

Bonding Test, HL Chemistry, Spring 2017 [54 marks]

You may use your calculator and the supplied tables from the Data booklet.

Multiple choice.

Circle the correct answer on your answer sheet.

1. Nitroglycerine, $\text{C}_3\text{H}_5\text{N}_3\text{O}_9$, can be used in the manufacture of explosives. What is the coefficient of $\text{C}_3\text{H}_5\text{N}_3\text{O}_9(\text{l})$ when the equation for its decomposition reaction is balanced using the lowest whole numbers? [1 mark]



- A. 2
B. 4
C. 20
D. 33
2. Which sample contains the largest amount, in mol, of oxygen atoms? [1 mark]
- A. 0.20 mol P_2O_5
B. 0.30 mol O_3
C. 0.40 mol CH_3COOH
D. 0.80 mol H_2O
3. 300 cm^3 of water is added to a solution of 200 cm^3 of 0.5 mol dm^{-3} sodium chloride. What is the concentration of sodium chloride in the new solution? [1 mark]
- A. 0.05 mol dm^{-3}
B. 0.1 mol dm^{-3}
C. 0.2 mol dm^{-3}
D. 0.3 mol dm^{-3}

4. Which electron configurations do not follow the Hund's rule? [1 mark]

	1s	2s	2p		
I.	↑ ↓	↑ ↓	↑	↑	↑
II.	↑ ↓	↑ ↓	↑ ↓	↑	
III.	↑ ↓	↑ ↓	↑	↓	↑

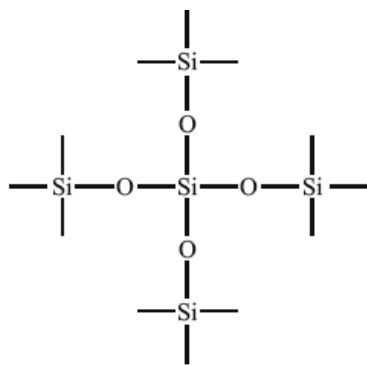
- A. I and II only
B. I and III only
C. II and III only
D. I, II and III

5. Which shows the sub-levels in order of **increasing** energy in the fourth energy level of an atom? [1 mark]
- A. $f < d < p < s$
B. $p < d < f < s$
C. $d < f < p < s$
D. $s < p < d < f$
6. Which series is arranged in order of **increasing** radius? [1 mark]
- A. $F < Cl^- < Cl$
B. $Rb < K < Na$
C. $Al^{3+} < Mg^{2+} < Na^+$
D. $I^- < Br^- < Cl^-$
7. Which compounds have an ionic lattice structure in the solid state? [1 mark]
- I. Silicon dioxide
II. Sodium fluoride
III. Ammonium nitrate
- A. I and II only
B. I and III only
C. II and III only
D. I, II and III
8. Which particles are responsible for electrical conductivity in metals? [1 mark]
- A. Anions
B. Cations
C. Electrons
D. Protons
9. What is the formula of magnesium nitride? [1 mark]
- A. Mg_2N_3
B. Mg_3N_2
C. $Mg(NO_3)_2$
D. $Mg(NO_2)_2$
10. Which sequence has the molecules in order of increasing nitrogen-nitrogen bond length? [1 mark]
- A. $N_2 < N_2H_4 < N_2H_2$
B. $N_2 < N_2H_2 < N_2H_4$
C. $N_2H_4 < N_2H_2 < N_2$
D. $N_2H_2 < N_2H_4 < N_2$
11. Which bonds are arranged in order of **increasing** polarity? [1 mark]
- A. $H-F < H-Cl < H-Br < H-I$
B. $H-I < H-Br < H-F < H-Cl$
C. $H-I < H-Br < H-Cl < H-F$
D. $H-Br < H-I < H-Cl < H-F$

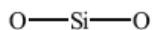
12. Which diagram represents the bonding in SiO_2 ?

[1 mark]

A.



