

**55th INTERNATIONAL
CHEMISTRY OLYMPIAD
2023**

**UK Round One
STUDENT ANSWER BOOKLET**

In order to print your certificate, we need to store your name, school, and mark in a database: these details are only viewable by your school and the RSC Chemistry Olympiad Working Group.

Your participation in the competition indicates that you are happy for us to do this.

Please PRINT details clearly:

Name

Nationality

Date of birth

School Year (e.g., Year 12, Scottish Higher)

Date paper taken

School use:

Centre number

Question	1	2	3	4	5	Total
Marks Available	7	20	18	21	20	86
Marks Scored						

1.	This question is about rocket fuel		Mark	
(a)			<input type="checkbox"/>	
(b)			<input type="checkbox"/>	
(c)	(i)		<input type="checkbox"/>	
	(ii)		<input type="checkbox"/>	
(d)	(i)		<input type="checkbox"/>	
	(ii)	Oxidation state of H in reactant	Oxidation state of C in reactant	<input type="checkbox"/>
		Oxidation state of H in product	Oxidation state of C in product	
(e)			<input type="checkbox"/>	
<i>Total out of 7</i>			<input type="checkbox"/>	

2.	This question is about electronegativity, bonding and structure	Mark
(a)		<input type="checkbox"/>
(b)		<input type="checkbox"/>
(c)		<input type="checkbox"/>
(d)	(i)	<input type="checkbox"/>
	(ii)	
	(iii)	
	(iv)	
	(v)	
(e)		<input type="checkbox"/>
(f)	(i)	<input type="checkbox"/>
	(ii)	<input type="checkbox"/>
	(iii)	<input type="checkbox"/>

(g)

(i)



(ii)



(h)

(i)



(ii)



(iii)



(iv)

(v)

Total out of 20

3. This question is about amino acid complexes

Mark

(a)

(i)

(ii)



(b)

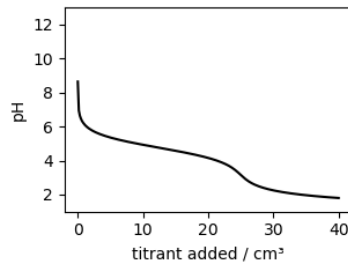
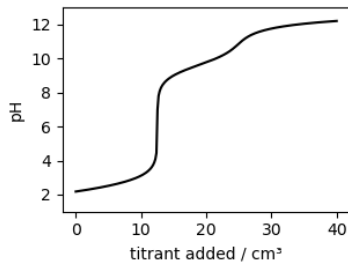
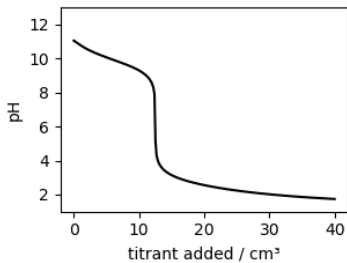
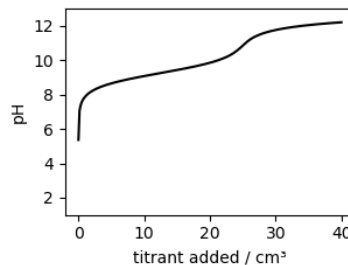
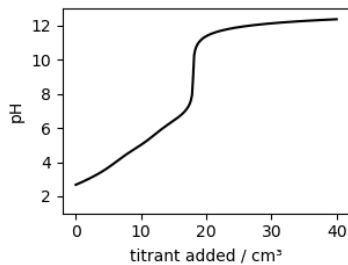
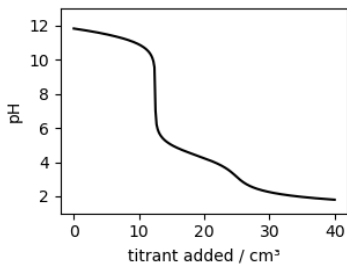
(i)



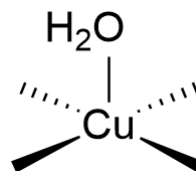
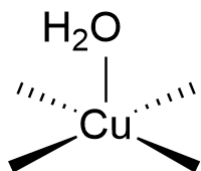
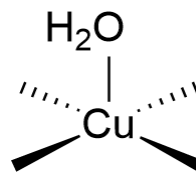
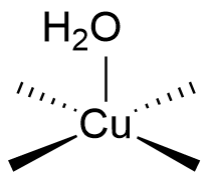
(ii)



