香港考試及評核局
HONG KONG EXAMINATIONS AND ASSESSMENT AUTHORITY

2014年香港中學文憑
HONG KONG DIPLOMA OF SECONDARY EDUCATION 2014

CHEMISTRY PAPER 1 & COMBINED SCIENCE (CHEMISTRY) SECTION B

MARKING SCHEME

本評卷參考乃香港考試及評核局專爲今年本科考試而編寫，供閱卷員參考之用。本評卷參考之使用，均受制於閱卷員有關之委任條款及閱卷員指引。特別是：

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3. The following symbols are used:

/	A single slash indicates an acceptable alternative within an answer.
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4. In questions asking for a specified number of reasons or examples etc. and a candidate gives more than the required number, the extra answers should not be marked. For instance, in a question asking candidates to provide two examples, and if a candidate gives three answers, only the first two should be marked.

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6. Award zero marks for answers which are contradictory.

7. Chemical equations should be balanced except those in reaction schemes for organic synthesis. For energetics, the chemical equations given should include the correct state symbols of the chemical species involved.

8. In the question paper, questions which assess candidates' communication skills are marked with an asterisk (*). For these questions, the mark for effective communication (1 mark per question) will be awarded if candidates can produce answers which are easily understandable. No marks for effective communication will be awarded if the answers produced by candidates contain a lot of irrelevant materials and/or wrong concepts in chemistry.

Part I

Marks

1. (a) (i) Layers of graphite are held together by van der Waals' forces / weak intermolecular forces only. 1

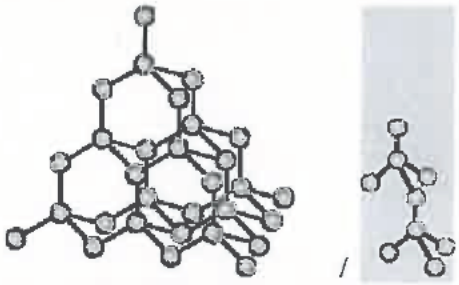
(ii) Yes, graphene has delocalised electrons / electrons in graphene are not localised / mobile electrons / electrons will flow. 1
Not accepted: No, ...
electrons / sea of electrons / free electrons

(iii)  (Accept any symbols of electrons, ignore shape) 1
Not accepted: Showing electrons in the inner shells

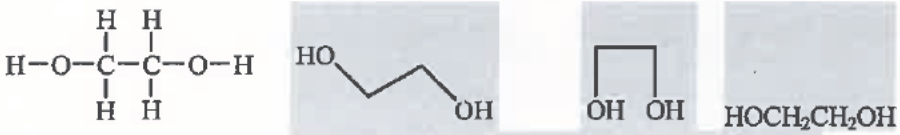
(b) No. Graphene layers are made up of a giant covalent structure. 1
A large amount of energy is needed during melting to destroy the large amount of strong covalent bonds between atoms. (1)
Not accepted: Yes, ...

(c) ● C_{60} has a spherical shape (ball) / and with strong covalent bonds between atoms. 1
● C_{60} has a simple molecular structure. 1
● The van der Waals' forces / attractive forces between C_{60} molecules are of comparable / similar strength as those in organic solvents. 1

For CS:

(c) (i)  1

(ii) Yes, diamond and graphite have the same number of electrons in the outermost shell / same electron arrangement / configuration / structure. (They are allotropes of carbon.) 1
Not accepted: No, ... They are the same element. / They are carbon.

2.  1

(Accept condensed or skeletal structural formula)

It has a small molecular size. / It is a small molecule. / It has a short carbon chain. 1
The hydroxyl groups in it can form hydrogen bonds with water. 1
Not accepted: It has a small size. / It has two hydroxyl groups.

