KWAZULU-NATAL PROVINCE

EDUCATION
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 11

PHYSICAL SCIENCES P2

COMMON TEST

JUNE 2024

MARKS: 75

TIME: 1½ hours

This question paper consists of 7 pages and a periodic table.

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INSTRUCTIONS AND INFORMATION TO CANDIDATES

1. Write your name on the **ANSWER BOOK.**
2. This question paper consists of FIVE questions. Answer ALL the questions in the ANSWER BOOK.
3. Start EACH question on a NEW page in the ANSWER BOOK.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Leave ONE line between two subsections, for example between QUESTION 2.1 and QUESTION 2.2.
6. You may use a non-programmable calculator.
7. You may use appropriate mathematical instruments.
8. You are advised to use the attached PERIODIC TABLE.
9. Show ALL formulae and substitutions in ALL calculations.
10. Round off your final numerical answers to a minimum of TWO decimal places.
11. Give brief motivations, discussions, et cetera where required.

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QUESTION 1 (start on a new page)

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (1.1 – 1.5) in the ANSWER BOOK, for example 1.6 D.

1.1 Which ONE of the following combinations represents INTERMOLECULAR forces ONLY?

A Ionic bonding and Covalent bonding
B Covalent bonding and London forces
C Hydrogen bonding and London forces
D Dipole-dipole forces and Covalent bonding (2)

1.2 An example of a NON-POLAR molecule with POLAR COVALENT bonds is:

A $PC\ell_3$
B $CC\ell_4$
C $HC\ell$
D H_2O (2)

1.3 For which ONE of the following pairs do the molecules have the SAME MOLECULAR shape?

A BeF_2 and CO_2
B H_2O and CO_2
C BF_3 and $CC\ell_4$
D $BeC\ell_2$ and H_2O (2)

1.4 In which ONE of the following compounds is the bonding ionic?

A $CC\ell_4$
B $C\ell_2$
C $HC\ell$
D $KC\ell$ (2)

1.5 Which of the statements below is/are TRUE for the WATER molecule?

(i) Hydrogen bonding occurs between O and H atoms to form H_2O molecules.
(ii) Hydrogen bonding occurs between H_2O molecules.
(ii) Covalent bonding occurs between O and H atoms to form H_2O molecules.

A (i) only
B (i) and (ii) only
C (i) and (iii) only
D (ii) and (iii) only (2)

[10]

QUESTION 2 (start on a new page)

2.1 Define the following terms:

2.1.1 Covalent bond (1)

2.1.2 Molecule (1)

2.1.3 Lone pair (2)

Consider the following substances:

NaCℓ O_2 CO_2 H_2O H_2 NH_3 N_2 CO

Answer the following questions based on the above.

2.2 Draw Lewis diagrams for the following:

2.2.1 Carbon dioxide (2)

2.2.2 Ammonia (2)

2.3 Consider the central atom of the ammonia molecule. How many

2.3.1 lone pairs of electrons are there on this central atom? (1)

2.3.2 bonded pairs of electrons are there on this central atom? (1)

2.4 Name the type of chemical bond that exists in each of the following compounds:

2.4.1 N_2 (1)

2.4.2 CO_2 (1)

2.5 Name TWO substances from the list above that can form dative covalent bonds. (2)

2.6 Write down the NAME AND FORMULA of the ion that forms as a result of the dative covalent bonds for each of the substances mentioned in QUESTION 2.5 above. (4)

2.7 Write down the number of valence electrons present in an atom of nitrogen. (1)

2.8 CO and CO_2 are molecules that have only C – O bonds, and are both linear in shape.

2.8.1 Define the term *electronegativity*. (2)

2.8.2 Calculate the difference in electronegativity (ΔEN) for the C – O bond. (2)

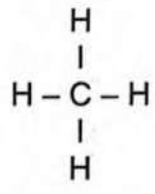
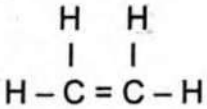
2.8.3 Explain why CO is a POLAR molecule, while CO_2 is NON-POLAR molecule (4)

[27]

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QUESTION 3 (start on a new page)

Study the table below and answer the questions that follow.

	Bonded atoms	Bond length (pm)	Bond energy ($kJ.mol^{-1}$)	Example of carbon compound
A	C – C	154	347	 Methane
B	C = C	134	614	 Ethene
C	C ≡ C	121	839	H – C ≡ C – H Acetylene/Ethyne

3.1 Define the term *bond order.* (2)

3.2 What is the bond order of **B** in the table? (1)

3.3 What is the relationship between:

3.3.1 bond order and bond length (1)

3.3.2 bond length and bond energy (1)