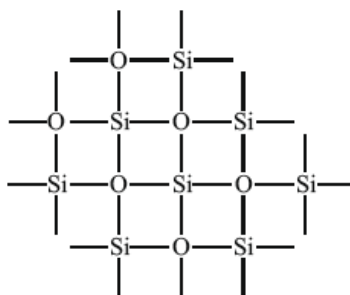
B.



C.



D.



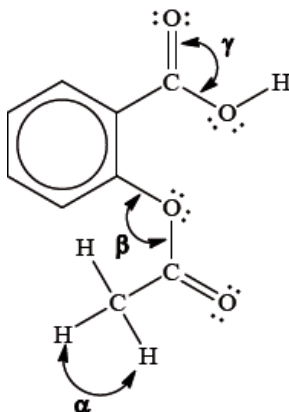
13. Which molecule is polar?

[1 mark]



14. The Lewis (electron dot) structure of aspirin is represented below.

[1 mark]



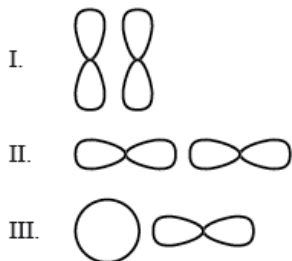
What are the approximate values of the bond angles α , β and γ , in the molecule?

	α	β	γ
A.	90°	104.5°	104.5°
B.	90°	120°	120°
C.	109.5°	120°	120°
D.	109.5°	104.5°	120°

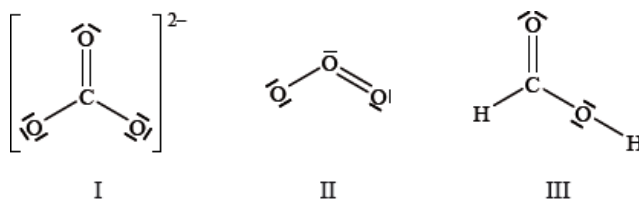
15. Diamond, C₆₀ fullerene and graphite are allotropes of carbon. Which statements are correct about these allotropes? [1 mark]
- In diamond each carbon is held in a tetrahedral arrangement.
 - In C₆₀ fullerene each carbon is held in a trigonal arrangement.
 - In graphite each carbon is held in a tetrahedral arrangement.
- A. I and II only
B. I and III only
C. II and III only
D. I, II and III
16. Which molecule has an octahedral shape? [1 mark]
- A. SF₆
B. PCl₅
C. XeF₄
D. BF₃
17. Which forces are present between molecules of carbon dioxide in the solid state? [1 mark]
- A. Permanent dipole-permanent dipole interactions
B. Temporary dipole-induced dipole interactions (London/dispersion forces)
C. Covalent bonding
D. Ionic bonding
18. Which process involves the breaking of hydrogen bonds? [1 mark]
- A. $2\text{HI}(\text{g}) \rightarrow \text{H}_2(\text{g}) + \text{I}_2(\text{g})$
B. $\text{CH}_4(\text{g}) \rightarrow \text{C}(\text{g}) + 4\text{H}(\text{g})$
C. $\text{H}_2(\text{l}) \rightarrow \text{H}_2(\text{g})$
D. $\text{NH}_3(\text{l}) \rightarrow \text{NH}_3(\text{g})$
19. Which change explains why the boiling points of the halogens increase as their molecular masses increase? [1 mark]
- A. The intermolecular attraction due to temporarily induced dipoles increases.
B. The gravitational attraction between molecules increases.
C. The polarity of the bond within the molecule increases.
D. The strength of the bond within the molecule increases.
20. What is the correct order of **increasing** boiling points? [1 mark]
- A. $\text{CH}_3\text{CH}_3 < \text{CH}_3\text{CH}_2\text{Cl} < \text{CH}_3\text{CH}_2\text{Br} < \text{CH}_3\text{CH}_2\text{I}$
B. $\text{CH}_3\text{CH}_2\text{Cl} < \text{CH}_3\text{CH}_2\text{Br} < \text{CH}_3\text{CH}_3 < \text{CH}_3\text{CH}_2\text{I}$
C. $\text{CH}_3\text{CH}_2\text{I} < \text{CH}_3\text{CH}_2\text{Br} < \text{CH}_3\text{CH}_2\text{Cl} < \text{CH}_3\text{CH}_3$
D. $\text{CH}_3\text{CH}_2\text{Br} < \text{CH}_3\text{CH}_2\text{Cl} < \text{CH}_3\text{CH}_2\text{I} < \text{CH}_3\text{CH}_3$