For CS:

2. (a) HOOCCH=CHCOOH / ClOCCH=CHCOCl 1

(b) Water / H_2O / Hydrogen chloride / HCl 1

(c) ● carbon-carbon double bond / C=C / -C=C- / >C=C<. Not accepted: alkene 1
● ester group / –COO– / $–CO_2–$ 1

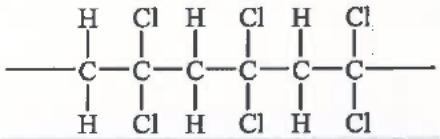
Marks

3. (a) Add in $Br_2(aq)$ or Br_2(organic solvent) / acidified $KMnO_4(aq)$ / neutral or alkaline $KMnO_4(aq)$. 1
Reddish brown or brown or orange $Br_2(aq)$ decolourised or becomes colourless (paler) 1
/ Purple $KMnO_4(aq)$ decolourised or becomes colourless (paler)
/ Purple $KMnO_4(aq)$ becomes brown
Not accepted: yellow $Br_2(aq)$, Br_2, Bromine, $Br_2(g)$, $Br_2(l)$.

(b) (i) † 1,1-dichloroethene 1

(ii) † addition (polymerisation) 1
Not accepted: additional polymerisation

(iii) 1



(Need to show 3 or more repeating units, in the following orders: B—B—B, B—B—B, etc.)

(c) 'Saran' is more heat resistant / has a higher melting temperature / is less soluble in oil 1
because the polar attraction (force) between 'Saran' polymer chains is stronger than that 1
between PE / the molecular sizes of 'Saran' are larger, hence it has a larger dispersion force or van del Waal's forces or intermolecular forces than that in PE.

(d) Incineration of food wrap made from 'Saran' will produce toxic gases / harmful gases / 1
dioxins / hydrogen chloride / HCl / chlorine / Cl_2, while that made from PE will not.
(For CS(c))

For CS(d)
Thermoplastics become soft / deform when heated, 1
and become a solid / solidify / harden when cooled, 1
They decompose / melt at high temperatures. (1)

4. • By heating oxide of silver directly, silver can be obtained, while copper and magnesium cannot be obtained by similar method. 1
• By heating with charcoal / carbon / hydrogen/ carbon monoxide/ town gas, oxide of copper can be reduced to copper, while magnesium cannot be obtained by similar method. 1
• Magnesium can only be obtained by electrolysis of its oxide in molten state. 1
• As more stable is the metal oxide, the more reactive is the metal. So, the order of reactivity is: magnesium > copper > silver 1
• Communication mark (demonstrate the ability to deduce the answer) 1
(chemical knowledge = 0 to 2, communication mark = 0
chemical knowledge = 3 to 4, communication mark = 0 or 1
incomplete answer / difficult to understand, communication mark = 0)

5. (a) Wearing protective gloves or plastic gloves or gown or safety goggles or any suitable PPE / adding concentrated acids into water when diluting the concentrated acids / use a fume cupboard. Not accepted: maintain a good ventilation. 1

(b) No, the strength of an acid is not related to its concentration. / Not all concentrated acids, e.g. ethanoic acid, are strong acids / use a concrete example to illustrate. 1
Not accepted: Yes, ...

(c) Concentrated sulphuric acid reacts with copper to liberate a colourless gas / irritating gas / gas with characteristic smell / black solid (copper(II) oxide). 1

Concentrated nitric acid reacts with copper to liberate a brown gas / bluish-green or blue solution. 1

When concentrated ethanoic acid is added to copper granules, no observable changes occur / no reaction. 1

Not accepted: exothermic / bluish-green or blue solution in concentrated sulphuric acid

†: correct spelling

Marks

6. (a) (i) Components having different boiling points can be separated from each other by fractional distillation. 1
The longer the carbon chain, the higher is the boiling point. 1

(ii) Cracking of heavy oil/heavy hydrocarbons 1

(iii) The enthalpy change when one mole of a compound (/ substance / octane) burns completely under standard conditions/25°C and 1 atm. 1

$C_8H_{18}(l) + \frac{25}{2} O_2(g) \rightarrow 8CO_2(g) + 9H_2O(l)$ (The eq. should have correct state symbols) 1

(b) (i) Catalytic converter (†) 1

(ii) $\Delta H^\ominus = 2(-394) - 2(-110.5) - 2(90.3)$ 2*
(1 mark for correct coefficients, 1 mark for correct signs of the terms)
$= -747.6$ kJ mol^{-1} (the answer should have correct sign and unit) 1

7. (a) Mass of HCl present in 1000 cm^3 of the concentrated acid = 1180 x 36% = 425 g 1*
Formula mass of HCl = 36.5
Concentration = 425 / 36.5 = 11.6 mol dm^{-3} (M) (Accept 11.5 – 11.644, 12, not accept 12.0) 1
(Accept answer without unit) (NOT accept wrong unit)(accept maximum 3 decimal places)

