SCIENCE TEACHERS ASSOCIATION VICTORIA 2022

TRIAL EXAMINATION

SOLUTIONS BOOK

CHEMISTRY

UNITS 3 & 4

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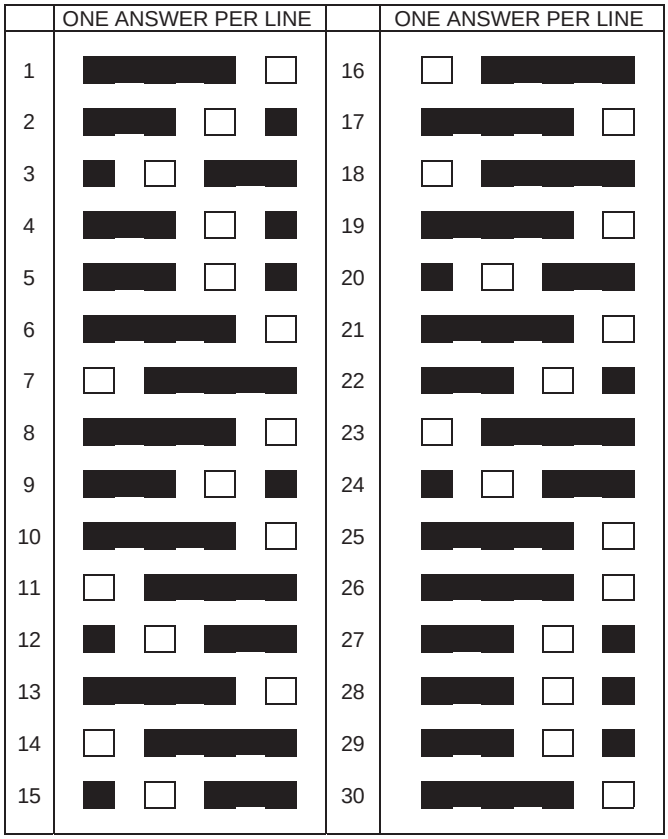
Use this page as an overlay for marking the multiple choice answer sheets. Simply photocopy the page onto an overhead projector sheet. The correct answers are open boxes below. Students should have shaded their answers. Therefore, any open box with shading inside it is correct and scores 1 mark.



SECTION A (Total 30 marks)

1.	**D**	**2.**	**C**	**3.**	**B**	**4.**	**C**	**5.**	**C**
6.	**D**	**7.**	**A**	**8.**	**D**	**9.**	**C**	**10.**	**D**
11.	**A**	**12.**	**B**	**13.**	**D**	**14.**	**A**	**15.**	**B**
16.	**A**	**17.**	**D**	**18.**	**A**	**19.**	**D**	**20.**	**B**
21.	**D**	**22.**	**C**	**23.**	**A**	**24.**	**B**	**25.**	**D**
26.	**D**	**27.**	**C**	**28.**	**C**	**29.**	**B**	**30.**	**D**

Comments for Section A answers.

Question 1
Both pipette and burette are highly accurate pieces of equipment. **Correct answer: D**

Question 2
PV = nRT
$V = \frac{nRT}{P} = \frac{0.0200}{32.0} \times \frac{8.31 \times 300}{107} = 0.0146$ L **Correct Answer: C**

Question 3
At constant temperature and pressure, use volume ratios instead of mole ratios.
From the equation $\frac{V(CO)}{V(CH_4)} = \frac{2}{4}$ $V(CO) = \frac{1}{2} \times V(CH_4) = \frac{1}{2} \times 10.0 = 5.00$ L **Correct Answer: B**

Question 4
1 mol of methane releases 890 kJ (from Data Book)
18.0 g of water as a liquid is converted into 18.0 g of steam
By ratio: $\frac{890}{44} = 20.2$ 20.2×18 g = 364 g **Correct Answer: C**

Question 5
Corrections to options A – D are in bold below:
A. when **6.0 g** of hydrogen reacts, 48 kJ of energy are released
B. reaction of 1.0 mol of carbon dioxide **releases** 48 kJ of energy
C. production of 2.0 mol of methanol would release 96 kJ of energy **Correct Answer: C**
D. formation of 1.0 mol of water vapour releases **48** kJ

Question 6
Calorimeter Constant (CC) = 530 J $°C^{-1}$
Energy released = CC × ΔT = 530 × 4.8 = 2544 J = 2.544 kJ
$n(Cu^{2+}) = c \times V = 0.10 \times 0.100 = 0.010$ mol
For 1.0 mol of Cu^{2+} need $100 \times 2.544 = 2.5 \times 10^2$ kJ released **Correct Answer: D**

Question 7
The carbon dioxide emissions from both petrodiesel and biodiesel are about the same i.e. 73 g MJ^{-1}.
So the combustion is not a valid argument. **Correct Answer: A**
(However, the advantage of biodiesel is that carbon dioxide is absorbed in the growth of the plants used to produce biodiesel.)

