

Inlämningsuppgift 1, FK2003, 20081118

```
> restart;
> with(plottools): with(plots):
> with(ScientificConstants): with(Units[Standard]):
```

Maple kan naturkonstanter (paketet ScientificConstants),
men jag vill inte kalla dem precis som Maple vill:

```
> mynames:=[m,e,epsilon0,h,c]: maplenames:=[m[e],e,epsilon[0],h,c]:
> vals:= seq(mynames[i]=map(evalf,map(Constant,maplenames,units))
[i],i=1..5);
```

$$\begin{aligned} \text{vals} := m &= 9.109381882 \cdot 10^{-31} \left[\frac{\text{kg}}{\text{kg}} \right], e = 1.602176462 \cdot 10^{-19} \left[\frac{\text{C}}{\text{C}} \right], \epsilon_0 \\ &= 8.854187815 \cdot 10^{-12} \left[\frac{\text{A}^2 \text{s}^4}{\text{kg m}^3} \right], h = 6.62606876 \cdot 10^{-34} \left[\frac{\text{m}^2 \text{kg}}{\text{s}} \right], c \\ &= 2.99792458 \cdot 10^8 \left[\frac{\text{m}}{\text{s}} \right] \end{aligned} \quad (1)$$

```
> vals_nounits:= seq(mynames[i]=map(evalf,map(Constant,maplenames))
[i],i=1..5):
> R:=m*e^4/(8*epsilon0^2*h^2);
```

$$R := \frac{1}{8} \frac{m e^4}{\epsilon_0^2 h^2} \quad (2)$$

```
> subs(vals,R);
```

$$\frac{2.179871903 \cdot 10^{-18} \left[\frac{\text{kg}}{\text{kg}} \right] \left[\frac{\text{C}}{\text{C}} \right]^4}{\left[\frac{\text{A}^2 \text{s}^4}{\text{kg m}^3} \right]^2 \left[\frac{\text{m}^2 \text{kg}}{\text{s}} \right]^2} \quad (3)$$

```
> Rval:=simplify(%);
```

$$Rval := 2.179871903 \cdot 10^{-18} \left[\frac{\text{J}}{\text{J}} \right] \quad (4)$$

I elektronvolt:

```
> R_check:=convert(Rval,units,Unit(eV));
```

$$R_check := 13.60568435 \left[\frac{\text{eV}}{\text{eV}} \right] \quad (5)$$

Ser bra ut.

Arbeta utan att skriva ut enheterna från och med nu:

```
> R_eV:=R_check/Unit(eV);
```

$$R_eV := 13.60568435 \quad (6)$$

Här är energierna:

```
> energies:= [seq(-R_eV/n^2,n=1..6)];
```

$$\text{energies} := [-13.60568435, -3.401421088, -1.511742706, -0.8503552719, -0.5442273740, -0.3779356764] \quad (7)$$

och energiskillnaderna:

```
> shifts:= [seq(energies[i]-energies[2],i=3..6)];
```

$$\text{shifts} := [1.889678382, 2.551065816, 2.857193714, 3.023485412] \quad (8)$$

Nu vill vi ha våglängden.

Inget h-streck här:

```
> nu:=c/lambda: E:=h*nu;
```

$$E := \frac{h c}{\lambda} \quad (9)$$

```
> wavelength:=solve(E=Eval,lambda);
```

$$\text{wavelength} := \frac{h c}{\text{Eval}} \quad (10)$$

Vi får de här våglängderna:

```
> wavelength_val:=sort(map(round,subs(vals_nounits,[seq(1e9*subs
(Eval=e*shifts[i],wavelength),i=1..4)])),`<`);
wavelength_val:= [410, 434, 486, 656]
```

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Representera detta grafiskt:

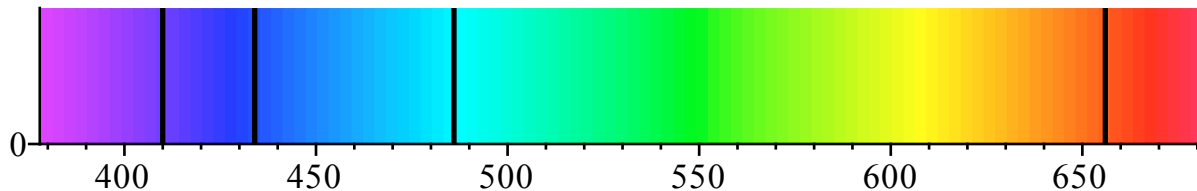
```
> start:=380; delta:=3;
```

$$\text{start} := 380$$

$$\delta := 3$$

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```
> display(seq(line([start+delta*i,0],[start+delta*i,2],color=COLOR
(HUE,0.80-i/120),linestyle=solid,thickness=5),i=0..100),seq(line(
[wavelength_val[i],0],[wavelength_val[i],2],color=black,
thickness=2),i=1..nops(wavelength_val)),tickmarks=[default,[0]]);
```



Jämför med Physics Handbook:

```
> energy_diff:= [seq(R_eV-R_eV/n^2,n=1..6)];
```

energy_diff:= [0., 10.20426326, 12.09394164, 12.75532908, 13.06145698, 13.22774867] (13)

```
> E_physhandbook=[10.198,12.087,12.748,13.054,13.220];
```

E_physhandbook= [10.198, 12.087, 12.748, 13.054, 13.220] (14)

```
> subs(vals_nounits,1e9*h*c/(energy_diff[2]*e));
```

121.5023394 (15)

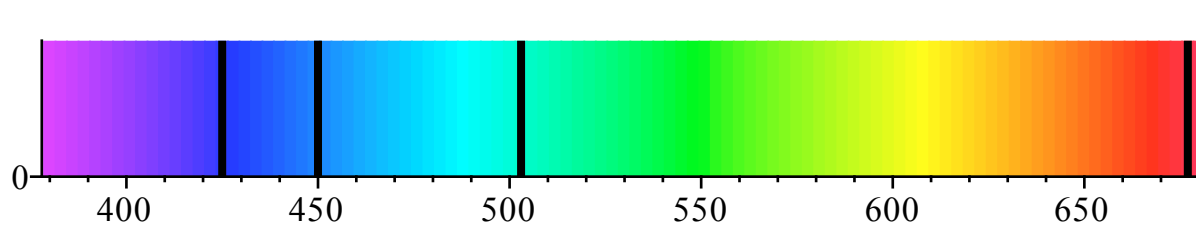
OK med Physics Handbook.

Här är en låtsasgalax: + 20, och lite variation:

```
> Hshift:=[425,450,503,677];
```

Hshift:= [425, 450, 503, 677] (16)

```
> display(seq(line([start+delta*i,0],[start+delta*i,2],color=COLOR
(HUE,0.80-i/120),linestyle=solid,thickness=5),i=0..100),seq(line(
[Hshift[i],0],[Hshift[i],2],color=black,thickness=3),i=1..nops
(Hshift)),tickmarks=[default,[0]]);
```



```
> z:=[seq(1.*Hshift[i]/wavelength_val[i],i=1..4)];
      z:= [1.036585366, 1.036866359, 1.034979424, 1.032012195]
```

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```
> av:=add(z[i],i=1..nops(z))/nops(z);
      av:= 1.035110836
```

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3,5% av ljusets hastighet.