21. Which substance is made up of a lattice of positive ions and free moving electrons? [1 mark]
- Graphite
 - Sodium chloride
 - Sulfur
 - Sodium

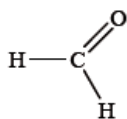
22. The diagrams below show s and p orbitals in different positions. Which combinations can form a σ -bond? [1 mark]



- I and II only
 - I and III only
 - II and III only
 - I, II and III
23. Which species have delocalized electrons? [1 mark]



- I and II only
 - I and III only
 - II and III only
 - I, II and III
24. What is the hybridization of the carbon atom, and the number of σ and π bonds in the methanal molecule? [1 mark]



	Hybridization	σ bonds	π bonds
A.	sp^2	3	1
B.	sp^3	3	1
C.	sp^3	4	0
D.	sp^2	4	0

25. A student heated a solid in a crucible. The student measured the mass of the solid and crucible before and after heating and recorded the results. [1 mark]

Mass of crucible and solid before heating = 101.692 g

Mass of crucible and solid after heating = 89.312 g

What value should the student record for the mass lost in grams?

- A. 12.4
- B. 12.38
- C. 12.380
- D. 12.3800

Free response.

Please write all answers in the provided answer box. Show all work on calculation questions.

26. When iodine reacts with excess chlorine, ICl_3 can form. Deduce the Lewis (electron dot) structure of ICl_3 and ICl_2^- and state the name of the shape (molecular) of each species. [4 marks]

	ICl_3	ICl_2^-
Lewis structure		
Name of shape		

- 27a. State the shape of the ozone, O_3 , molecule and estimate the bond angle. [2 marks]

Shape:

Bond angle:

.....
.....
.....

27b. State the hybridization of the central oxygen atom.

[1 mark]

.....

.....

.....

27c. In terms of σ and π bonds, describe the two oxygen-oxygen bonds in the Lewis structure.

[1 mark]

.....

.....

.....

27d. The two oxygen-oxygen bonds in ozone are in fact of equal length. Deduce why this is the case and how the length of these would compare to oxygen-oxygen bond lengths in hydrogen peroxide, H_2O_2 , and in the oxygen molecule, O_2 . [2 marks]

.....

.....

.....

.....

.....

.....

28a. Apply the Aufbau principle to state the **full** electron configuration for an atom of phosphorus.

[1 mark]

.....

.....

.....

28b. Deduce the Lewis structures for PCl_3 and PCl_5 .

[2 marks]



28c. Predict the molecular shapes and the bond angles in the two molecules.

[4 marks]

	PCl_3	PCl_5
Shape
Bond angles

28d. Identify the type of hybridization present in PCl_3 .

[1 mark]

.....

.....

.....

28e. Compare the melting points of PCl_3 and PCl_5 and explain the difference.

[3 marks]

.....

.....

.....

.....

.....

.....

29a. Draw Lewis (electron dot) structures for C_2H_4 and N_2H_4 showing all valence electrons.