(b) (i) • Weigh accurately the amount of sodium carbonate needed and dissolve it using deionised water / distilled water. (accept using "a known amount of sodium carbonate"; not accept if state "water" only) 1
• Transfer all the solution made to a volumetric flask, add deionised water to the graduation mark of the flask, and mix the content thoroughly. 1

(ii) No. of mole of H^+ present in the diluted acid = 1.06 x (10/1000) x 2 1*
= 0.0212
Concentration of the acid in the bottle = 0.0212 / (20.30/1000) x 10 1*
= 10.4 mol dm^{-3} (M) 1
(Accept answer without unit)(NOT accept wrong unit)
(accept maximum 3 decimal places)

(c) Some HCl escaped / vaporised from the concentrated acid as HCl(g) 1
/ (Concentrated hydrochloric acid is volatile.)

8. (a) (i) The electrode dissolves / becomes smaller / becomes thinner gradually. 1

(ii) (Colourless) bubbles / gas are given out. 1

(b) (i) $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$ 1

(ii) $Ag^+ + e^- \rightarrow Ag$ 1

(c)

electrode W	electrode Z
anode	cathode

1

(d) Electrons would not flow through the electric wires / no observable changes on all electrodes / no reaction occurs because ethanol is not an electrolyte / cannot conduct electricity. 1

†: correct spelling

Marks

9. (a) (i) A blue precipitate is obtained. 1

(ii) $Cu^{2+}(aq) + 2OH^-(aq) \rightarrow Cu(OH)_2(s)$ / $CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$ 1
(State symbols are not required)

(b) (i) Purple acidified potassium permanganate solution is decolourised / turns into colourless / turns into pale pink. 1

(ii) (1) Redox / reduction (of acidified potassium permanganate) / oxidation-reduction (†) 1

(2) $2MnO_4^-(aq) + 5SO_3^{2-}(aq) + 6H^+(aq) \rightarrow 2Mn^{2+}(aq) + 5\ SO_4^{2-}(aq) + 3H_2O(l)$ 1
(State symbols are not required)

Part II

Marks

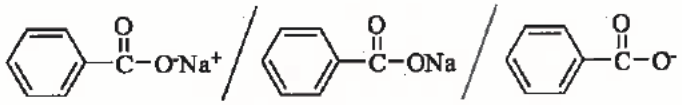
10. • Proper way to follow the progress of the reaction (e.g. measure the volume of CO_2 evolved / measure the loss in mass of the reaction mixture over a certain time interval / measure the pressure of the CO_2 formed in a sealed reaction vessel.) (accept graphical representation) (no communication mark if no description about "time") 1
• Dilute 1M HCl to different concentrations by adding water. 1
• Repeat the experiment with the diluted HCl
• State one requirement for carrying out fair comparison (e.g $CaCO_3$ used should be of the same amount / under same experimental conditions such as same temperature or pressure) 1
• Communication mark 1
(chemical knowledge = 0 to 2, communication mark = 0
chemical knowledge = 3 to 4, communication mark = 0 or 1
incomplete answer / difficult to understand, communication mark = 0)

11. (a) Vanadium exhibits variable oxidation numbers and its ions in aqueous solutions carry colours. 1

(b) (i) 1 (mol of) VO_2^+(aq) ions gains 2 (mol of) electrons from 1 (mol of) SO_2(g) to become 1 (mol of) V^{3+} (aq). 1
V^{3+} (aq) is green in colour. 1

(ii) $SO_2(g) + VO_2^+(aq) \rightarrow SO_4^{2-}(aq) + V^{3+}(aq)$ (State symbols are not required) 1

12. (a) (i) (alkaline) hydrolysis (†) 1

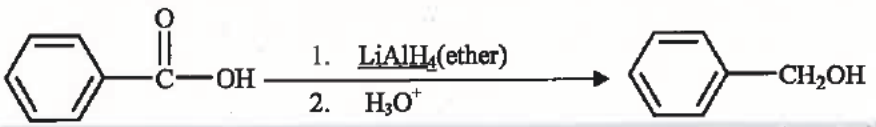
(ii)  1

(iii) HCl(aq) / H_2SO_4(aq) (accept other reasonable strong acids, not accept H^-) 1