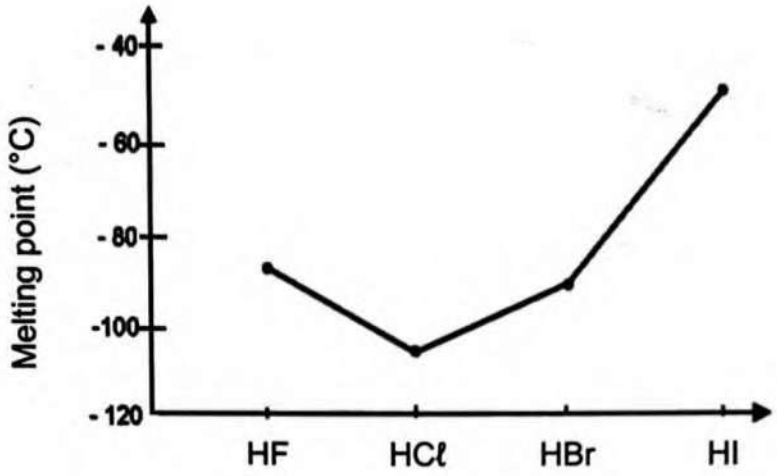
3.4 Acetylene (C_2H_2) is the world's most efficient and hottest burning welding gas. Use the table above to calculate the amount of energy needed to break all the bonds in 1 mol of C_2H_2, if the energy for a C – H bond is 437 $kJ.mol^{-1}$. (3)

[8]

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QUESTION 4 (start on a new page)

4.1 The melting points of four hydrogen halides are represented in the graph below.



4.1.1 Explain the meaning of the term *intermolecular force.* (2)

4.1.2 Define the term *melting point*. (2)

4.1.3 Provide a label for the x-axis on the graph. (1)

4.1.4 Identify the type of intermolecular forces present in HBr. (1)

4.1.5 Fully explain the difference in melting points between:

a) HF and HCℓ (4)

b) HI and HCℓ (4)

4.1.6 NAME the compound that will need the most amount of energy to melt. (1)

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4.2 The boiling points of three liquids are given below:

Compound	Boiling point
CH_4	-161
CH_3OH	65
H_2O	100

4.2.1 Define the term *boiling point*. (2)

4.2.2 Explain the difference in the boiling points of the above three compounds. (5)

4.2.3 NAME the molecule that will have the highest vapour pressure. Provide a reason for the answer. (2)

[24]

QUESTION 5 (start on a new page)

5.1 Define the term *solubility*. (2)

5.2 Iodine (I_2) is soluble in carbon tetrachloride ($CC\ell_4$), but is insoluble in water (H_2O). Fully account for this observation in terms of the forces between the particles. (4)

[6]

TOTAL MARKS: 75

TABLE 3: THE PERIODIC TABLE OF ELEMENTS

1 (I)	2 (II)	3	4	5	6	7	8	9	10	11	12	13 (III)	14 (IV)	15 (V)	16 (VI)	17 (VII)	18 (VIII)
2,1 H 1																	2 He 4
1,0 Li 7	1,5 Be 9											2,0 B 11	2,5 C 12	3,0 N 14	3,5 O 16	4,0 F 19	10 Ne 20
0,9 Na 23	1,2 Mg 24											1,5 Aℓ 27	1,8 Si 28	2,1 P 31	2,5 S 32	3,0 Cℓ 35,5	18 Ar 40
0,8 K 39	1,0 Ca 40	1,3 Sc 45	1,5 Ti 48	1,6 V 51	1,6 Cr 52	1,5 Mn 55	1,8 Fe 56	1,8 Co 59	1,8 Ni 59	1,9 Cu 63,5	1,6 Zn 65	1,6 Ga 70	1,8 Ge 73	2,0 As 75	2,4 Se 79	2,8 Br 80	36 Kr 84
0,8 Rb 86	1,0 Sr 88	1,2 Y 89	1,4 Zr 91	41 Nb 92	1,8 Mo 96	1,9 Tc	2,2 Ru 101	2,2 Rh 103	2,2 Pd 106	1,9 Ag 108	1,7 Cd 112	1,7 In 115	1,8 Sn 119	1,9 Sb 122	2,1 Te 128	2,5 I 127	54 Xe 131
0,7 Cs 133	0,9 Ba 137	57 La 139	1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	1,8 Tℓ 204	1,8 Pb 207	1,9 Bi 209	2,0 Po	2,5 At	86 Rn
0,7 Fr	0,9 Ra 226	89 Ac															

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce 140	Pr 141	Nd 144	Pm	Sm 150	Eu 152	Gd 157	Tb 159	Dy 163	Ho 165	Er 167	Tm 169	Yb 173	Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

KEY/*SLEUTEL*

Atomic number
Atoomgetal

Electronegativity
Elektronegatiwiteit

Symbol
Simbool

Approximate relative atomic mass
Benaderde relatiewe atoommassa

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MARKING GUIDELINES

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This marking guideline consist of 5 pages.

