Advanced Notice Article for F332 – June 2013- Questions based upon the Article.

1) Draw dot and cross structures for N_2 and N_2O based upon the structures suggested in the article.

(5)

2) One structure suggested for ozone is O=O→O .

(a)Draw a dot and cross diagram to represent this structure.

(3)

(b) Predict and explain the bond angle. Bond angle = _____ ^{o} (1)

Reason:

(3)

(c) What name is given to the shape of the ozone molecule? _____(1)

3) Give the oxidation states of nitrogen in

NO_2 _____ HNO_3_____ NO_____ NH_3_____

$(NH_4^+)_2SO_4^{2-}$ _____ (5)

4) $\mathbf{2NH_4^+ + 3O_2 \rightarrow 2NO_2^- + 2H_2O + 4H^+}$

(a) In the equation above use oxidation states (numbers) to indicate which element is

(i) oxidised _____(1) (ii) reduced _____(1)

(b) Name the reducing agent in the equation . _____(1)

5) Name the species OH and use a dot and cross diagram to explain why it is referred to as a radical.

Dot and cross:

(2)

Name _____ (1) Radical because : (1)

6) (a) Which property of ammonia makes it readily removable from the atmosphere by “wet deposition”?

(1)

(b) Draw a diagram showing the strongest intermolecular bond formed between water and ammonia indicating any lone pairs and partial charges.

(4)

7) For the reaction $NO_2 + hv \rightarrow NO + O$, what type of bond breaking is involved?

_____ _____ (2)

8) Assuming NO, NO_2, O and O_2 are classed as radicals, find from the article

(a) two equations that can be described as “initiation” reactions. (2)

(b) five examples of “propagation” reactions (5)

(c) Two examples of “termination” reactions. (2)

9) Write a balanced equation with state symbols showing the conversion of carbon monoxide and nitrogen monoxide to nitrogen and carbon dioxide in the three way catalytic converter.

$\rightarrow$ (3)

10) Peroxyacetylnitrate (PAN) has formula $CH_3C(O)O_2NO_2$. Assuming the nitrogen forms one single dative bond to one of the end oxygen atoms and the molecule contains one O-O single bond, draw a **full** structural formula for PAN.

(2)

11) The loss of NO_x by wet deposition from the atmosphere contributes to which environmental problem?

(1)

12) What is unique about ammonia gas in the Earth's atmosphere and write an equation to show how it could use this property to react with another compound in shown in figure 3.

Property (1)

Equation (1)

13) (a) Combine the equations shown below to show that they do represent the interconversion of NO and NO_2.

$NO + O_3 \rightarrow NO_2 + O_2$ $NO_2 \rightarrow NO + O$ $O + O_2 \rightarrow O_3$

Combined: (1)

Overall reaction : (1)

(b) Suggest (considering all substances are in the gaseous state) the exact terms used to describe role of Ozone in this interconversion and justify your answer.

(3)

(c) What term could be used to describe the species O and O_2 in this process?

(1)

15) (a) Draw the full structural formula of urea $(NH_2)_2CO$

(1)

(b) Urea breaks down in the presence of water to form just two simple gases one of which is alkaline. Write a balanced equation for this reaction.

(2)

16) A nitrogen molecule N_2 contains triple covalent bonds. The data book value for the bond enthalpy of N_2 is +945.4 kJ mol^{-1}. The Avogadro constant is 6.02 x 10^{23} mol^{-1} and Planck's constant is 6.63 x 10^{-34} JHz^{-1}.

(a) Calculate the energy (to 3 significant figures) needed to break the triple bond in a single molecule of N_2. Indicate suitable units and show working.

Working

Answer _____ units = _____(4)

(b) Using answer (a) calculate the frequency of a photon of radiation needed to break this bond giving your answer to 3 sig figs.

Frequency _____Hz (2)

(c) Use your answer to (b) and the formula

Speed of light (ms^{-1}) = frequency (Hz) x wavelength (m) ($c = \lambda v$)

to calculate the wavelength of radiation needed to break up a molecule of N_2. Express your final answer in *nanometres* to 3 sig figs. Speed of light c = 3.00 x 10^{8} ms^{-1} 1nm = 10^{-9} m.

Wavelength = _____m

Wavelength = _____nm (3)

17) N_2O is present in air at a concentration of 310 ppbv.

(a) Given a cubic metre contains 10^{6} cm^3, calculate how many cm^3 of N_2O would be in a cubic metre of air.

_____cm^3 (1)

(b) 1 mole of any gas occupies 24dm^3 at room temperature and pressure, so use answer (a) to find out how many moles (to 3 sig figs) of N_2O are in a cubic metre of air.

_____ mol (2)

(c) A cubic metre contains 1000 dm^3. Use this and answer (b) to express the concentration of N_2O in air in mol dm^{-3}.

_____ mol dm^{-3} (1)

(d) Using answer (c) convert your answer to a concentration of N_2O in g dm^{-3} (A_r N = 14.0, O= 16.0).

_____ mol dm^{-3} (1)

18) The rate of formation of NO from the reaction between N_2 and O_2 in the air is negligible at ordinary temperatures but becomes significant at the temperature of an engine. Explain this in terms of particles and energy. (5)