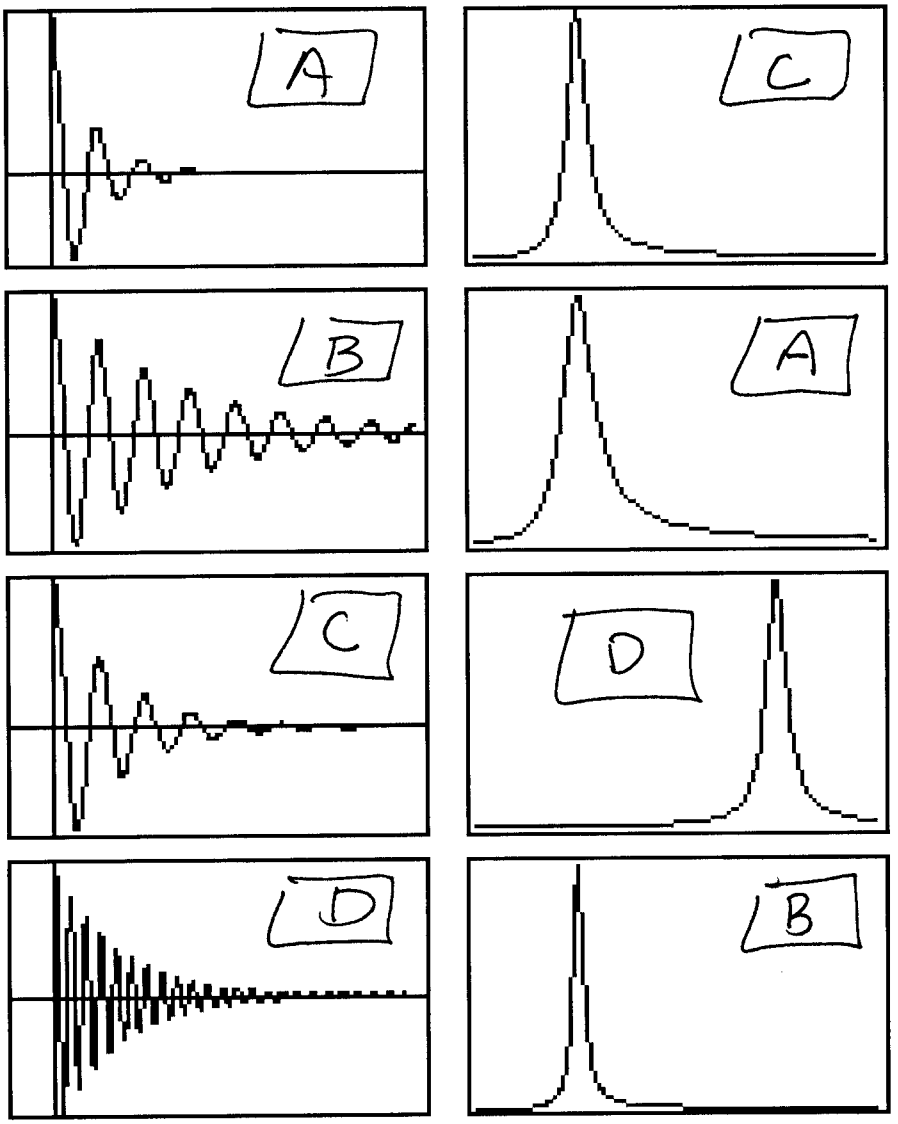
Key

Quiz 2: Pchem

1. Match the appropriate Fourier transform pairs. All time (frequency) graphs are plotted over the same time (frequency) range.

4



2. BCl_3 is a trigonal planar molecule belonging to the D_{3h} point group.

6

D_{3h}	E	$2C_3$	$3C_2$	σ_h	$2S_3$	$3\sigma_v$			
A_1'	1	1	1	1	1	1		x^2+y^2, z^2	$x(x^2-3y^2)$
A_2'	1	1	−1	1	1	−1	R_z		$y(3x^2-y^2)$
E'	2	−1	0	2	−1	0	(x, y)	(x^2-y^2, xy)	(xz^2, yz^2)
A_1''	1	1	1	−1	−1	−1			
A_2''	1	1	−1	−1	−1	1	z		z^3
E''	2	−1	0	−2	1	0	(R_x, R_y)	(xz, yz)	$[xyz, z(x^2-y^2)]$
$\Gamma_{x,y,z}$	3	0	−1	1	−2	1			

2

(a) How many normal modes does BCl_3 have?

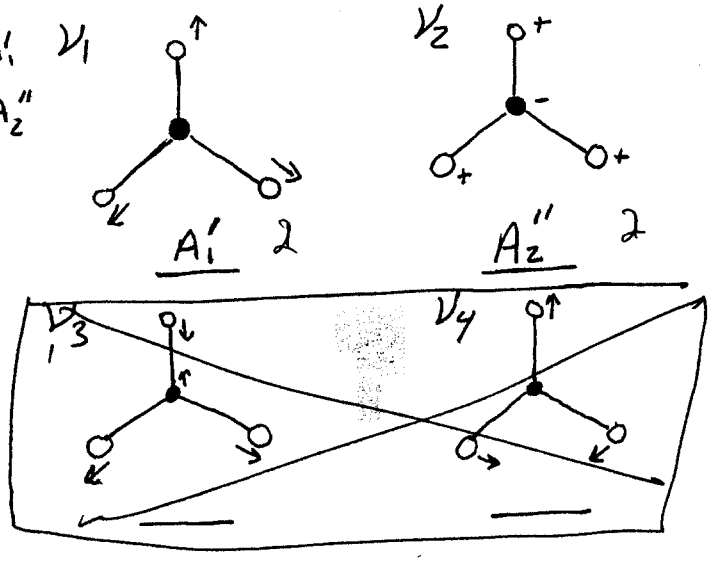
$3(4)-6 = 6$

(b) Below are 2 of the normal modes of BCl_3. Assign each mode to a vector in the character table ~~and also indicate the degeneracy of the mode~~.

	E	$2C_3$	$3C_2$	σ_h	$2S_3$	$3\sigma_v$	
ν_1	1	1	1	1	1	1	A_1'
ν_2	1	1	−1	−1	−1	1	A_2''

~~ν_3~~

4



(c) Which of the above modes are Raman active and which are IR active?

2

ν_1 is Raman active 1

ν_2 is IR active 1

8

3. Sketch a picture illustrating in the complete process of absorption followed by fluorescence. Include all important information. Also sketch a qualitative gas phase spectrum which shows both the absorbance and fluorescence spectra. Then do the same for a condensed (liquid) phase spectrum. Indicate the Stokes shift on this spectrum