Question 8
Temperature rise would be greater as there is less water to heat.
E = CF × ΔT would be higher and this would lead to a higher ΔH. **Correct answer: D**

Question 9
Two Na^+ ions so BeF_4 has an overall −2 charge. Be + 4 × (−1) = −2 so Be = +2.
Correct Answer: C

Question 10
The oxidising agent must be higher placed in the electrochemical series (see Data Book) than the reducing agent, to predict a reaction. Au^+ is such an oxidising agent. **Correct Answer: D**

Question 11
A. This is correct.
B. The copper will have the negative polarity and act as the anode.
C. Electrons flow from the copper to the platinum.
D. Electrons do not move through the salt bridge. **Correct Answer: A**

Question 12
The copper will be oxidised and so it will look corroded. **Correct Answer: B**

Question 13
$n(Ag) = \frac{m}{M} = \frac{1.47}{107.9} = 0.0136$ mol
$n(e^-) = n(Ag) = 0.0136$ mol
At 80 % efficiency, $Q = n(e^-) \times F = 0.0136 \times 96\,500 = 1315$ C
For 100 % efficiency, $Q = 1315 \times \frac{100}{80} = 1644$ C
$Q = I \times t$ $t = \frac{Q}{I} = \frac{1644}{4.00} = 411$ s **Correct Answer: D**

Question 14
Lithium cannot be produced from aqueous solution. Twice as many mole of silver compared with copper will be produced as silver has a 1+ charge and copper has a 2+ charge.
Correct Answer: A

Question 15
B is correct for the aqueous electrolyses as OH^- ions are produced at the cathode. Hence the pH increases. **Correct Answer: B**

Question 16
Need powdered substance with strongest acid and highest temperature. **Correct Answer: A**

Question 17
The size of the constant relates to how much product is formed and not to the rate at which the product is formed. The relatively small value of K_c indicates that not much product is formed.
Correct Answer: D

Question 18
Compound A is 2-methylpentane and Compound B is 2-methylpentan-1-ol **Correct Answer: A**

Question 19
A substitution reaction occurs to produce a secondary alcohol. **Correct Answer: D**

Question 20
There are 5 isomers. These are hexane, 2–methylpentane, 3-methylpentane, 2,2-dimethylbutane and 2,3-dimethylbutane. **Correct Answer: B**

Question 21
The underlined C atom in $CH_3CH_2\underline{C}H(OH)CH_3$ has 4 different groups attached and is therefore chiral. **Correct Answer: D**

Question 22
Glycerol is not a carbohydrate. **Correct Answer: C**

Question 23
M(monomer) = 90.0 g mol^{-1} $500 \times 90.0 - 499 \times 18.0 = 45\,000 - 8982 = 36\,018$
Correct Answer: A

Question 24
Formation of starch and cellulose from glucose are both endothermic. **Correct Answer: B**

Question 25
A and B are saturated. C is monounsaturated. D has two C/C double bonds and is therefore polyunsaturated. **Correct Answer: D**

Question 26
In CH_3CH_2Br, the H of the CH_3 split the CH_2 signal into 4 peaks. The H of the CH_2 split the CH_3 signal into 3 peaks. So 7 peaks in all will be seen. **Correct Answer: D**

Question 27
Because of symmetry, there are only 3 different C environments and 3 different H environments.
Correct Answer: C

Question 28
Masses of the atoms and strength of the covalent bonds both have an effect on the ability to resonate. **Correct Answer: C**

Question 29
Paracetamol is adsorbed less strongly onto the stationary phase than caffeine as it elutes first and consequently has a smaller retention time. **Correct Answer: B**

Question 30
Options A – D would result in:
A. more sodium hydroxide so more fruit juice would be needed
B. dilutes the fruit juice so more would be needed.
C. correct procedure
D. dilutes sodium hydroxide so less fruit juice would be needed.
Correct Answer: D as the volume is lower than the others.

SECTION B (90 marks)

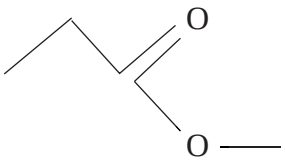
Question 1 (8 marks)

a. **i.** Longest sequence of C atoms is 5. It is a pentane **(1 mark)**
From the right 2, 2, 3, 4 –tetramethylpentane **(1 mark)**

ii. Longest sequence of C atoms is 3. It is a propane **(1 mark)**
dimethylpropane or 2, 2-dimethylpropane **(1 mark)**

b. 5-chloro-4-methylhex-2-ene **(1 mark for hex-2-ene, 1 mark for the rest)**

c.



