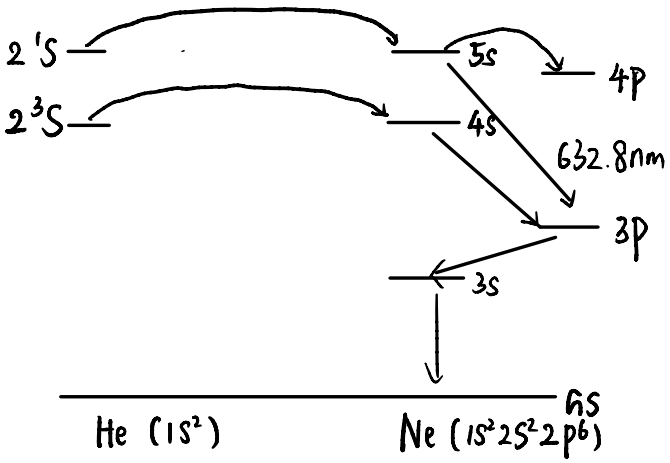
Upload your finished worksheet as a single pdf file on moodle before the next class session in order to get participation credit.
Try to keep your books closed. Discuss with your fellow students to come to an answer.
Show your work.

Name:_____

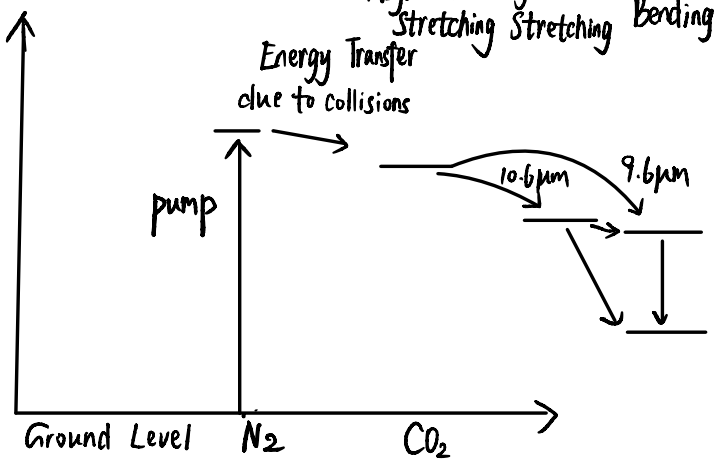
1. Name the a) excited and ground state and b) transition type for a HeNe, a CO_2, and an Excimer laser

HeNe Laser: Electronic State Transition

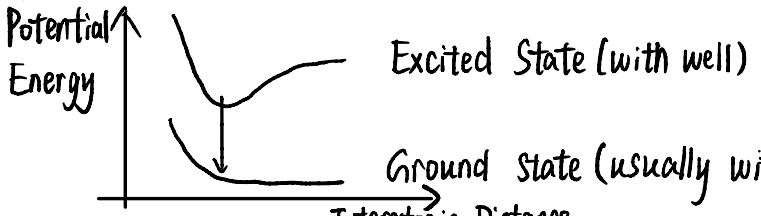


CO_2 Laser (Vibrational Mode Transition)

Asymmetric Stretching, Symmetric Stretching, Bending



Excimer Laser: Electronic State Transition

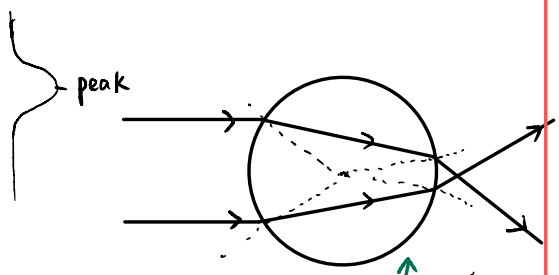


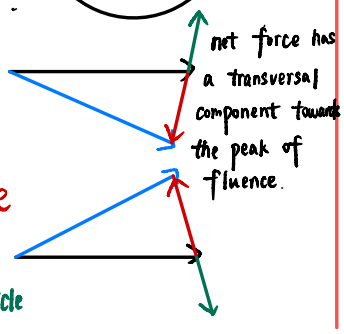
no stable ground state solution
dissociate to separate atoms

2. Draw the force diagram of a transparent particle in an optical trap. Which forces act in which direction. Use ray optics.

Remark: force will drag particle toward the center

Parallel Light:

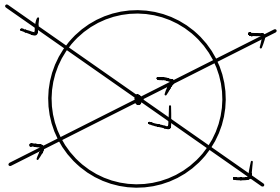




Black: Incident
Blue: Refracted
Red: Momentum change
Green: Force from light to particle

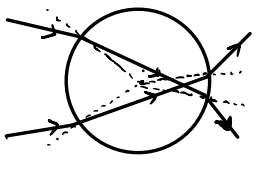
Unparallel Light:

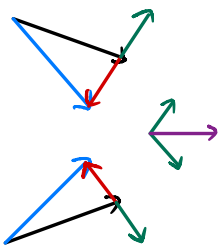
① Particle Center Overlaps with Focus



No momentum change
No force acting on particle

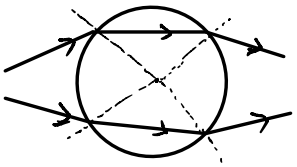
② Before focus

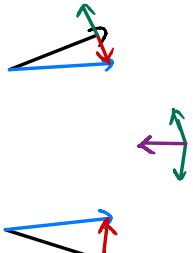




Purple: Total Force

③ After Focus





3. In a simplified form, Ashkin (Biophys Journal 61, page 569, 1992 - pdf also on moodle) describes the force on a trapped particle as

$$F = Q\frac{n_1 P}{c} \tag{1}$$

Q is in experimental factor, n_1 the relative refractive index, P the laser power, and c the speed of life. Estimate the force acting on a 3 μm polystyrene sphere (n=1.6) in water (n=1.3). Q is an experimental factor estimated to be 0.25. The used laser power is 10 mW.

$$n_1 = \frac{1.6}{1.3} = 1.23$$

$$F = 1.03 \times 10^{-11}\ N = 10.3\ pN$$

The End.