

# Theory



54<sup>th</sup> IChO 2022  
International Chemistry Olympiad  
TAINAN, CHINA

# A1-1

English (Official)

## Rapid and Visual Nucleic Acid Testing for COVID-19

9% of the total						
Question	1.1	1.2	1.3	1.4	1.5	Total
Points	1	1	4	4	4	<b>14</b>
Score						

**1.1** (1.0 pt)

[ ] (a)      [ ] (b)      [ ] (c)      [ ] (d)      [ ] (e)      [ ] (f)

**1.2** (1.0 pt)

[ ] (a)      [ ] (b)      [ ] (c)

**1.3** (4.0 pt)

$N =$  \_\_\_\_\_

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# A1-2

English (Official)

1.4 (4.0 pt)

$\epsilon =$  \_\_\_\_\_  $\text{L mol}^{-1} \text{cm}^{-1}$

1.5 (4.0 pt)

$C_X =$  \_\_\_\_\_  $\mu\text{g mL}^{-1}$

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# A2-1

English (Official)

## Chromium in Ancient and Modern Times

11% of the total										
Question	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	Total
Points	2	1	6	1	2	1	1	5	2	<b>21</b>
Score										

2.1 (2.0 pt)

A : \_\_\_\_\_ B : \_\_\_\_\_

2.2 (1.0 pt)

2.3 (6.0 pt)

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# A2-2

English (Official)

2.4 (1.0 pt)

2.5 (2.0 pt)

2.6 (1.0 pt)

(A)       (B)       (C)       (D)

2.7 (1.0 pt)

(A)       (B)       (C)       (D)



2.8 (5.0 pt)

CFSE = \_\_\_\_\_  $\text{cm}^{-1}$

2.9 (2.0 pt)

$\mu = \text{_____} \mu_{\text{B}}$

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# A3-1

English (Official)

## Capture and Transformation of Carbon Dioxide

14% of the total													
Question	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10	3.11	3.12	Total
Points	2	5	2	3	2	8	2	2	5	7	2	2	42
Score													

3.1 (2.0 pt)

A: \_\_\_\_\_

B: \_\_\_\_\_

3.2 (5.0 pt)

step 1:

step 2:

step 3:



**3.3** (2.0 pt)

A:

C:

**3.4** (3.0 pt)

**reaction 1:**

**reaction 2:**

**reaction 3:**

**3.5** (2.0 pt)

[ ] (a)

[ ] (b)

[ ] (c)

[ ] (d)

[ ] (e)



3.6 (8.0 pt)

$r(\text{CO}_2) = \text{_____} \text{mmol min}^{-1}$

3.7 (2.0 pt)

3.8 (2.0 pt)



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# A3-4

English (Official)

3.9 (5.0 pt)

$$S = \text{_____} \text{ m}^2$$

3.10 (7.0 pt)

$$R = \text{_____}; V_p = \text{_____} \text{ cm}^3$$

3.11 (2.0 pt)

I: [ ] (a)      [ ] (b)      [ ] (c)      [ ] (d)  
II: [ ] (a)      [ ] (b)      [ ] (c)      [ ] (d)

3.12 (2.0 pt)

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# A4-1

English (Official)

## A New Journey for Ancient Sulfur

16% of the total													
Question	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	4.10	4.11	4.12	Total
Points	2	4	4	3	1	5	2	4	5	4	6	5	<b>45</b>
Score													

**4.1** (2.0 pt)

**4.2** (4.0 pt)

**4.3** (4.0 pt)

\_\_\_\_\_ %

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# A4-2

English (Official)

**4.4** (3.0 pt)

(a)

(b)

**4.5** (1.0 pt)

mass ratio: \_\_\_\_\_

**4.6** (5.0 pt)

\_\_\_\_\_h

# Theory



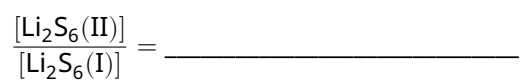
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# A4-3

English (Official)

4.7 (2.0 pt)

4.8 (4.0 pt)





4.9 (5.0 pt)

$$K_{d1}^{\ominus} = \underline{\hspace{10em}}$$

4.10 (4.0 pt)

$$(1) \underline{\hspace{2em}} > (2) \underline{\hspace{2em}} > (3) \underline{\hspace{2em}} > (4) \underline{\hspace{2em}}$$

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# A4-5

English (Official)

**4.11** (6.0 pt)

$$E^{\ominus}(\text{Li}^+(\text{DME})/\text{Li}) = \text{_____} \text{ V}$$

**4.12** (5.0 pt)

$$m(\text{Li}_2\text{S}) = \text{_____} \text{ mg}$$

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# A5-1

English (Official)