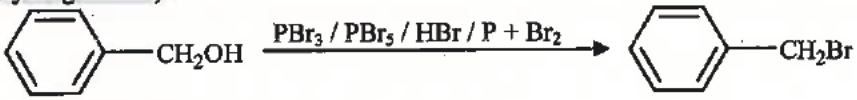
(iv) X (sodium benzoate) is an ionic compound which has strong(er) interactions with water ./ Benzoic acid exists as molecules which has weak(er) intermolecular interactions with water. / 1
X is an ionic compound while benzoic acid exists as molecules.

(v) Filter the mixture to obtain the solid benzoic acid. Wash it with deionised water and then dry in oven. (not accept mixing with drying agents) (not accept evaporation or crystallisation before filtration) 1

(b)



(not accept using $LiAlH_4$ in acidic medium, not accept using $NaBH_4$ and catalytic hydrogenation)



1+1
Correct reagent for each step in the conversion 1
Intermediate ($C_6H_5CH_2OH$)

†: correct spelling

Marks

13. (a) (i)

	$2NO(g)$	+	$O_2(g)$	$\rightleftharpoons$	$2NO_2(g)$
Initial conc.:	1.02/50 = 0.0204		1.29/50 = 0.0258		0
Equil. conc.:	0.0204 x 0.39 = 0.007956		0.0258–0.006222 = 0.019578		0.0204 x 0.61 = 0.012444

1*

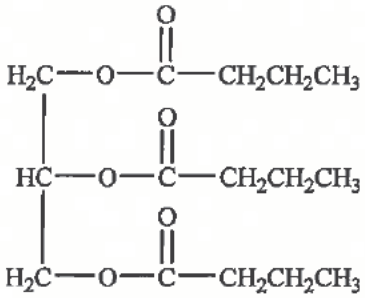
$K_c = \dfrac{(0.012444)^2}{(0.007956)^2(0.019578)}$ / $K_c = \dfrac{[NO_2]^2}{[NO]^2[O_2]}$ 1*

= 125 $dm^3\ mol^{-1}$ (accept 118-125) (answer should have correct unit; not accept M^{-1}) 1
(accept maximum 3 decimal places)

(ii) No change, because K_c is independent of concentration / only depends on temperature. 1

(b) As revealed from the data, when temperature increases, K_c decreases. Therefore the forward reaction is exothermic. / 1
As higher temperature favours endothermic side of reaction, so the forward reaction is exothermic.

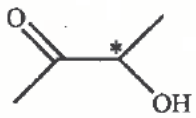
14. (a) 1



- Accept represent $-CH_2CH_2CH_3$ as $-C_3H_7$.
- Accept the answer has 1-2 $-CH_2CH_2CH_3$ carbon chains, while the other carbon chains have different chain lengths and structurally correct

(b) methylpropanoic acid (†) (2-methylpropanoic acid) 1

(c) (i) 1



(ii) Correct chemical reagent 1
Correct observations with comparison between the tests on **Q** and **Z** 1

Possible tests and the corresponding observations:

$Cr_2O_7^{2-}$ / H^+	Observations: **Q** – no change; **Z** – from orange to green
MnO_4^- / H^+	Observations: **Q** – no change; **Z** – from purple to colourless
MnO_4^- / OH^-	Observations: **Q** – no change; **Z** – formation of brown ppt.
2,4-DNP	Observations: **Q** – no change; **Z** – formation of orange ppt.
CH_3CH_2OH / H^+ / heat	Observations: **Q**–fruity smell compound formed; **Z** – no change.
CH_3COOH / H^+ / heat	Observations: **Q**–no change; **Z**–fruity smell compound formed.
CO_3^{2-}	Observations: **Q** – formation of gas (CO_2); **Z** – no change
HCO_3^-	Observations: **Q** – formation of gas (CO_2); **Z** – no change

(also accept other reasonable chemical tests with correct observations stated. E.g. use of suitable acid-base indicators (litmus) or suitable metal (Mg))
(not accept using physical methods or using inappropriate metals (K, Na))
2,4-DNP = 2,4-dinitrophenylhydrazine