[2 marks]

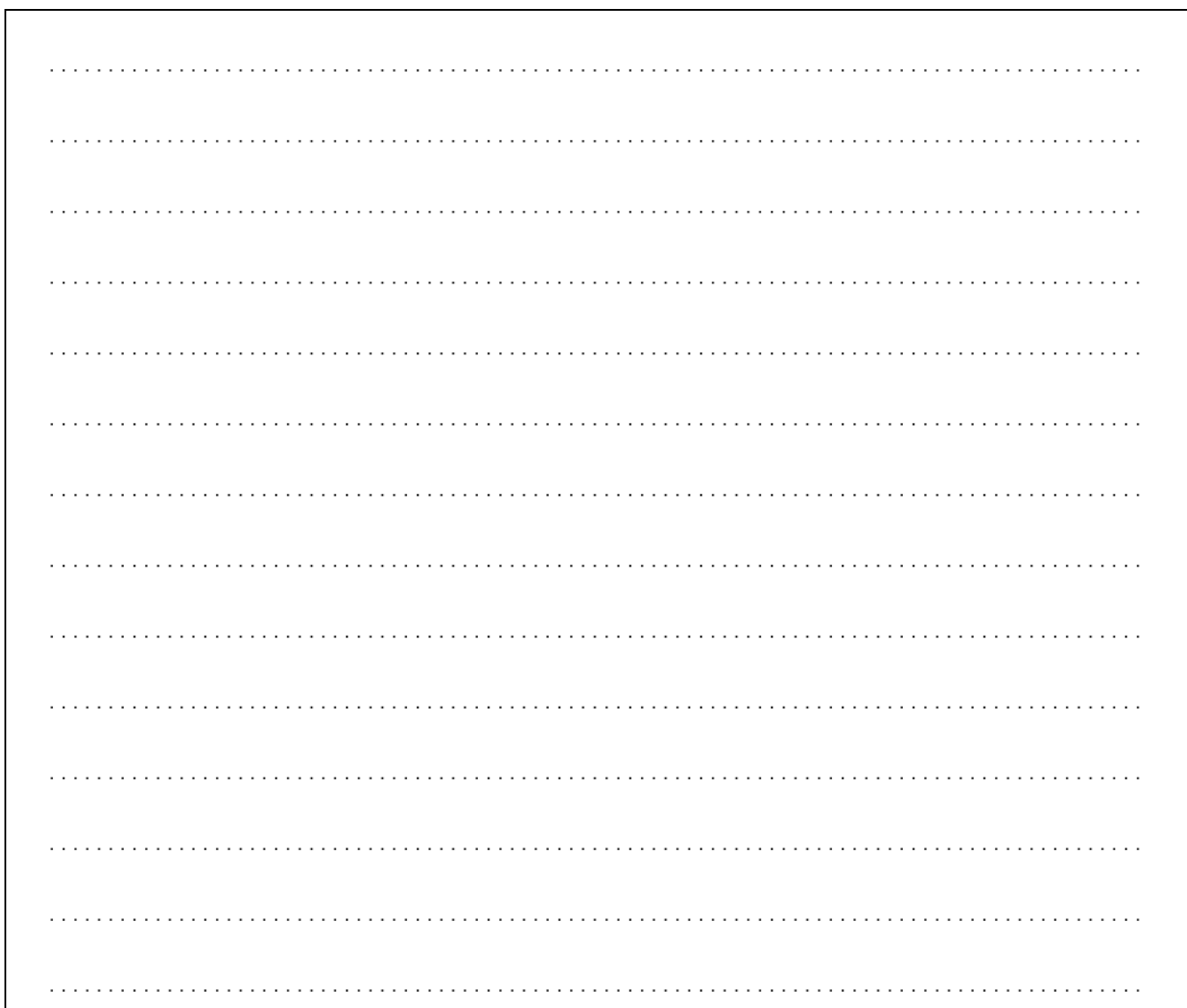


29b. (i) Define the term *electronegativity*.

[4 marks]

(ii) Compare the relative polarities of the C-H bond in ethene and the N-H bond in hydrazine.

(iii) Hydrazine is a polar molecule and ethene is non-polar. Explain why ethene is non-polar.



29c. The boiling point of hydrazine is much higher than that of ethene. Explain this difference in terms of the intermolecular forces in each compound.

[2 marks]

.....

.....

.....

.....

.....

.....