## Interconversion among Nitrogen Oxides

15% of the total											
Question	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	5.10	Total
Points	4	4	2	4	3	8	4	6	4	6	45
Score											

5.1 (4.0 pt)

$r_+$  = \_\_\_\_\_

5.2 (4.0 pt)

$A_+$  = \_\_\_\_\_,  $E_{a^+}$  = \_\_\_\_\_

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# A5-2

English (Official)

5.3 (2.0 pt)

$$k_+(700\text{ K}) = \text{_____} \text{ L}^2 \text{ mol}^{-2} \text{ min}^{-1}$$

5.4 (4.0 pt)

$$K_p^\ominus(600\text{ K}) = \text{_____}$$



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# A5-3

English (Official)

5.5 (3.0 pt)

$$\Delta_r U_m^\ominus = \text{_____} \text{ kJ mol}^{-1}$$

5.6 (8.0 pt)

$$r_- = \text{_____}, k_- (600 \text{ K}) = \text{_____}$$

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# A5-4

English (Official)

5.7 (4.0 pt)

$p_{\text{total}} =$  \_\_\_\_\_ kPa



5.8 (6.0 pt)

$\theta_v =$  \_\_\_\_\_

5.9 (4.0 pt)

(A)       (B)       (C)       (D)

5.10 (6.0 pt)

(A)       (B)       (C)

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# A6-1

English (Official)

## Enabling Phosphines

7% of the total								
Question	6.1	6.2	6.3	6.4	6.5	6.6	6.7	Total
Points	3	6	8	5	6	3	5	<b>36</b>
Score								

**6.1** (3.0 pt)

\_\_\_\_\_

**6.2** (6.0 pt)



**6.3** (8.0 pt)

**B'** (4.0 pt)

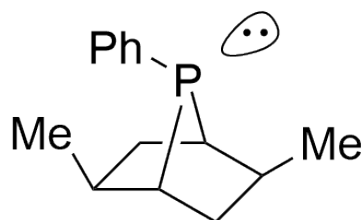
**C'** (4.0 pt)

**6.4** (5.0 pt)

**6**



6.5 (6.0 pt)



P2

6.6 (3.0 pt)

\_\_\_\_\_

6.7 (5.0 pt)

(a)

(b)

(c)

(d)

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# A7-1

English (Official)

## Organic Molecules in Life

9% of the total				
Question	7.1	7.2	7.3	Total
Points	12	8	12	<b>32</b>
Score				

### 7.1 (12.0 pt)

**7 (4.0 pt)**

**9 (4.0 pt)**

**12 (4.0 pt)**

### 7.2 (8.0 pt)

**15 (4.0 pt)**

**16 (4.0 pt)**

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# A7-2

English (Official)

**7.3** (12.0 pt)

**21** (4.0 pt)

**24** (4.0 pt)

**25** (4.0 pt)



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# A8-1

English (Official)

## Amazing Chiral Spiro Catalyst

10% of the total									
Question	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	Total
Points	16	2	2	2	2	8	2	2	36
Score									

### Part A

**8.1** (16.0 pt)

**1**(4.0 pt)

**2**(4.0 pt)

**4**(4.0 pt)

**5**(4.0 pt)

**8.2** (2.0 pt)

(a)

(b)

(c)

(d)

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# A8-2

English (Official)

**8.3** (2.0 pt)

(a)       (b)       (c)       (d)

## Part B

**8.4** (2.0 pt)

\_\_\_\_\_

**8.5** (2.0 pt)

\_\_\_\_\_

**8.6** (8.0 pt)

**15**(4.0 pt)

**16**(4.0 pt)

**8.7** (2.0 pt)

(a)       (b)       (c)       (d)

**8.8** (2.0 pt)

(a)       (b)       (c)       (d)

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# A9-1

English (Official)

## Total Synthesis of Capitulactone

9% of the total					
Question	9.1	9.2	9.3	9.4	Total
Points	24	2	16	2	<b>44</b>
Score					

### 9.1 (24.0 pt)

**3** (4.0 pt)

**4** (4.0 pt)

**5** (4.0 pt)

**8** (4.0 pt)

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# A9-2

English (Official)

## 9.1 (cont.)

9 (4.0 pt)

11(4.0 pt)

## 9.2 (2.0 pt)

(a)

(b)

(c)

(d)

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# A9-3

English (Official)

## 9.3 (16.0 pt)

15 (4.0 pt)

16 (4.0 pt)

18 (4.0 pt)

19 (4.0 pt)

## 9.4 (2.0 pt)

[ ] (a)

[ ] (b)

[ ] (c)

[ ] (d)