53rd INTERNATIONAL CHEMISTRY OLYMPIAD

2021

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) .....

☐ Paper taken in school ☐ Paper taken at home

School use:

Centre number .....

Question	1	2	3	4	5	6	Total
Marks Available	9	9	16	13	21	17	85
Marks Scored							

1.	This question is about life on Venus		Mark
(a)			
(b)	(i) phosphine	phosphoric acid	
	(ii)		
(c)	(i)		
	(ii)		
	(iii)		
(d)	(i)		
	(ii)		
		Total out of 9	

2.	This question is about capturing carbon	Mark
(a)		
(b)		
(c)		
(d)		
(e)		
(f)		

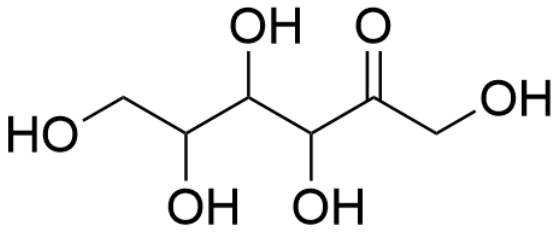
(g)

- ☐ The standard enthalpy change is positive
- ☐ The standard enthalpy change is zero
- ☐ The standard enthalpy change is negative
- ☐ More information is needed to calculate the standard enthalpy change

(h)

- ☐ The entropy change of the universe is positive
- ☐ The entropy change of the universe is negative
- ☐ The entropy change of the universe is zero
- ☐ More information is needed to calculate the entropy change of the universe
- ☐ The entropy change of this direct air capture process is positive
- ☐ The entropy change of this direct air capture process is negative
- ☐ The entropy change of this direct air capture process is zero
- ☐ More information is needed to calculate the entropy change of this direct air capture process

Total out of 9

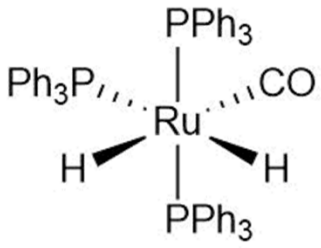
3.	This question is about levulinic acid	Mark
(a)	☐ ester ☐ aldehyde ☐ ketone ☐ acetal ☐ carboxylic acid ☐ alkene ☐ alcohol ☐ hemiacetal	
(b)		
(c)		
(d) (i)	**Alkene A**	
(ii)	**Other trisubstituted alkenes**	

(e) **Compounds C and D**

(f) **Compound F**

(g)

(h)

Catalyst 			
Has enantiomer		Has enantiomer	
Yes	No	Yes	No
Has enantiomer		Has enantiomer	
Yes	No	Yes	No

Not all boxes have to be used.

(i)

- ☐ one singlet
- ☐ one doublet
- ☐ one triplet
- ☐ two singlets
- ☐ two doublets
- ☐ two triplets
- ☐ one doublet and one singlet
- ☐ one triplet and one singlet
- ☐ one triplet and one doublet
- ☐ three singlets
- ☐ three doublets
- ☐ three triplets

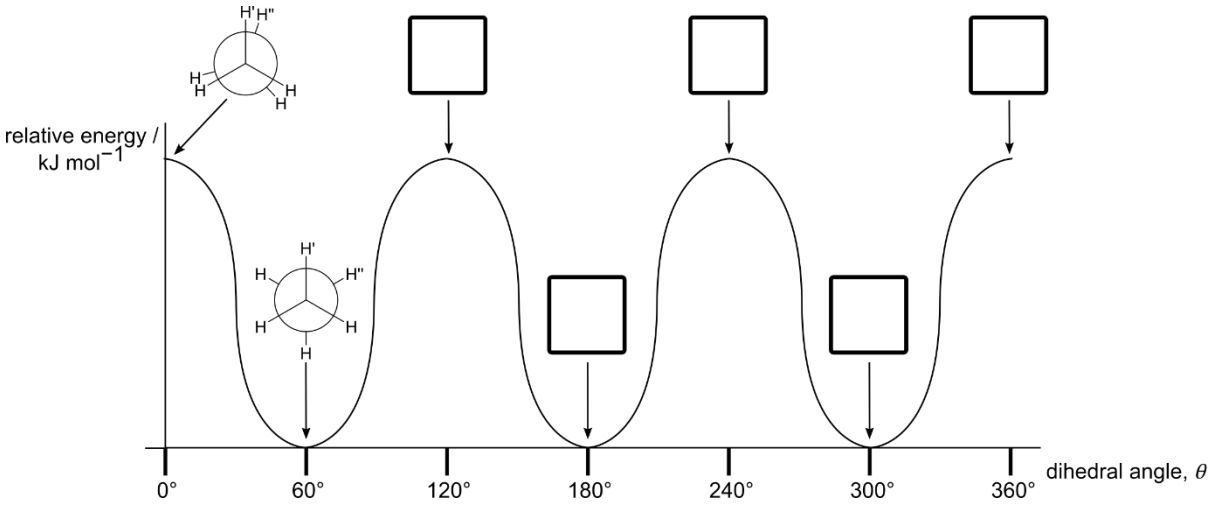
(j)

H^J–H^K	H^K–P^W
H^J–P^W	H^K–P^X
H^J–P^X	H^K–P^Y
H^J–P^Y	

Total out of 16

4.	This question is about 'social distancing' within molecules	Mark

(a)