(1 mark for correct propanoate skeletal structure & 1 mark for correct methyl attachment)

Question 2 (8 marks)

a. $2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$
or
$C_4H_{10}(g) + 6½O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$
(1 mark for correct balance & 1 mark for correct states. Water must be a liquid.)

b. Use ratio of $\frac{\text{energy}}{\text{mole}}$ from the Data Book and second balanced equation:
$\frac{2880}{1.00} = \frac{x}{0.450}$ **(1 mark)** $x = \frac{2880 \times 0.450}{1.00} = 1.30 \times 10^3$ kJ **(1 mark)**

c. Use ratio of $\frac{\text{volume } CO_2 \text{ in L}}{\text{energy}}$ from the Data Book and second balanced equation:
$\frac{4 \times 24.8}{2880} = \frac{y}{100}$ **(1 mark)** $y = \frac{4 \times 24.8 \times 100}{2880} = 3.44$ L **(1 mark)**

d. Use ratio of $\frac{\text{energy}}{\text{mass } H_2O \text{ in g}}$ from the Data Book and second balanced equation:
$\frac{2880}{5 \times 18} = \frac{z}{2.50}$ **(1 mark)** $z = \frac{2880 \times 2.50}{5 \times 18} = 80.0$ kJ **(1 mark)**

Question 3 (8 marks)

a. $E = V \times I \times t = 5.73 \times 0.862 \times 10.0 \times 60$ **(1 mark)** $= 2.964 \times 10^3$ J **(1 mark)**
Calorimeter Constant (CC) $= \frac{E}{\Delta T}$ $\Delta T = \frac{E}{CC}$ **(1 mark)**
$\Delta T = \frac{2964}{750} = 3.95°C$ **(1 mark)**

b. With 200 g of water the CC should be at least 2×418 J $= 836$ J $°C^{-1}$ **(1 mark)**

c. $M(KOH) = 56.1$ g mol^{-1}
$\Delta T = 29.16 - 21.35 = 7.81°C$
By ratio: $\frac{57.6}{56.1} = \frac{x}{6.73}$ $x = \frac{57.6 \times 6.73}{56.1} = 6.91$ kJ $= 6910$ J **(1 mark)**
$CC = \frac{E}{\Delta T} = \frac{6910}{7.81}$ **(1 mark)** $= 885$ J $°C^{-1}$ **(1 mark)**

Question 4 (9 marks)

a. $n(P)_{reacting} = 1.00 - 0.600 = 0.400$ mol **(1 mark)**

$n(Q)_{reacting} = 2 \times n(P)_r = 2 \times 0.400 = 0.800$ mol **(1 mark)**

$n(P)_e = 0.600$ mol

$n(Q)_e = 1.00 - 0.800 = 0.200$ mol **(1 mark)**

$n(R)_e = n(P)_{reacting} = 0.400$ mol $\quad n(S)_e = n(P)_{reacting} = 0.400$ mol **(½ + ½ = 1 mark)**

b. $[P]_e = \frac{n}{V} = \frac{0.600}{2.00} = 0.300$ M $\quad [Q]_e = \frac{n}{V} = \frac{0.200}{2.00} = 0.100$ M **(½ + ½ = 1 mark)**

$[R]_e = \frac{n}{V} = \frac{0.400}{2.00} = 0.200$ M $\quad [S]_e = \frac{n}{V} = \frac{0.400}{2.00} = 0.200$ M **(½ + ½ = 1 mark)**

$K = \frac{[R][S]}{[P][Q]^2}$ **(1 mark)** $= \frac{0.200 \times 0.200}{0.300 \times 0.100^2} = 13.3$ **(1 mark)** M^{-1} **(1 mark)**

Question 5 (9 marks)

a. **i.** temperature increases **(1 mark)**

ii. As T↑, LCP will require a net forward reaction to partially reduce temperature **(1 mark)** as the forward reaction is endothermic **(1 mark)**. Hence $[Cl_2]$ and [CO] both increase and $[COCl_2]$ decreases.

b. **i.** [CO] decreases **(1 mark)**

ii. Net forward reaction to partially counteract the decrease **(1 mark)**, increasing the concentration of Cl_2 and CO and decreasing the concentration of $COCl_2$ **(1 mark)**.

c. **i.** V of the system increases **(1 mark)** as all concentrations decrease simultaneously.

ii. As a result of the decrease in pressure, a net forward reaction occurs **(1 mark)** to produce more particles (1 vs 2) **(1 mark)** and therefore offset the disturbance to partially increase pressure. $[Cl_2]$ and [CO] both increase and $[COCl_2]$ decreases.

