

CHEMISTRY

ATAR Year 11

Multiple choice answers:

1. d	6. c	11. b	16. c
2. c	7. d	12. d	17. d
3. a	8. b	13. d	18. b
4. d	9. c	14. a	19. c
5. c	10. a	15. b	20. a

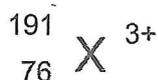
Section One: Multiple-choice

25% (40 Marks)

This section has 20 questions. Answer all questions on the separate Multiple-choice Answer Sheet Provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through that square, do not erase or use correction fluid, and shade your new answer. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question

Suggested working time: 40 minutes

1. Consider the ion below



Which one of the following lists the number of protons, neutrons and electrons for this ion correctly?

	Protons	neutrons	electrons
(a)	191	115	73
(b)	115	76	79
(c)	73	115	76
(d)	76	115	73



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Section Two: Short answer 45% (70 Marks)

This section has eleven (11) questions. Answer all questions. Write your answers in the spaces provided.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
- Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time: 60 minutes

Question 21**(7 marks)**

The table below shows the atomic structure of six particles, represented by the letters A-F. The letters are not the symbols of the elements.

Particle	Protons	Neutrons	Electrons
A	1	1	1
B	8	9	8
C	12	12	10
D	14	14	14
E	1	2	1
F	13	14	10

- (a) Which particle has a mass number of 28? D
- (b) Which two particles are positive ions? F and C
- (c) Which particle is in period 2 in the periodic table? B
- (d) Which two particles are isotopes of the same element? A and E
- (e) Which particle has an atomic number of 13? F
- (f) Which particle is in group 2? C
- (g) Which particle has similar chemical properties to Ca? C



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Question 22

(7 marks)

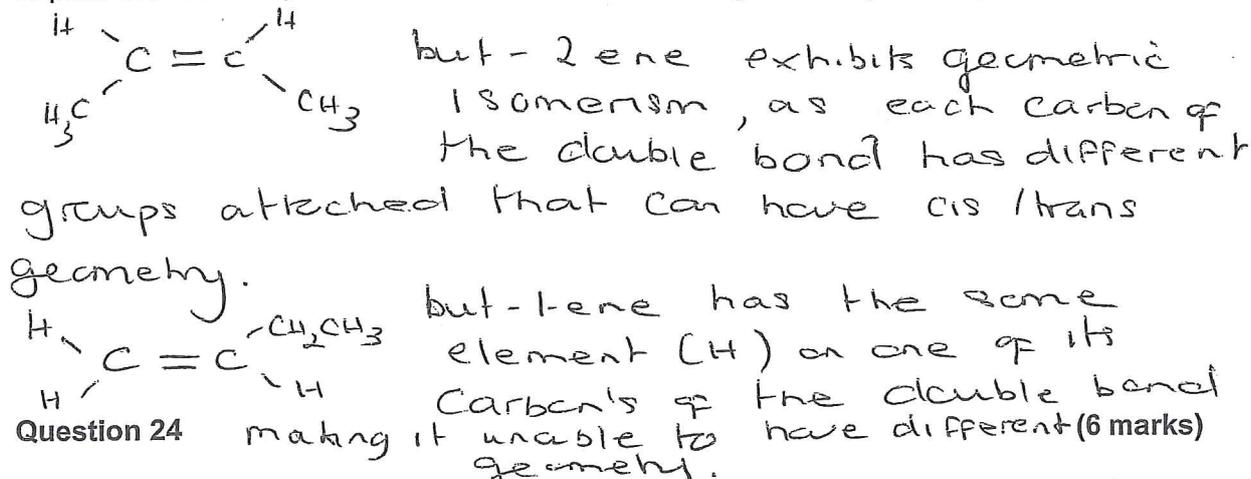
Complete the table below by naming or writing the chemical formulae of each substance.

Name	Formula
Rubidium dichromate	$Rb_2Cr_2O_7$
Cobalt dihydrogenphosphate	$CoHPO_4$
Dichlorine heptaoxide	Cl_2O_7
Silicon tetra phosphide	SiP_4
Ammonium oxalate	$(NH_4)_2C_2O_4$
Iron (III) Sulfite	$Fe_2(SO_3)_3$
Barium ethanoate	$Ba(CH_3COO)_2$

Question 23

(2 marks)

Explain which isomer, but-1-ene or but-2-ene can exhibit geometric (cis/trans) isomerism.



Question 24

(6 marks)

Pure substances can be separated from mixtures by using physical separation methods.

Separation is possible due to substances having different properties. Complete the table below by naming the technique for each example and the property that allows this method to work.