(b)

A	B	C	D	E	F

(c) (i)

	$G_1 \leftrightharpoons AP$	$AP \leftrightharpoons G_2$	$G_2 \leftrightharpoons G_1$
$\Delta G^{\ominus}$	−3.63 kJ mol^{-1}		
K			

(ii)

(d)

(e)

	W	X	Y	Z	None
7					
8					
9					
10					
11					
12					

Total out of 13

5.	This question is about Donald Trump and the coronavirus	Mark
(a)		
(b)	**B** / **C**	
(c)	☐ Br_2 / UV light ☐ $KMnO_4$ ☐ H_2 / Ni catalyst ☐ acidified $K_2Cr_2O_7$ ☐ OsO_4 ☐ ethylamine ☐ O_2 / UV light ☐ H_2SO_4 catalyst	
(d)	**D** / **E** **F**	
(e)	**Anion V^-**	

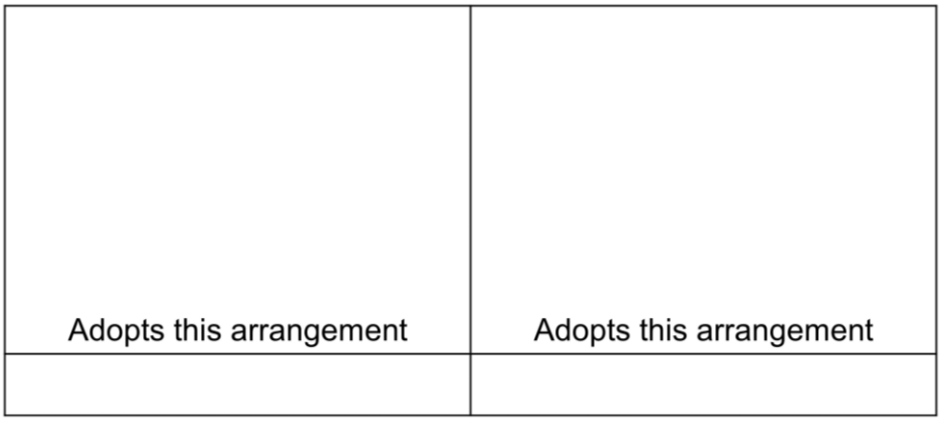
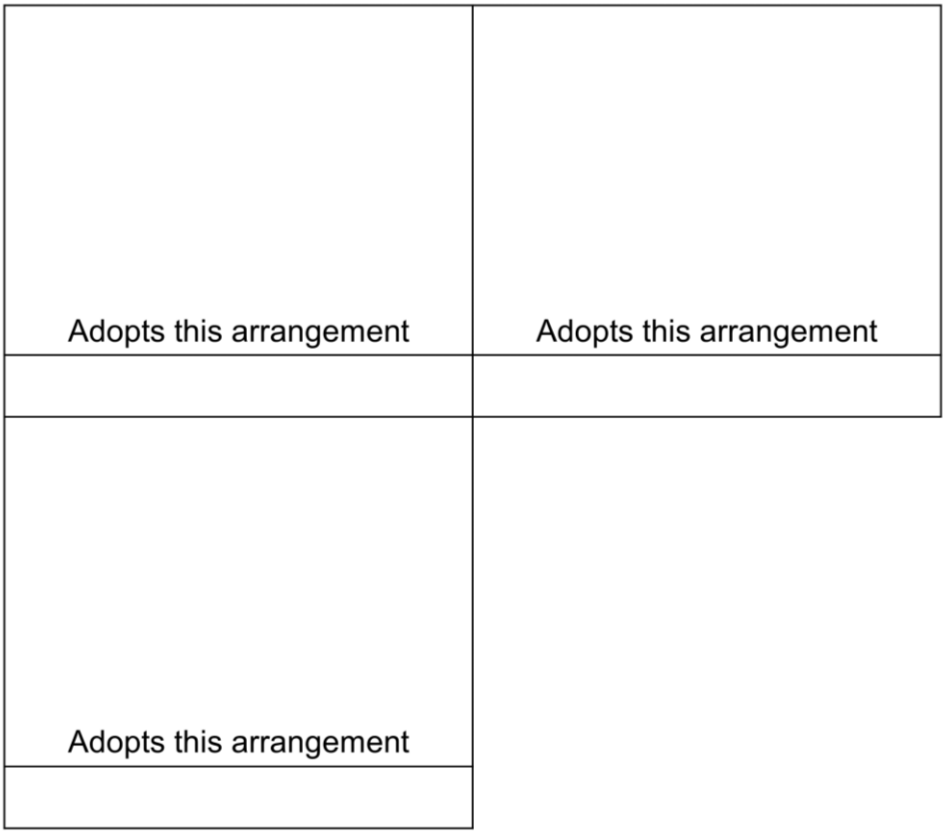
	Cation W^+		
	Cation X^+		
	Intermediate Y	**Reagent Z**	
(f)	**G**		

H

I

J

Total out of 21

6.	This question is about fluorides of xenon	Mark
(a)		
(b)		
(c)		
(d)		

(e)		☐
(f)		☐
(g)		☐ ☐ ☐
(h)		☐ ☐ ☐

(i)

Total out of 17