(d) (Catalytic) hydrogenation / addition of hydrogen 1

†: correct spelling

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CHEMISTRY PAPER 2

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Marks

1. (a) (i) 'Activation energy' refers to the minimum energy possessed by the colliding reactant particles in order that a reaction can occur. 1

(ii)
- Yeast provides enzyme / catalyst. 1
- At high temperature, the enzyme (yeast) is denatured / destroyed so that it cannot function as a catalyst. 1

(iii) It is to solve the problems of inadequate or shrinking supply of vitamin C. 1

(iv) Any TWO: chlorine, hydrogen, sodium hydroxide , NaOCl, HCl, $NaClO_3$, ClO^-, ClO_3^-, bleaching solution 1

(b) (i) Initial rate is the instantaneous rate at the start of the reaction. OR rate at t = 0 1

(ii)
- Follow the colour intensity of the solution / by colorimetry 1
- The solution changes from colourless to brown/yellow. 1

OR
- Titrate with standard $Na_2S_2O_3$ solution. (1)
- Quenching. Add starch indicator. End point: blue to colourless. (1)

(iii)
- The initial rate is directly proportional to $[BrO_3^-(aq)]$. / The graph is linear / a straight line. / rate $\propto [BrO_3^-]$ 1
- Therefore, the order of reaction with respect to $BrO_3^-(aq) = 1$ 1

(iv) (1) Rate = $k[BrO_3^-][I^-][H^+]^y$
where y is the order of the reaction with respect to H^+

$$\frac{\text{initial rate 1}}{\text{initial rate 2}} = \frac{(0.17)(0.15)}{(0.17)(0.30)}\left(\frac{0.10}{0.20}\right)^y = \frac{2.30\times10^{-3}}{1.84\times10^{-2}}$$ 1*

y = 2 1

Reaction is second order with respect to $H^+(aq)$ (1)
(Accept other explanation.)
When initial $[I^-]$ increases by a factor of 0.30 / 0.15 = 2/doubles and initial $[H^+]$ increases by a factor of 0.20 / 0.10 = 2/doubles while keeping initial $[BrO_3^-]$ constant, the initial rate increases by a factor of $1.84 \times 10^{-2} / 2.30 \times 10^{-3} = 8$. Since the rate of reaction is first order with respect to I^-, the initial rate increased by four times when the initial $[H^+]$ is doubled. (1*)

(2) Rate of consumption of BrO_3^- = 1/3 × rate of formation of I_2
The initial rate with respect to $BrO_3^-(aq)$ in Trial 1
$= -2.30 \times 10^{-3} \times 1/3$
$= -7.67 \times 10^{-4}$ mol dm^{-3} s^{-1} (Accept –7.7, –7.667, –7.6667 but not –7.70) 1

(c) (i) Haber process produces ammonia which can be used to manufacture fertilizers / explosives, etc. (HNO_3, NH_4NO_3 / NO_3^-/ refrigerant) 1

(ii) Natural gas remains the more convenient / cheap way to provide hydrogen as feedstock for production of ammonia in the Haber process. 1

(iii) Provide a larger surface area that makes the catalyst more effective. 1

(iv)
- equilibrium position / yield 1
- reaction rate / effective collisions 1

(v) Any unreacted reactants are reused /recycled and are allowed to react again. 1
Removing ammonia / Liquefying ammonia from the product mixture so as to shift the equilibrium position to the product side /Further H_2 addition. (1)

(vi) As the demand for mining the natural nitrate to produce fertilisers drops drastically, the mining work was no longer profitable /mining work might be closed/a high unemployment rate. (Accept other reasonable answers.) 1

Marks

2. (a) (i) (1)  1

(2)  1

(ii) Any two: 1+1
- With a fairly rigid molecular backbone containing double bonds defining the long axis of the molecule
- many liquid-crystalline materials have benzene rings
- rod-like or disc-like molecules
- polar groups

(iii) Thermoplastics: polyvinyl chloride, polystyrene 1
Thermosetting plastics: urea-methanal