Substance to be recovered from mixture	Separation technique	Property making it possible
Sand from water	Filtration	Sand is insoluble in water
Water from a salt solution	distillation	different boiling points
Chlorophyll from plant pigment	Chromatography	differing solubilities in solvent phase

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Question 25

(12 marks)

(a) State the meaning of the term isotope.

(2 marks)

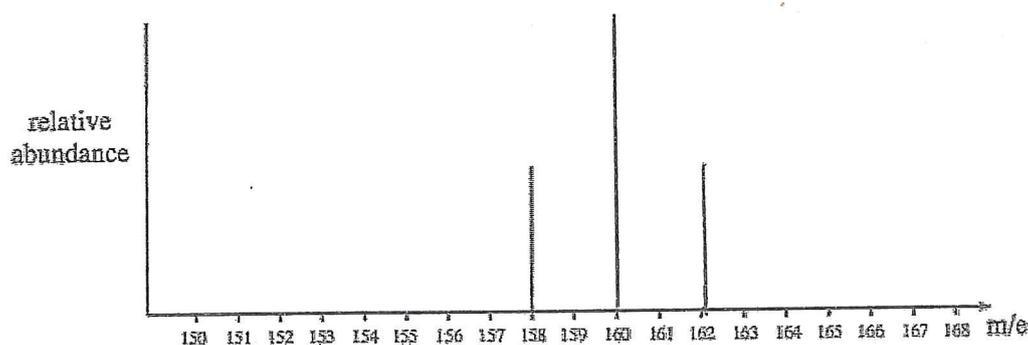
Atoms of the same element, with the same number of protons, but different number of neutrons (same atomic number, different mass number)

(b) Explain why isotopes have different physical properties but identical chemical properties.

(2 marks)

Identical chemical properties - same electron arrangement hence valence electrons. \therefore similar reactivity. Different physical properties - different masses. \therefore density etc

Bromine that has been vaporised contains the isotopes ^{79}Br and ^{81}Br in almost equal proportions. Part of the mass spectrum of the molecular ions Br_2^+ is shown below.

(c) Complete the diagram to show the full spectrum of the molecular ions Br_2^+ . (2 marks)

(d) Explain the number of peaks present in your diagram.

(2 marks)

3 possible combinations, \therefore 3 peaks.

$^{79}\text{Br} - ^{79}\text{Br}$ peak at 158

$^{79}\text{Br} - ^{81}\text{Br}$ peak at 160

$^{81}\text{Br} - ^{81}\text{Br}$ peak at 162

(e) Explain the ratio of the heights of the peaks in your diagram.

(1 mark)

For each Br_2 molecule, there is 50% chance that 2nd atom is the same isotope and 50% chance it is the other. hence there will be twice as many molecules of mass 160 compared to 158, 162.



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A sample of iron was analysed in a mass spectrometer. Four peaks with mass/charge (m/z) values were observed and are shown in the table below:

Relative abundance (%)	5.8	91.6	2.2	0.33
m/z	54	56	57	58

- (f) Calculate the relative atomic mass of iron from this data. (2 marks)

$$\text{RAM} = \frac{(54 \times 5.8) + (56 \times 91.6) + (57 \times 2.2) + (58 \times 0.33)}{100}$$

$$= 55.8734$$

- (g) What is used to accelerate the ions in the mass spectrometer? (1 mark)

Electric field

Question 26 (5 marks)

Superphosphate, $\text{Ca}(\text{H}_2\text{PO}_4)_2$ is the main source of phosphorus in agriculture.

- (a) What is the % by mass of phosphorus in this superphosphate? (2 marks)

$$M = 234.052$$

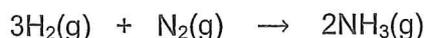
$$\% \text{ P} = \frac{(2 \times 30.97)}{234.052} \times 100 = 26.46\%$$

- (b) What mass of hydrogen is present in 0.650 mol of $\text{Ca}(\text{H}_2\text{PO}_4)_2$? (2 marks)

$$n(\text{H}) = 4n(\text{Ca}(\text{H}_2\text{PO}_4)_2) = 2.60$$

$$m(\text{H}) = nM_{1.008} = 2.62 \text{ g}$$

- (c) Hydrogen reacts with nitrogen to produce ammonia in an industrial process called the Haber process. The reaction is represented as follows:



What volume of ammonia is produced from the reaction of 9.00 L of hydrogen with excess nitrogen if the gases are at the same temperature and pressure? (1 mark)

$$V(\text{NH}_3) = \frac{2}{3} \times V(\text{H}_2) = \frac{2}{3} \times 9 = 6.00 \text{ L}$$

Question 27

(8 marks)

Draw the electron dot diagrams (Lewis structures) of the compounds below.