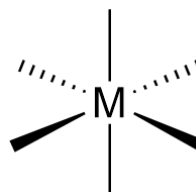
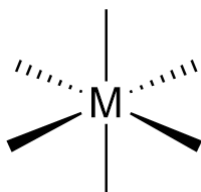
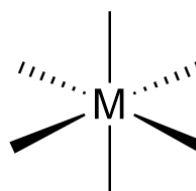
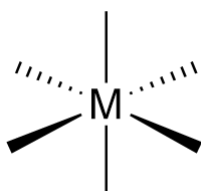
(c)



(d) Draw each stereoisomer only once. If the stereoisomer is chiral, you should only draw one enantiomer. Not all boxes may be required.



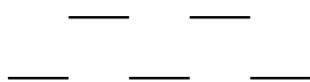
(e) Draw each stereoisomer only once. If the stereoisomer is chiral, you should only draw one enantiomer. Not all boxes may be required.



(f)

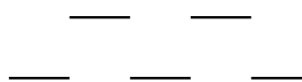


Number of d-electrons in outer shell



Arrangement 1

Spin magnetic moment, μ

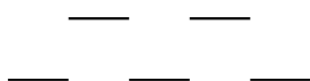


Arrangement 2

Spin magnetic moment, μ

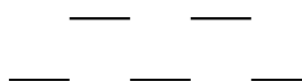


Number of d-electrons in outer shell



Arrangement 1

Spin magnetic moment, μ



Arrangement 2

Spin magnetic moment, μ

(g)

High spin	Low spin

Total out of 18

4. This question is about vaping

Mark

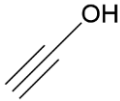
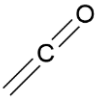
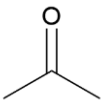

(a)

(i)

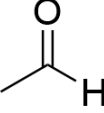
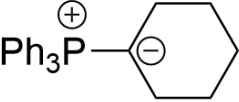
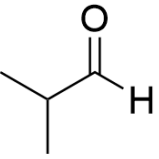
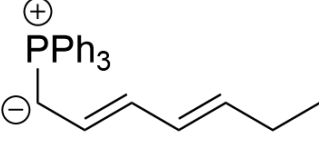
Nitrile	Alcohol	Ester	Ketone	Ether	Carboxylic Acid

(ii)

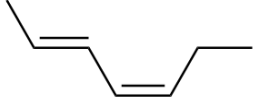
(b)

Structure	Is this structure consistent with the data from...		
	... mass spectrometry?	... ¹ H NMR?	... ¹³ C NMR?
			
			
			
			

(c)

aldehyde/ketone	phosponium ylide	major alkene product
		
		

Continued on next page

aldehyde/ketone	phosphonium ylide	major alkene product
		
OR		



(d)	A	B
	C	D



(e)	carbocation
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(f)	W	X	
	Y	Z	
	<i>Total out of 21</i>		

5.	This question is about cheese						Mark	
(a)	(i)						<input type="checkbox"/>	
	(ii)						<input type="checkbox"/>	
(b)							<input type="checkbox"/>	
(c)	(i)	Oxidation	Reduction	Condensation	Hydrolysis	Isomerisation	Elimination	<input type="checkbox"/>
	(ii)	A			B			<input type="checkbox"/>
(d)							<input type="checkbox"/>	
(e)							<input type="checkbox"/>	
(f)	(i)						<input type="checkbox"/>	

(ii)



(g)



(h)



	$k_H V_{ch} p_b$	$\frac{4\pi r^3 p_b}{3RT}$	$\frac{4\pi r^3 p_b}{3RT} K \cdot 10^{pH}$	$K \cdot 10^{pH} k_H V_{ch} p_b$	$\frac{V_{ch} p_b}{3RT}$	$K \cdot 10^{-pH} k_H V_{ch} p_b$
$n_{CO_2(g)}$						
$n_{CO_2(ch)}$						
$n_{HCO_3^-(ch)}$						

(i)

(i)

Total out of 20