If you do not want your graded exam placed in the box outside my office, then please tick here.

Answer all the questions.
1) Draw Lewis structures (lines for bonds and dots for all lone pairs) for the following molecules: (8pts)

(a) \( \text{BeCl}_2 \)

(b) \[
\begin{array}{c}
\text{C} \\
\text{N}
\end{array}
\]

(c) 

(d) 

2) Draw a Lewis structure for this molecule. (3pts)

\[
\begin{array}{c}
\text{H}_2\text{N} \\
\text{NH} \\
\text{O}
\end{array}
\]

3) Also indicate the hybridization of each C, N, and O atom in the above molecule. (10pts)
3(b) There is a bonus point if you can name this muscle building chemical.

4) (i) Write all the resonance forms for the following two species.
(ii) Indicate which are major and minor contributors (or if they are the same energy).
(iii) Use curly arrows to show the movement of electrons which converts one into the others. (10pts)

(a) 

(b) 

5) (i) Give any two definitions of an ‘acid’, and state the name/inventor of each definition. (4pts)

(ii) Indicate which reactant is acting as a BASE and which is acting as an ACID for the following reactions. (4pts)
(iii) Also circle the conjugate acid of the basic species. (2pts)

(a) \( \text{H}_2\text{SO}_4 + \text{H}_2\text{O} \rightarrow \text{H}_3\text{O}^+ + \text{HSO}_4^- \)

(b) \( \text{CH}_3\text{O}^- + \text{CH}_3\text{CH}_2\text{I} \rightarrow \text{CH}_3\text{OCH}_2\text{CH}_3 + \text{I}^- \)
6) What two components contribute to the ring strain of a cycloalkane? (2pts)

7) Draw and label an energy level diagram showing an exothermic reaction which proceeds via a single intermediate, and the first step of this two step process is rate determining. (10pts)

8) Using Newman projections (looking along C2 and C3), draw any two different conformations of butane, and indicate which of the two you have drawn would have the lower energy. (8pts)
9) Name the following compounds in IUPAC form. (15pts)

(a) 

(b) 

(c) 

(d) 

(e) \[\text{H}_3\text{C} \quad \text{CH}_3\]
10) The most stable conformation for a cyclohexane ring bearing a propyl group is a “chair conformation with the propyl group equatorial”.

(i) explain what the chair conformation is (4pts)

(ii) explain what ‘equatorial’ is (4pts)

(iii) explain why it is energetically preferred to put the substituent equatorial. (6pts)
11) Explain why a carbocation like CH$_3^+$ has a planar structure. (10pts)
If you do not want your graded exam placed in the box outside my office, then please tick here________

Answer all the questions.
1) Draw Lewis structures (lines for bonds and dots for all lone pairs) for the following molecules: (8pts)

(a) BeCl₂

(b)

(c) 

(d) 

2) Draw a Lewis structure for this molecule. (3pts)

3) Also indicate the hybridization of every C, N, and O atom in the above molecule. (10pts)
3(b) There is a bonus point if you can name this muscle building chemical.

\[ \text{Creatine} \]

4) (i) Write all the resonance forms for the following two species.
(ii) Indicate which are major and minor contributors (or if they are the same energy).
(iii) Use curly arrows to show the movement of electrons which converts one into the others. (10pts)

(a)

(b)

5) (i) Give any two definitions of an ‘acid’, and state the name/inventor of each definition. (4pts)

- Arrhenius: Substance that dissolves in water to give \( H_3O^+ \) ions.
- Bronsted-Lowry: A \( H^+ \) donor.
- Lewis: An electron pair acceptor.

(ii) Indicate which reactant is acting as a BASE and which is acting as an ACID for the following reactions. (4pts)
(iii) Also circle the conjugate acid of the basic species. (2pts)

(a) \( H_2SO_4 + H_2O \rightarrow H_3O^+ + HSO_4^- \)

(b) \( CH_3O^- + CH_3CH_2-I \rightarrow CH_3OCH_2CH_3 + I^- \)
6) What two components contribute to the ring strain of a cycloalkane? (2pts)

Angle Strain
Torsional Strain

7) Draw and label an energy level diagram showing an exothermic reaction which proceeds via a single intermediate, and the first step of this two step process is rate determining. (10pts)

\[ \Delta H = \text{-ve} \quad \text{Exothermic} \]

8) Using Newman projections (looking along C2 and C3), draw any two different conformations of butane, and indicate which of the two you have drawn would have the lower energy. (8pts)

\[ \text{CH}_3-\text{CH}-(\text{CH}_3)\text{CH}_3 \]

ANTI  GAUCHÉ

LOWEST  HIGHEST
9) Name the following compounds in IUPAC form. (15pts)

(a) \[ \text{hexane} \]

(b) \[ 2\text{-methylheptane} \]

(c) \[ 2,3,3\text{-trimethylpentane} \]

(d) \[ 2,3\text{-dimethylbutane} \]

(e) \[ \text{trans-1,2-dimethylcyclopentane} \]
10) The most stable conformation for a cyclohexane ring bearing a propyl group is a "chair conformation with the propyl group equatorial".

(i) explain what the chair conformation is (4pts)

The chair conformation places the 6 carbons as shown and it looks like a chair.

(ii) explain what 'equatorial' is (4pts)

When a cyclohexane is in a chair, there are two different hydrogen positions: Equatorial which point out almost horizontally and Axial which alternatingly point vertically up or down.

(iii) explain why it is energetically preferred to put the substituent equatorial. (6pts)

Placing a substituent in an axial position creates unfavorable 1,3 di axial interactions arising from e-e repulsions.

However, placing the substituent in the equatorial position, the substituent away from the rest of the molecule and thus reducing steric hindrance.
11) Explain why a carbocation like CH$_3^+$ has a planar structure. (10pts)

The central C in CH$_3^+$ has 3 bonding regions and is therefore sp$^2$ hybridized. Thus the four atoms lie in a plane, with bond angles of 120°.

There is an empty, unhybridized P orbital at right angles to the plane of 3 bonds.