
- Starting October 2033 thru March 2034 degradation of the radiation shielding leads to a linear increase in background radiation, resulting in a radiation increase of 300% from the original amounts in March 2034. The shielding is fixed and background levels are at their original amounts in April 2034.

What is the cumulative effective dose exposure level to radiation in Sv at the end of the mission?

```
photon = 6e-3;
electron = 5e-3;
proton = 5e-3;
rad = [photon, electron, proton];

photonElevated = 18e-3;
electronElevated = 15e-3;
protonElevated = 8e-3;
radElevated = [photonElevated, electronElevated, protonElevated];

photonElevated2 = 21e-3;
electronElevated2 = 19e-3;
protonElevated2 = 9e-3;
radElevated2 = [photonElevated2, electronElevated2, protonElevated2];

photonW = 1;
electronW = 1;
protonW = 2;
weight = [photonW, electronW, protonW];

HtNormal = rad(1)*weight(1) + rad(2)*weight(2) + rad(3)*weight(3);
HtElevated = radElevated(1)*weight(1) + radElevated(2)*weight(2) +
radElevated(3)*weight(3);
HtElevated2 = radElevated2(1)*weight(1) + radElevated2(2)*weight(2) +
radElevated2(3)*weight(3);

Enormal = 1*1*HtNormal;
Eelevated = 1*1*HtElevated;
Eelevated2 = 1*1*HtElevated2;

% Normal months = 28, elevated = 1, elevared2 = 1;

radiation = rads(28,1,1,HtNormal,HtElevated,HtElevated2)
```

```
radiation =
   0.695000000000000
```

```
linear = [1, 1.4, 1.8, 2.2, 2.6, 3];
for i = 1:6
    rad(i) = Enormal*linear(i);
end

radiation = radiation + sum(rad)
```

```
radiation =
   0.947000000000000
```

```
count = 0;
while radiation > 0.9
    radiation = radiation - HtNormal;
    count = count + 1;
end

36 - count
```

```
ans =
    33
```

Question 10:

Determine the Larmor radius for an electron with kinetic energy of 100 keV in a magnetic flux density of 0.15x10-4 T. Provide your answer in meters to two decimal places. Assume the charge is 1.6e-19 C and the mass is 9.11e-31 kg.

```
B = 0.15e-4; %T
m = 9.11e-31; % kilograms
q = 1.6e-19; %coulumbs

syms v
eq = 0.5*m*v^2 == (100e3)*q;
Vp = max(double(solve(eq,v))); %m/s

rl = (m*Vp)/(q*B); %meters
disp(['Larmor Radius: ', num2str(rl'), ' m'])
```

```
Larmor Radius: 71.1415 m
```

Question 11:

```
Ix = 1984/(3*10);
I0 = 2439/10;
x = 3; %cm

syms mu
eq2 = x == -(1/mu)*log(Ix/I0);
linearAtt = double(solve(eq2,mu))
```

```
linearAtt =
   0.435028466346404
```

Functions:

```
function [R] = penDepth(rho,Ke,Stop)
    R = (1./rho).*(Ke./Stop);
end

function [out] = rads(month1,month2,month3,Ht1,Ht2,Ht3)
```

```
    out1 = month1*Ht1;
    out2 = month2*Ht2;
    out3 = month3*Ht3;
    out = out1 + out2 + out3;
end
```