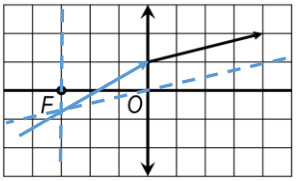
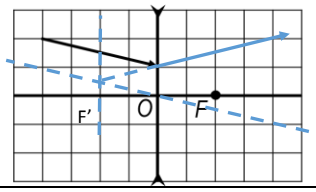
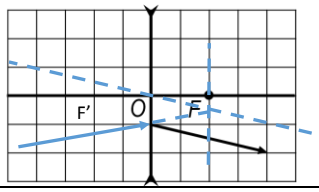
1 – Prisms placed side by side (6 points)

1. N sinα= n sin β	0.5
2. $\beta = \frac{\pi}{2} - \gamma$	0.5
2. At I_2 : The critical angle is such that n.sin(i_c)= 1 , i.e. $\sin i_c = \frac{1}{n}$ Therefore we have $\sin\gamma > \frac{1}{n}$ At I_1 : N sinα = n sin β = n sin($\frac{\pi}{2} - \gamma$) = $n \cos\gamma$ As a consequence, $N \sin\alpha < n\sqrt{1 - \left(\frac{1}{n}\right)^2}$ Since α=45°, we get $N < \frac{2}{\sqrt{2}}\sqrt{n^2 - 1}$	1 1 0.5 1 0.5
4. If ε = 0 , δ = 0 so γ= 45° and β=45°. By using the Snell-Descartes' law at I_1, we get N = n	0.5 0.5

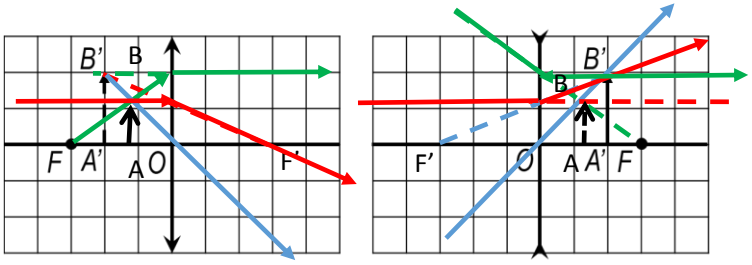
2 – Projection system (7 points)

1. real object (we can touch the document), real image (observed on a screen)	0.25 + 0.25
2. converging lens with the object placed before F	0.5 + 0.5
3. We have 3 equations with 3 unknown elements: I : $\frac{1}{\overline{f'}} = \frac{1}{\overline{OA'}} - \frac{1}{\overline{OA}}$, which gives $\overline{f'} = \frac{\overline{OA'}\,\overline{OA}}{\overline{OA} - \overline{OA'}}$ II : $\gamma = \frac{\overline{A'B'}}{\overline{AB}} = \frac{\overline{OA'}}{\overline{OA}}$, i.e. $\overline{OA'} = \gamma.\overline{OA}$ III : $D = \overline{AO} + \overline{OA'} = -\overline{OA} + \overline{OA'}$, By combining II & III, we get $\overline{OA} = \frac{D}{\gamma - 1}$ and $\overline{OA'} = \frac{\gamma D}{\gamma - 1}$ Then, from I, $f' = \frac{-\gamma}{(\gamma-1)^2} D$	0.5 0.5 0.5 1 + 1 1
4. γ = -9 f' = 9 cm	0.5 0.5 (0 if no unit)

3 – Ray-tracing (3 points)

  	1 1 + 1

4 – Image-object ray diagrams (4 points)

	**2 + 2** 0.5 for each ray 0.5 for the object 0 if rays and construction lines cannot be distinguished from each other