#Task 1

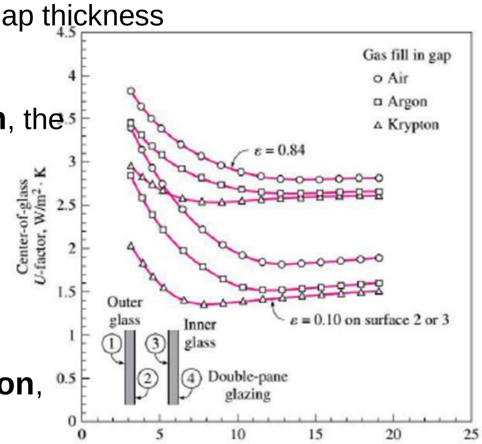
The U - value of a window:

$$Uwindow = \frac{UcenterAcenter + UedgeAedge + UframAfram}{Awindow}$$

If it is a double - pane window, disregard the thermal resistances of glass layers:

$$\frac{1}{Udouble - pane\ (ceter\ region)} = \frac{1}{\mathrm{hi}} + \frac{1}{\mathrm{h}space} + \frac{1}{\mathrm{h0}},\ \mathrm{h}space$$
$$= \mathrm{h}rad, space + \mathrm{h}conv, space$$

The hspace changes by changing the gas that fills the gap.
From the diagram in the right side, we can see that: When the gap thickness is 13 mm,



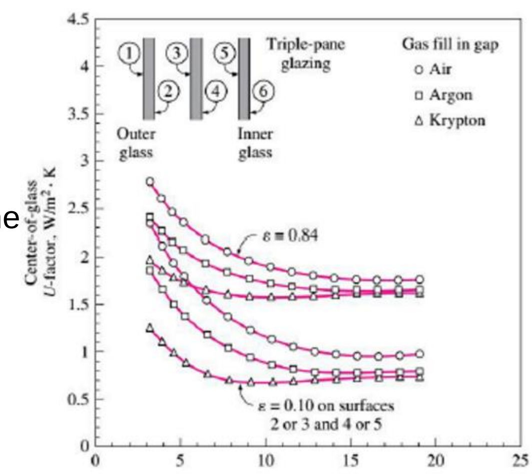
By changing the gas that fills the gap from air to argon, the U-value of the center of the glass decreases from 2.8 $\frac{w}{m2k}$ to 2.65$\frac{w}{m2k}$

, which means the U-value decreases about 6.43%

By changing the gas that fills the gap from air to krypton, the U-value of the center of the glass decrease from 2.8$\frac{w}{m2k}$ to 2.6$\frac{w}{m2k}$

, which means the U-value decreases about 7.14%.

The hspace changes by adding an extra pane.
From the diagram in the right side, we can see that:
When the gap thickenss is 13 mm, and the gas that fills the gap is air,



By adding an extra pane,

the U-value of the center of the glass decreases
from 2.8$\frac{w}{m2k}$ to 1.8$\frac{w}{m2k}$
, which means the U-value decreases about 55.6%.

Another way to change the Ucenter, is to coat the glass surfaces
with a film that has a low emissivity.

From the diagram in the right we can see that:
When the gap thickenss is 13 mm, and the gas fills the gap is air,

By coating the glass surfaces with a film that has the emissivity of 0.1 to change the Ucenter, , the U-value of the center
of the glass
decreases from 2.8$\frac{w}{m2k}$ to 1.8$\frac{w}{m2k}$
, **which means the U-value decreases about 55.6%.**

#**Task 2**

Cooling design temperature **Tcooling = 24 °C**,
,and heating design temperature **Theating = 20 °C**, therefore,

$\Delta T_{cooling}$ = 31.9 °C - 24 °C = 7.9 °C = 7.9K

$\Delta T_{heating}$ = 20°C - (-4.8°C) = 24.8 °C = 24.8K

From the table above, DR = 11.9 °C = 11.9K

The cooling load of the fixed window on the west is:

q windowwest = A x CF windowwest
A = 14.4m2,

CF windowwest(Heat Trasnfer Part) = U windowwest ($\Delta T_{cooling}$ - 0.46 DR)
,The window has a fixed heat absorbing double layer glass with a wooden frame,
And so, U windowwest = 2.84$\frac{w}{m2k}$

CF windowwest(Heat Trasnfer Part)= 2.84$\frac{w}{m2k}$x (7.9 K - 0.46x11.9 K) = 6.89$\frac{w}{m2k}$

PXI windowwest = ED + Ed = 559 +188 = 747

SHGC = 0.54

No internal shading, so IAC = 1 FFs = 0.56
CF windowwest(Irradiation Part) = PXI x SHGC x IAC x FFs

qwindowwest = A x CF windowwest = A x (CF windowwest(Heat Trasnfer Part) + CF windowwest(Irradiation Part))
=14.4 m2 x (6.89 +747x 0.54 x 1 x 0.56) $\frac{W}{m2}$= 3352.07 W

The heating load of the fixed window on the west is:

q windowwest = A x HF windowwest = A x U windowwest.ΔTheating
= 14.4 m2 x 2.84$\frac{w}{m2k}$x 24.8K = 1014.22 W