Question 6 (4 marks)

compound	number of <u>low</u> resolution ^1H signals	number of ^{13}C signals	
A	3	2	**(½ + ½ = 1 mark)**
B	1	2	**(½ + ½ = 1 mark)**
C	4	4	**(½ + ½ = 1 mark)**
D	3	3	**(½ + ½ = 1 mark)**

Question 7 (7 marks)

a. $CH_3CH_2Cl + NH_3 \rightarrow CH_3CH_2NH_2 + HCl$
(1 mark for correct chemical formulae & 1 mark for recognition of ammonia)

b. $CH_2CH_2 + H_2O \xrightarrow{H_3PO_4} CH_3CH_2OH$
(1 mark for correct chemical formulae & 1 mark for correct reagent above the arrow)

c. $CH_3CH_2CH_2OH + HCOOH \xrightarrow{\text{conc. } H_2SO_4} HCOOCH_2CH_2CH_3 + H_2O$
(1 mark for all correct chemical formulae on left, 1 mark for all correct chemical formulae on right & 1 mark for correct reagent above the arrow)

Question 8 (10 marks)

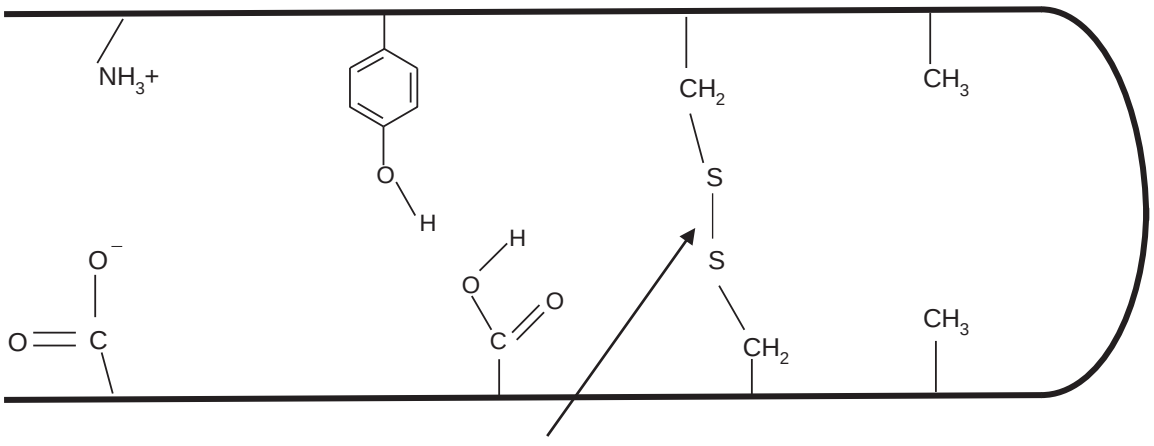
a. $H_2NCH(CH_3)COOH + HCl \rightarrow H_3N^+CH(CH_3)COOH + Cl^-$
(1 mark for correct formulae, 1 mark for recognition that the N atom accepts a proton and has a positive charge)

b. $H_2NCH(CH_2C_6H_5)CONHCH(CH_3)COOH$ **(1 mark)**
$H_2NCH(CH_3)CONHCH(CH_2C_6H_5)COOH$ **(1 mark)**

c. water **(1 mark)**

d. **i.** Any four of: ion-ion attractions, hydrogen bonding, disulfide links (bonds), ion-dipole, dispersion forces **(4 × ½ = 2 marks)**

ii.



(1 mark for formation of disulfide link as shown above)

iii. secondary structure of the protein: H bonds are broken **(1 mark)**.
The protein chains can uncoil.
primary structure of the protein: is not affected **(1 mark)**.

Question 9 (8 marks)

a. In trial 1, using 20 mL of $S_2O_8^{2-}(aq)$ in a total of 100 mL, the time taken for the blue to appear was 220 seconds but in trial 2, a volume of 40 mL in a total of 100 mL of $S_2O_8^{2-}(aq)$ was used and the reaction only took 150 seconds **(1 mark)**. Hence increasing concentration in trial 2 produces a faster reaction rate **(1 mark)**.

b. In trial 1, using 20 mL of $I^-(aq)$ in a total volume of 100 mL, the time taken for the blue to appear was 220 seconds but in trial 3 where a volume of 40 mL of $I^-(aq)$ in a total of 100 mL, the reaction only took 142 seconds **(1 mark)**. Hence the increased iodide concentration increased the rate of reaction **(1 mark)**.