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QUESTION ONE

1.1 C ✓✓ (2)

1.2 B ✓✓ (2)

1.3 A ✓✓ (2)

1.4 D ✓✓ (2)

1.5 D ✓✓ (2)

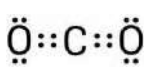
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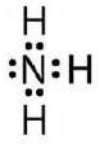
QUESTION TWO

2.1.1 The bond formed when two atome share electrons (when orbitals overlap). ✓ (1)

2.1.2 A group of two or more atoms that are covalently bonded and that function as a unit. ✓ (1)

2.1.3 A pair of electrons in the valence shell of an atom that is not shared with another atom. ✓✓ (2)

2.2.1  ✓✓ (2)

2.2.2  ✓✓ (2)

2.3.1 one✓ (1)

2.3.2 three✓ (1)

2.4.1 Covalent ✓ (1)

2.4.2 Covalent.✓ (1)

2.5 H_2O ✓ and NH_3 ✓ (2)

2.6 Hydronium ion✓ - H_3O^+ ✓
Ammonium ion✓ - NH_4^+ ✓ (4)

2.7 Five ✓ (1)

2.8.1 A measure of the tendancy of an atom in a molecule to attract bonding electrons / shared pairs of electrons. ✓✓ (2)

2.8.2 ΔEN_{C-O} = 3,5 – 2,5 ✓
= 1,0 ✓ (2)

2.8.3 CO is linear with O being more electronegative, ✓ therefore forming a slightly negative end / The charge distribution in CO is asymmetrical. ✓ thus is a polar molecule.
CO_2 molecule is also linear with a central C atom✓ so that the O atoms on either side have the same polarity /The charge distribution is symmetrical ✓ thus is a non-polar molecule. (4)

[27]

QUESTION 3

3.1 Is the number of bonds (single,double or triple) that exist between two atoms.✓✓ (2)

3.2 2✓ (1)

3.3.1 As bond order increases, bond length decreases. ✓ (1)

3.3.2 As bond length increases bond energy decreases. ✓ (1)

3.4 Amount of energy = 1 x 839✓ + 2 x 437 ✓
= 1713 $kJ.mol^{-1}$ ✓ (3)

[8]

QUESTION 4

4.1.1 Forces of attraction between molecules. ✓✓ (2)

4.1.2 The temperature at which the solid and liquid phases of a substance are in equilibrium✓✓ (NOTE: The word temperature must be mentioned) (2)

4.1.3 Hydrogen halides✓ (1)

4.1.4 Dipole-dipole forces ✓ (No marks for *Van Der Waal Forces*) (1)

4.1.5
a) HCℓ has dipole-dipole forces (which are weak). ✓
HF (has weak dipole-dipole forces but also) has strong Hydrogen bonds. ✓
Since intermolecular forces are stronger between molecules of HF✓, more energy is needed to overcome the intermolecular forces between HF molecules.✓
Thus HF will have a higher melting point that HCℓ. (4)

4.1.5
b) HCℓ and HI both have (weak) dipole-dipole forces, ✓ however HI has a greater molecular mass/size (than HCI), ✓ hence stronger intermolecular forces. ✓
Thus more energy is needed to overcome the intermolecular forces/ dipole-dipole forces between molecules of HI (than HCℓ). ✓
Thus HI will have a higher melting point. (4)

4.1.6 Hydrogen iodide✓ (Do not accept HI) (1)

4.2.1 The temperature at which the vapour pressure of a liquid equals atmospheric pressure. ✓✓(NOTE: The word temperature must be mentioned) (2)

4.2.2 **MARKING CRITERIA:**

Compare boiling points of CH_4 and CH_3OH:

- Identify type of IMFs in CH_4 and CH_3OH.✓
- Compare strength of IMF in CH_4 and CH_3OH✓
- Refer to the energy required

Compare boiling points of H_2O and CH_3OH:

- Compare number of sites for hydrogen bonding for molecules of H_2O and molecules of CH_3OH. ✓
- Compare strength of Hydrogen bonding in molecules of H_2O and CH_3OH✓
- Refer to the energy required

Any one✓

Methane/CH_4- has weak London forces/dispersion forces between molecules while methanol/CH_3OH has (weak London forces and) strong hydrogen bonds. ✓
Therefore, intermolecular forces are stronger between molecules of methanol /CH_3OH✓(than between molecules of methane/CH_4).
More energy needed to overcome intermolecular forces between molecules of methanol/CH_3OH✓ (than between molecules of methane/CH_4).
Thus methanol has a higher boiling point than methane.

Molecules of water/H_2O have more (two/four/multiple) sites for hydrogen bonding than molecules of CH_3OH.✓
Thus, molecules of water have stronger / the strongest intermolecular forces, ✓ thus the highest boiling point. (5)

4.2.3 Methane. ✓ It has the lowest boiling point. ✓ (2)

[24]

QUESTION 5

5.1 The property of a solid, liquid or gaseous chemical substance(solute) to dissolve in a solid, liquid or gaseous solvent to form a homogenous solution. ✓✓ (2)

5.2 Bonds between iodine molecules and carbon tetrachloride molecules are weak London forces. ✓ These intermolecular forces are of comparable strength / Non-polar solute will dissolve in a non-polar solvent.✓

Between water molecules are hydrogen bonds✓ that are much stronger than London forces✓

(4)

(NB: “Like dissolves like” is NOT an explanation. Hence NO marks awarded)

[6]

TOTAL MARKS: 75