When the frame were to be aluminium,
U windowwest = 3.61$\frac{w}{m2k}$, HSGC = 0.56

CF' windowwest (heat transfer part) = U'windowwest (ΔTcooling - 0.46 DR)

=3.61$\frac{w}{m2k}$ x (7.9 K - 0.46 x 11.9 K) =8.76 $\frac{W}{m2}$

Cooling load q'windowwest = A x CF' window
= A x (CF'windowwest(Heat Transfer Part) + CF' windowwest(Irradiation Part))
= 14.4 m2 x (8.76 +747x 0.56 x 1 x 0.56) $\frac{W}{m2}$ =3499.48 W

Heating load q'windowwest = A x HF'windowwest = A x U'windowwest. ΔTheating

= 14.4 m2 x 3.61$\frac{w}{m2k}$x 24.8 K = 1289.20 W

The cooling load of the fixed window on the south is:

q windowsouth = A x CF windowsouth
A = 3.6 m2,

CF windowsouth(Heat Trasnfer Part) = Uwindowsouth (ΔTcooling - 0.46 DR)

The window has a fixed heat absorbing double layer glass with a wooden frame,
So, U windowwast=2.842.84$\frac{w}{m2k}$
, CF windowsouth(Heat Transfer Part)= 2.842.84$\frac{w}{m2k}$ x (7.9 K - 0.46 x 11.9 K) = 6.89$\frac{W}{m2}$

PXI windowsouth = ED + Ed = 348 +209 = 557

SHGC = 0.55

No internal shading, so IAC =1

FFs = 0.47

CF windowsouth(Irradiation Part) = PXI x SHGC x IAC x FFs
qwindowsouth = A x CF windowsouth = A x (CF windowsouth(Heat Transfer Part) + CF windowsouth(Irradiation Part))
=3.6 m2 x (6.89 +557 x 0.54 x 1 x 0.47) $\frac{W}{m2}$ = 553.72 W

The heating load of the fixed window on the south is:

q windowsouth = A x HF windowsouth = A x U windowsouth ΔTTheating
= 3.6 m2 x 2.84 $\frac{w}{m2k}$x 24.8K = 253.56 W

When the frame were to be aluminium,
U windowsouth = 3.61$\frac{w}{m2k}$, , HSGC = 0.56

CF' windowsouth(Heat Trasnfer Part) = U'(winidow south)(ΔTcooling - 0.46 DR)

=3.61$\frac{w}{m2k}$ X (7.9 K - 0.46 X 11.9 K) = 8.76$\frac{W}{m2}$

Cooling load q' windowsouth = A X CF'windowsouth

= A X (CF'windowsouth(Heat Trasnfer Part) + CF'windowsouth(Irradiation Part))
= 3.6 m2 X (8.76 +557 X 0.56 X 1 X 0.47) $\frac{W}{m2}$ = 559.30 W

Heating load q' windowsouth = A X HF'windowsouth
= A X U' windowsouth ΔTheating
= 3.6 m2 X 3.61$\frac{w}{m2k}$X 24.8 K = 322.30 W

The cooling load of the operable window on the south is:

q windowsouth = A X CF windowsouth
A = 3.6 m2,

CF windowsouth(Heat Trasnfer Part) = U windowsouth (ΔTcooling - 0.46 DR)
,The window has an operable heat absorbing double layer glass with a wooden frame,

So, U windowwast = 2.87$\frac{w}{m2k}$

, CF windowsouth(Heat Trasnfer Part) = 2.87$\frac{w}{m2k}$ X (7.9 K - 0.46 X 11.9 K) = 6.96$\frac{W}{m2}$

PXI windowsouth = ED + Ed = 348 +209 = 557
SHGC = 0.46

No internal shading, so IAC = 1

FFs = 0.47

CF windowsouth(Irradiation Part) = PXI X SHGC X IAC X FFs
q windowsouth = A X CF windowsouth = A X (CF windowsouth(Heat Trasnfer Part) + CF windowsouth(Irradiation Part))
=3.6 m2 X (6.96 +557 X 0.54 X 1 X 0.47) $\frac{W}{m2}$ = 553.98 W

The heating load of the fixed window on the south is:

q windowsouth = A X HF windowsouth = A X U windowsouth ΔTheating
= 3.6 m2 X 2.87$\frac{w}{m2k}$X 24.8K = 256.23 W

When the frame were to be aluminium, U windowsouth = 4.62$\frac{w}{m2k}$, HSGC = 0.55

CF' windowsouth(Heat Trasnfer Part) = U' windowsouth (ΔTcooling - 0.46 DR)
=4.62$\frac{w}{m2k}$X (7.9 K - 0.46 X 11.9 K) = 11.21 $\frac{W}{m2}$

Cooling load q' windowsouth = A X CF'windowsouth
= A X (CF'windowsouth(Heat Trasnfer Part) + CF'windowsouth(Irradiation Part))
= 3.6 m2 X (11.21 +557 X 0.55 X 1 X 0.47) $\frac{W}{m2}$ = 558.70 W

Heating load q' windowsouth = A X HF' windowsouth = A X U' windowsouth ΔTTheating
= 3.6 m2 X 4.62$\frac{w}{m2k}$ X 24.8 K = 412.47 W