(b) (i) (1) Both of them have giant structures. 1

(2) Silicates are natural materials, while ceramics are synthetic materials. 1

(ii) (1) $Si_2O_5^{2-}$ 1

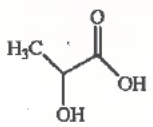
(2)
- Talc: Sheet structure in which the sheets are held together by van der Waals' forces / weak intermolecular forces. 1
- Quartz: Si and O atoms joined by a giant network / strong covalent bonds. 1
- A small amount of energy can make the sheets slip over one another in talc, while a large amount of energy is needed to break the giant network in quartz. 1

(iii) High hardness 1

(c) (i) Blow moulding / Injection moulding 1

(ii)
- low density polyethene (LDPE) and high density polyethene (HDPE) (Accept "polythene", "polyethylene") 1
- As the bottle for cough syrup is hard, HDPE is more suitable. HDPE molecules have a linear structure that pack more closely. 1
  OR
  As the bottle for cough syrup is soft, LDPE is more suitable. LDPE molecules are highly branched that cannot pack closely.

(iii)
- The polar PET molecules are held together by much stronger polar-polar interactions. 1
- The non-polar PE (HDPE) molecules are held together by van der Waal's forces / weak intermolecular forces. 1

(iv) (1)  1

(2) PLA is made from renewable resources, while PE and PET are made from non-renewable petroleum products. 1
OR
PLA is biodegradable, while PE and PET are non-biodegradable.

(3) PLA is made from agricultural products. Massive production of PLA may affect the supply of food. 1

Marks

3. (a) (i) (1)
- Place HCl(g) near NH_3(g/conc). 1
- Dense white fume is observed. 1

OR

Dissolve HCl(g) in deionised water.
- + Na_2CO_3 (s/aq) gives a gas (1)
- + $AgNO_3$/H^+ gives a white ppt (1)

OR
- HCl + Na_2CO_3 (aq) gives a gas (1)
- HCl + $AgNO_3$/H^+ gives a white ppt (1)

(2)
- Add 2,4-dinitrophenylhydrazine. 1
- Yellow/ orange/ red precipitate is formed. 1

(ii) (anhydrous) magnesium sulphate 1

(b) (i) To ensure the reaction go to completion. / To increase the reaction rate. 1

(ii) (1) No more gas is given out. / All solids are dissolved. 1

(2) Brown precipitate formed. 1

(iii) No. of mole of CaC_2O_4 formed in step 6:
2.374 / 128.1 = 0.01853 1*
Mass of $CaCO_3$ in the limestone sample:
0.01853 x 100.1 = 1.855 g 1*
Percentage of $CaCO_3$ by mass in the limestone sample:
1.855 g / 2.025 g = 91.60 (%) [91.3 – 91.9 Accept up to 5 sig. fig. or 91/92] 1

(iv) Gravimetric analysis 1

(c) (i)
- Dissolve the sample in pentane and shake the solution with $NaHCO_3$(aq) in a separating funnel. 1
- Collect the organic layer and carry out fractional distillation / distillation. 1

[Only fractional distillation / distillation: 0 mark]

(ii) • The spectrum does not show strong absorption at about 3230-3670 cm^{-1}, ruling out the presence of a hydroxyl group (the possibility of being an alcohol) 1

The absence of absorption at 2070-2250 cm^{-1} ruled out the presence of C≡C group. (1)

The absence of absorption at 1610 - 1680 cm^{-1} ruled out the presence of C=C group. (1)

• The spectrum has a strong absorption at 1730 (one number from 1700 to 1750) cm^{-1} / (1680 to 1800 cm^{-1}), which corresponds to C=O stretching. The compound may contain an aldehyde group or a ketone group. 1

[Accept without cm^{-1}]
[if write cm^{-1} as cm or /cm^{-1}: deduct 1 mark]

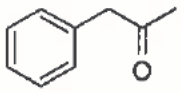
1

- The negative result in Tollens' test ruled out the presence of aldehyde group in the compound. / The compound may contain a ketone group [IR: C= O].

(iii) m/z = 43: $[CH_3CO]^+$ 1

m/z = 134: $[C_7H_7COCH_3]^+$ 或 $[C_6H_5C_2H_5O]^+$ 1

[Accept: ( ); without [ ]; use structures below to represent]
[If not write any numbers (43 and 134), regard the first one to appear as 43.]
[Not accept: $[C_2H_3O]^+$ / $[C_9H_{10}O]^+$.]

(iv)  1

Other possible structures: