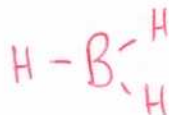


Name

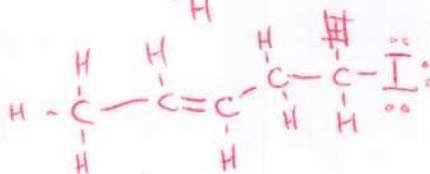
N.O. Itall

Answer all the questions.

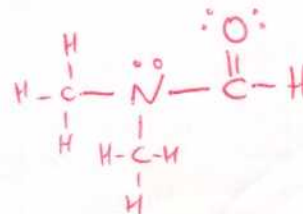
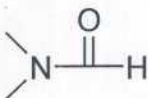
1) (12pts) Draw Lewis structures (lines for bonds and dots for lone pairs) for the following molecules:

(a)  $\text{BH}_3$ 

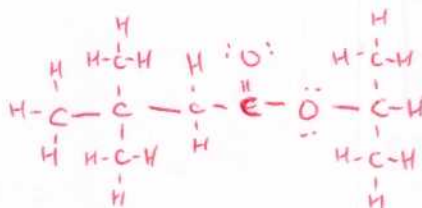
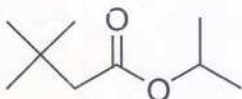
(b)



(c)



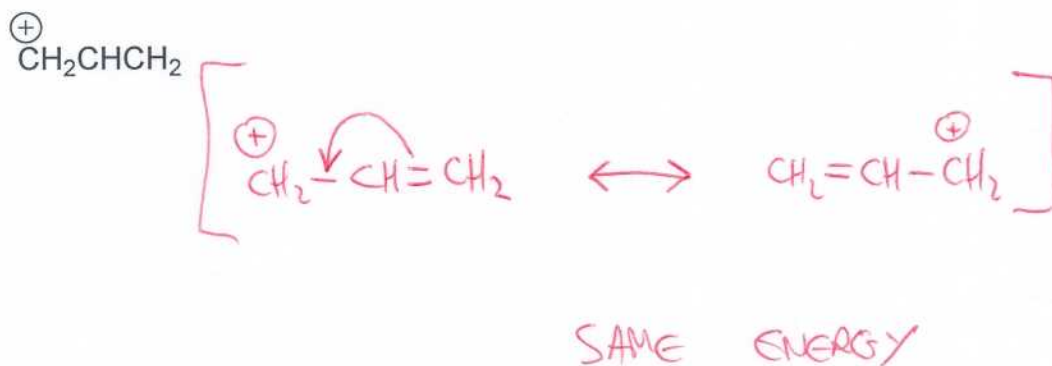
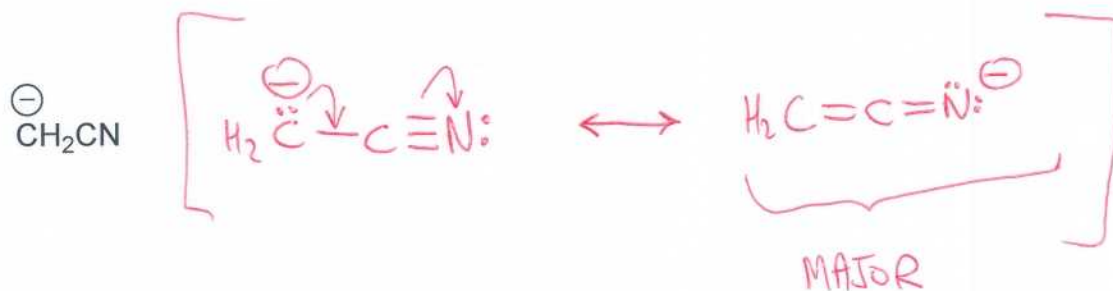
(d)



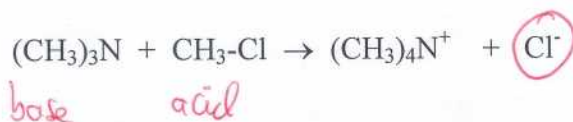
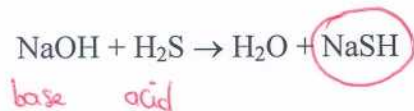
2) (3pts) What is the hybridization of the

Boron in (a) sp<sup>2</sup>Nitrogen in (c) sp<sup>3</sup> $\pi$  bonded O in (d)? sp<sup>2</sup>

- 3) (10pts) Write all the resonance forms for the following two species, and in both cases indicate which forms are the major and minor contributors (or if they are the same energy). Use curly arrows to show the movement of electrons which converts one to the other.