All valence shell electron pairs should be represented as : or —

<p>N_2O (i.e. NNO)</p> $ N \equiv N - \bar{O} $ <p>or</p> $ \bar{N} = N = \bar{O} $	<p>Potassium sulfate</p> $[K]^+_2 \left[\begin{array}{c} \text{O} \\ \text{O} \\ \text{O} \\ \text{O} \\ \text{S} \\ \text{O} \\ \text{O} \end{array} \right]^{2-}$
<p>Magnesium phosphide</p> $[Mg]^{2+}_3 \left[\begin{array}{c} \text{O} \\ \text{O} \\ \text{O} \\ \text{O} \\ \text{P} \\ \text{O} \\ \text{O} \end{array} \right]^{3-}_2$	<p>CO_2</p> $:\text{O} = \text{C} = \text{O}:$

Question 28

(8 marks)

Explain each of the following:

- (a) When most of the air is removed from inside a thin-walled metal can (by a vacuum pump), the can begins to crush (collapses inwards).

Originally, Internal pressure = external pressure (2 marks)
 \therefore Can holds its shape

When air is removed, number of particles decreases and internal pressure drops
 external pressure pushes on walls of can and it caves in

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- (b) The strongest covalent bond of all is the triple bond in nitrogen N_2 , hence its stability, yet liquid nitrogen boils at -196 C

N_2 is covalent molecules
 $| N \equiv \bar{N} |$, takes a lot of (3 marks)
 energy to break the strong triple covalent bond \therefore it is not very reactive
 Boiling does not involve breaking the covalent bonds.
 Weak intermolecular forces need to be overcome which takes a lot less energy \therefore its low B.p.

- (c) Diamond is one of the hardest substances known; yet graphite, another allotrope of carbon, is soft and a good lubricating agent.

Both are covalent network (3 marks)
 structures.

In diamond, carbons are bonded to 4 others by strong covalent bonds. These extend throughout a huge 3D network and take vast amount of energy to break hence it is extremely hard.

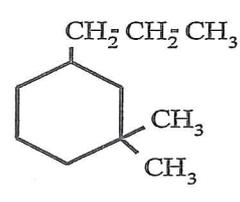
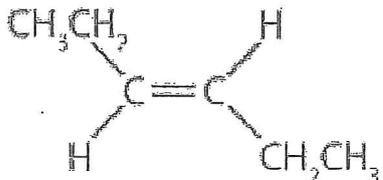
Graphite is a 2D structure of hexagonal layers of carbon atoms bonded to 3 others.

Weak intermolecular forces exist between the layers, allowing them to slide over one another, hence it is soft and slippery.

Question 29

(5 marks)

Draw the structural formula or name the following compounds.

Name	Structural Formula
tetramethylbutane	$ \begin{array}{c} \text{CH}_3 \quad \text{CH}_3 \\ \quad \\ \text{CH}_3 - \text{C} - \text{C} - \text{CH}_3 \\ \quad \\ \text{CH}_3 \quad \text{CH}_3 \end{array} $
1,1-dimethyl-3-propyl Cyclohexane	
5,5-diethyl-3-methyloct-3-ene	$ \begin{array}{c} \text{CH}_2\text{CH}_3 \\ \\ \text{CH}_3 - \text{CH}_2 - \text{C} = \text{CH} - \text{C} - \text{CH}_2 - \text{CH}_2 - \text{CH}_3 \\ \quad \\ \text{CH}_3 \quad \text{CH}_2\text{CH}_3 \end{array} $
5-butyl-5,8-diethyl-3- -methyl decane	$ \begin{array}{c} \text{CH}_3 \quad \text{CH}_2\text{CH}_3 \quad \text{CH}_2\text{CH}_3 \\ \quad \quad \\ \text{CH}_3\text{CH}_2\text{CH} \cdot \text{CH}_2 \cdot \text{C} \cdot \text{CH}_2\text{CH}_2\text{CH} \cdot \text{CH}_2\text{CH}_3 \\ \\ \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \end{array} $
trans hex-3-ene	

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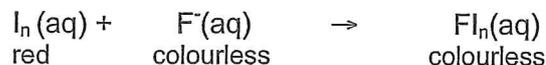


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Question 30

(8 marks)