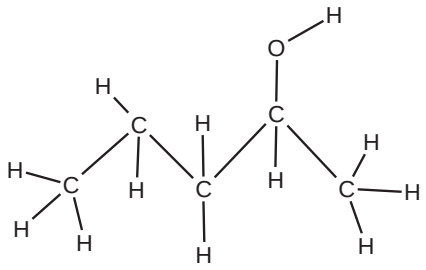
c. If the reacting solutions were at a lower temperature the reaction time would be much longer **(1 mark)**.
A lower proportion of the particles can overcome the activation energy at the lower temperature, less fruitful collisions would occur per second and the reaction slows **(1 mark)**.

d. To ensure the overall volume stayed constant at 100 mL so concentrations can be compared **(1 mark)**.

e. So there is only the one variable in the trials **(1 mark)**.

Question 10 (9 marks)

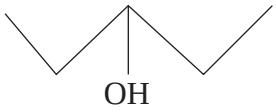
a.



(1 mark)

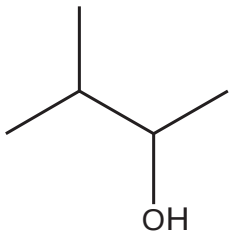
b. There is one chiral carbon **(1 mark)**.
The C atom with the –OH group has four different groups attached to it **(1 mark)**.

c. **i.**



(1 mark)

OR it is possible to have the isomer 3-methylbutan-2-ol.
The C atom with the –OH group has four different groups attached.



(1 mark)

ii. If pentan-3-ol, no **(1 mark)**. The carbon atom with the −OH group does not have four different groups attached **(1 mark)**.
(Answers must match for both marks.)
If 3-methylbutan-2-ol, yes **(1 mark)**. The carbon atom with the −OH group does have four different groups attached **(1 mark)**.

d. i. 88 the molecular ion $CH_3CH_2CH_2CH(OH)CH_3^+$ **(1 mark)**
15 + 14 + 14 + (13 + 17) + 15 = 88

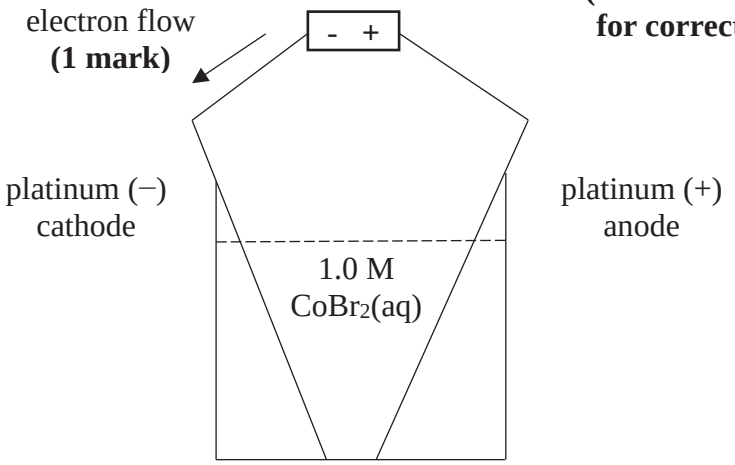
ii. 73 $CH_3CH_2CH_2CH(OH)^+$ or $^+CH_2CH_2CH(OH)CH_3$ **(1 mark)**
Loss of CH_3 (mass of 15) from either end

iii. 45 $CH(OH)CH_3^+$ **(1 mark)** the loss of $CH_3CH_2CH_2$ (mass of 43)
(Note: Positive charges must be shown to obtain marks)

Question 11 (10 marks)

a.

(1 mark for general diagram and 1 mark for correct identification of anode as +)



b. (− cathode) $Co^{2+}(aq) + 2e^- \rightarrow Co(s)$ **(1 mark)**
(+ anode) $2Br^-(aq) \rightarrow Br_2(aq) + 2e^-$ **(1 mark)**

c. $Co^{2+}(aq) + 2Br^-(aq) \rightarrow Co(s) + Br_2(aq)$ **(1 mark)**

d. Greater than the potential difference between the two half-cells.
From Data Book 0.28 + 1.09 i.e. > 1.37 V **(1 mark)**

e. Cu is a stronger reducing agent than Br^- and would be preferentially oxidised at the anode **(1 mark)**
$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$ **(1 mark)** Bromine would not be formed **(1 mark)**

END OF SUGGESTED SOLUTIONS