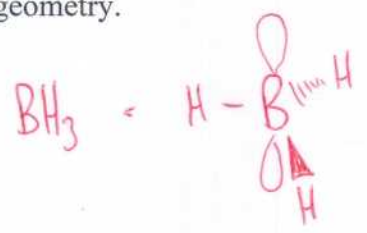


- 4) (4pts) Label which reactant is a BASE and which is an ACID in the following reactions, and also circle the conjugate base of the acidic species.

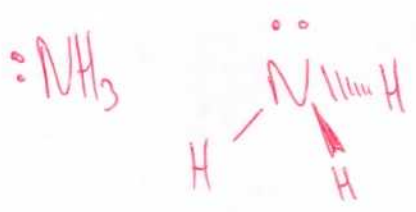


5) (1pt) How is  $K_a$  mathematically related to  $pK_a$ ?  $pK_a = -\log_{10} K_a$

6) (10pts) Explain why  $BH_3$  has a trigonal planar shape whilst  $NH_3$  has a tetrahedral geometry.



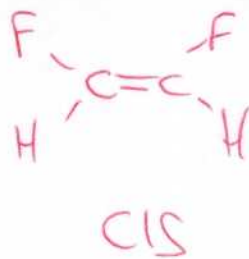
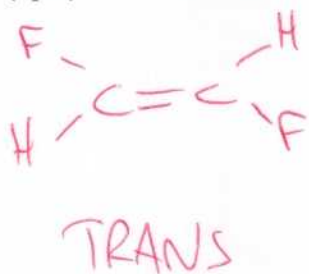
3  $\sigma$  bonds, no  $l.p.$   $\Rightarrow$  3 orbitals required  
 $sp^2$  hybridization of B = trigonal planar  
vacant p orbital



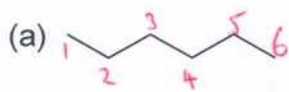
3  $\sigma$  bonds, 1 lone pair  $\Rightarrow$  4 orbitals required  
 $\Rightarrow sp^3$  = tetrahedral.

7) (1pt) Which of the above two compounds is the better NUCLEOPHILE?  $:NH_3$

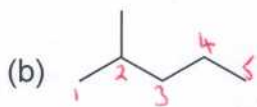
8) (4pts) Draw and label the 2 geometric isomers of  $\text{CFH}=\text{CFH}$ .



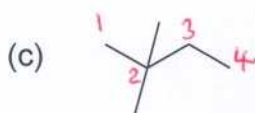
9) (10pts) Name (in IUPAC form) the following compounds:



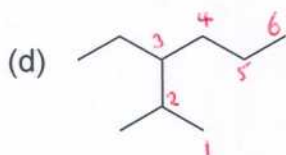
hexane



2-methylpentane



2,2-dimethylbutane

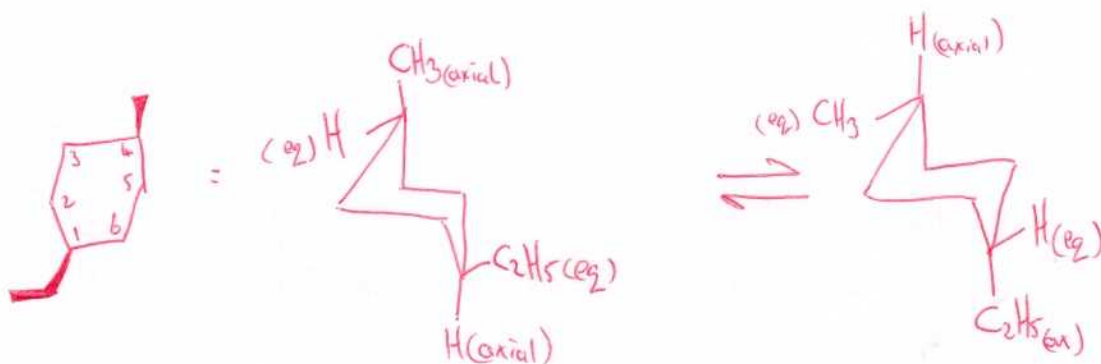


3-ethyl-2-methylhexane (more branching)

10) (3pts) Draw (using sticks and wedges, ~~trans~~-1,3-dimethylcyclopentane.



11) (15pts) Draw the 2 possible chair conformations of *cis*-1-ethyl-4-methylcyclohexane.

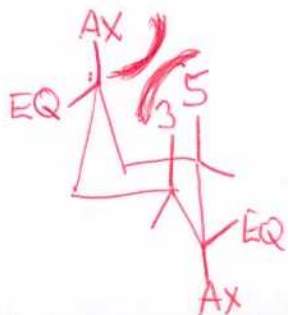


More stable

12) (5pts) Explain which is the more stable conformation for the previous molecule. (you may use the back of this page if necessary).

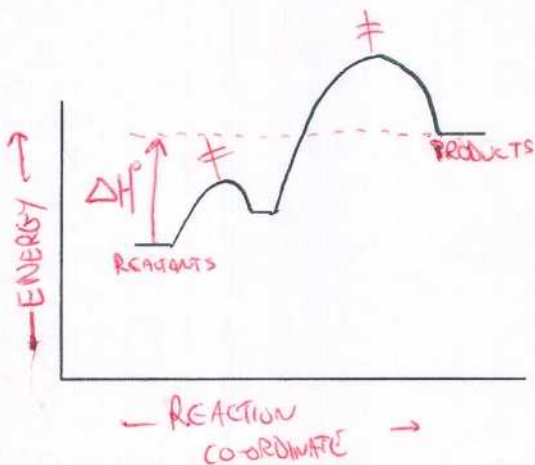
larger substituent goes equatorial,  $\therefore$   $C_2H_5$  goes equatorial.

AXIAL groups have unfavorable 1,3 & 1,5 steric interactions



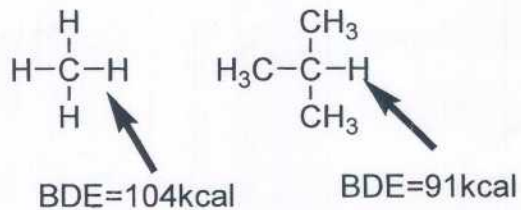
13) (12pts) On the below reaction energy diagram, label:

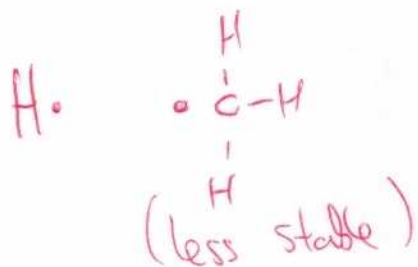
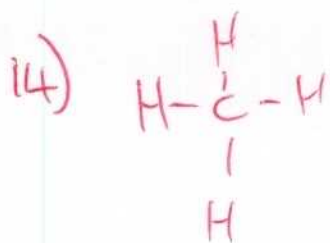
- (a) the axes (b) the reactants and products (c) any transition states (using ‡) (d)  $\Delta H^\circ$  for the overall reaction (e) is this reaction exothermic or endothermic?



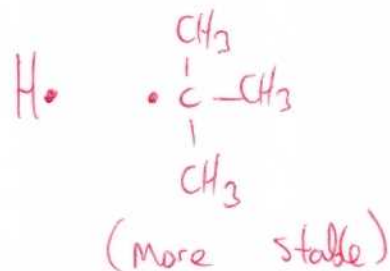
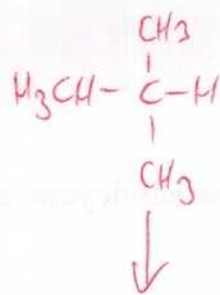
$\Delta H^\circ = +ve \therefore$  ENDOTHERMIC

14) (10pts) Use the stability of radicals to rationalize why the bond dissociation energy of the indicated C-H bond in methane is 104kcal, whereas the indicated C-H bond dissociation for 2-methylpropane is only 91kcal. (you may use the back of this page if necessary).





The  $\cdot\text{CH}_3$  radical has no electron releasing substituents and is therefore less stable than the  $\cdot\text{Butyl}$  radical, and thus breaking of the C-H bond requires more energy.



The  $\cdot\text{C}(\text{CH}_3)_3$  radical has electron releasing substituents, and thus the electron deficient centre is stabilised, thus less energy is required to break the C-H bond and form this radical.