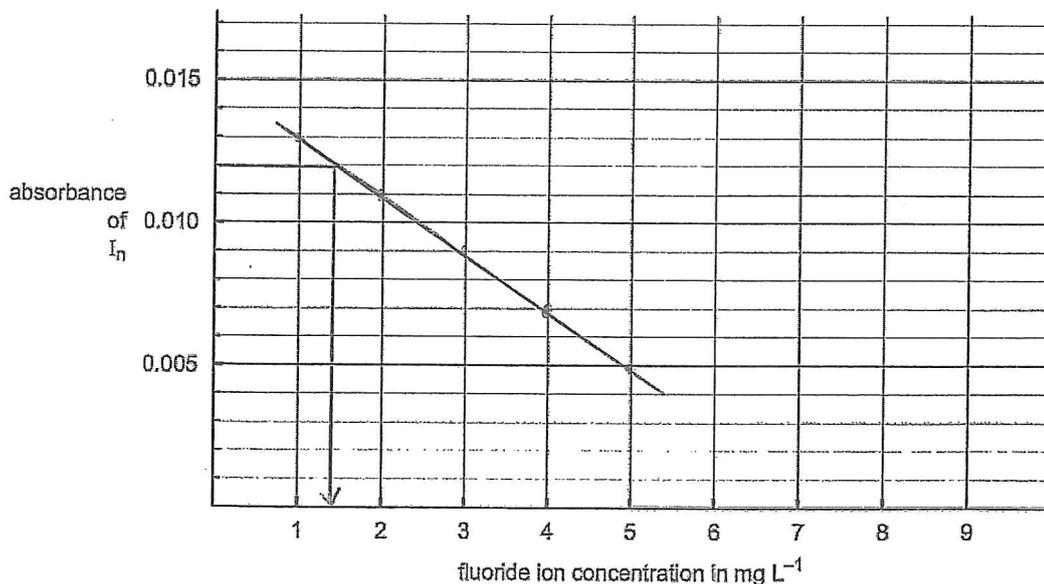
One method of determining the concentration of fluoride ions in tap water uses red- coloured indicator I_n . The indicator reacts with the fluoride ions in water to give a colourless product. The reaction can be represented as:



A calibration curve was prepared using different aqueous solutions of sodium fluoride, each of known fluoride ion concentration. A fixed concentration of the I_n indicator is then added to 25.00mL of each of the five sodium fluoride solutions and the water sample of unknown NaF concentration. The intensity of the red I_n colour of each mixture is then determined using the UV-visible spectrometer. The results are tabulated below:

Fluoride ion concentration in mg/L	Absorbance of I_n
1.00	0.0130
2.00	0.0110
3.00	0.0090
4.00	0.0070
5.00	0.0050
Water sample	0.0120

- (a) Draw a calibration curve of the results in the grid below. (2 marks)



- (b) Using your graph determine the concentration of the sodium fluoride and hence fluoride ion in the water sample. (1 mark)

$$\sim 1.40 \text{ mg L}^{-1}$$

- (c) What is the mass (in grams) of fluoride ions present in a 250mL glass of tap water? (2 marks)

$$1.40 \times 10^{-3} \text{ g L}^{-1}$$

$$1.40 \times 10^{-3} \text{ g in } 1000 \text{ mL}$$

$$\therefore 0.35 \text{ g in } 250 \text{ mL}$$

See next page

There are not sufficient amounts of sodium fluoride present in our tap water, so it is added to toothpastes as it helps to prevent cavities. Sodium fluoride can be manufactured by the reaction of sodium carbonate and hydrofluoric acid. The reaction is represented as follows:



- (d) If 4.50kg of sodium carbonate is added to excess hydrofluoric acid, what mass of sodium fluoride can be recovered, once it is filtered, washed and dried? (3 marks)

$$n(\text{Na}_2\text{CO}_3) = \frac{m}{M} = \frac{4500}{105.99} = 42.468, \dots$$

$$n(\text{NaF}) = 2n(\text{Na}_2\text{CO}_3) = 84.936, \dots$$

$$m(\text{NaF}) = nM$$

$$= 84.936 \times 41.99$$

$$= 3.57 \times 10^3 \text{ g or } 3.57 \text{ kg}$$

Question 31

(2 marks)

Draw the structural formula of the organic product formed in each reaction described below:

Reaction	Organic product formed
Bromine solution is shaken with cyclohexane in UV light (1:1 ratio)	
Chlorine gas is bubbled through methyl propene	$\begin{array}{c} \text{H} \quad \text{CH}_3 \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{CH}_3 \\ \quad \\ \text{Cl} \quad \text{Cl} \end{array}$ <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 5px auto;"> $\text{CH}_2\text{Cl}-\text{C}(\text{CH}_3)\text{Cl}-\text{CH}_3$ </div>

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End of Section Two



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