2024 Sec 4 Preliminary / Year 4 End-of-Year Examination
Chemistry 6092/03 Practical
Answer scheme

<table>
<tr><th>Qn</th><th>Type</th><th>Answers</th></tr>
<tr><td>1(ai)</td><td>MMO
PDO</td><td>[T] <u>T</u>able containing headings with correct units [1]
• Final/initial (burette) <u>reading</u> / cm^3
• Volume (of P) / cm^3
I: units with values
[R] Burette <u>R</u>eadings recorded to nearest 0.05 cm^3 + correct volume of P calculated [1]

[A] <u>A</u>ccuracy [2] Teacher value <u>20.60 cm^3</u> for all shifts
for average titre (of consistent readings) within 0.20 cm^3 of SS's average value score - 2 marks for corrected titres
for average titre (of consistent readings) within 0.30 cm^3 of SS's average value score - 1 mark for corrected titres

[C] 2 <u>C</u>onsistent readings within 0.20 cm^3 of each other [1]

Example:
<table>
<tr><td>Titration number</td><td>1</td><td>2</td></tr>
<tr><td>Final burette reading / cm^3</td><td>20.60</td><td>20.60</td></tr>
<tr><td>Initial burette reading / cm^3</td><td>0.00</td><td>0.00</td></tr>
<tr><td>Volume of P / cm^3</td><td>20.60</td><td>20.60</td></tr>
<tr><td>Best titration results</td><td>✓</td><td>✓</td></tr>
</table>
</td></tr>
<tr><td>1(aii)</td><td>MMO</td><td>calculates mean correctly to 2 decimal places (dp) [1]
- candidate must take the average of two (or more) titre values that are within a total spread of not more than 0.20 cm^3 / average of closest titre values
- working / explanation must be shown or ticks must be put next to the two (or more) accurate readings selected
- the mean should be quoted to 2 d.p. and be rounded to the nearest 0.01 cm^3</td></tr>
<tr><td>1(bi)</td><td>ACE</td><td>Correctly calculates amount of HCl used [1]
amount of HCl = $\frac{0.100 \times \text{volume in } \textbf{(a)(ii)}}{1000}$ (mol)</td></tr>
<tr><td>1(bii)</td><td>ACE</td><td>Correctly uses equation [1]
amount of sodium carbonate = (b)(i) × $\frac{1}{2}$ (mol)</td></tr>
<tr><td>1(biii)</td><td>ACE</td><td>concentration of sodium carbonate in 1.00 dm^3
= amount of sodium carbonate from (b)(ii) × $\frac{1000}{25.0}$ (mol/dm^3)</td></tr>
<tr><td>1b(iv)</td><td>ACE</td><td>$M_r = \frac{\text{mass}}{\text{moles}}$
$M_r = \frac{14.30}{\text{concentration from (b)(iii)}}$ [1] ;

M_r of nH_2O = M_r – 106
n = $\frac{M_r \text{ of } nH_2O}{18}$ [1]

leaving answers to 3sig fig for b(i), b(ii) and b(iii) [1];</td></tr>
</table>

1(c)	**ACE**	Volume of P to be smaller than expected + amount of P to be smaller than expected + amount of Na_2CO_3 to be smaller than expected ; n will be larger than expected; R: increase	
1(d)	**MMO** **PDO**	precision of volume to .0 or .5 cm^3 ; calculate mass of **P** correctly + precision of mass to 2 dp ;	
1(ei)	**ACE**	Gas lost from the boiling tube before the rubber bung was replaced	
1(eii)	**ACE**	use a small test-tube and thread/ drop(ping) funnel/ thistle funnel; R: delivery funnel/ dropper flask/ dropper funnel	
2(a)	**MMO** **PDO**	black solid/residue; gas produced relights a glowing splint + oxygen (gas) is produced ; (A: glowing splint becomes brighter)	
2(b)(i)	**MMO** **PDO**	**1**	(green/dark green/blue-green solution) which turns purple/ dark purple/ black (upon standing)
		2	purple solution
		3	purple* solution turns colourless / pale yellow / yellow ; OR (pale) green solution turns pale/ light yellow / yellow **mention 'purple' at least once in Test 2 or 3*
		4	off-white ppt. (formed) + insoluble in excess (aq. ammonia) ; A: light yellow/ light brown/ cream/ beige / yellow/ brown R: white/ whitish
		5	no observable changes +
		6	white ppt. ;
2(b)(ii)	**ACE**	redox ; (pale yellow/yellow) Fe^{3+} / $Fe_2(SO_4)_3$ is formed + oxidation state of Fe in $FeSO_4$ increases from +2 to +3 OR Fe^{2+} loses electron (to form Fe^{3+}) + hence Fe in $FeSO_4$ is oxidised (by acidified $KMnO_4$) ; A: oxidation	
2(b)(iii)	**ACE**	SO_4^{2-} / Sulfate + Test 6 ;	
2(b)(iv)	**ACE**	Does not affect (conclusion) + any carbonate present will be removed by dilute nitric acid regardless of order of addition (OWTTE) ;	

3(A) **PDO**

[Axes] Axes labelled + units ;
[Scale] Appropriate scale + every 10 small squares marked + plotted points take up more than 50% of graph grid
[Plots] Plot all points correctly within half of smallest square
[Line] Two best-fit straight lines ;

3(B) **ACE**

Reading off the best-fit line with dotted line drawn + indicate value on y-axis OR coordinates written +
y-value (0.25 ^{o}C) error allowance is half the smallest square ;

3(C) **ACE**

As volume of **B** increases from 0 cm^3 to 25 cm^3, the highest temperature reached increased +

As volume of **B** increases from 25 cm^3 to 40 cm^3, the highest temperature reached decreased ;

As volume of **B** increased from 0 cm^3 to 25 cm^3, **B** is the limiting reactant. As volume of **B** increased from 25 cm^3 to 40 cm^3, all the alkali is neutralised/ reaction is complete (OWTTE), no more heat is produced (so heat is evenly distributed over a larger volume.)

4 **P**

Method: Measuring mass over time

1. Measure a known/fixed volume of drink using a measuring cylinder / pipette / burette
2. Add <u>excess</u> (solid) $NaHCO_3$
3. suitable apparatus for experiment: conical flask (R: beaker) + cotton wool placed in the mouth of the conical flask (to prevent acid spray, while allowing the carbon dioxide gas to escape) + (electronic) mass balance + stopwatch OR labelled diagram
4. Measure mass of the conical flask and its contents at fixed time intervals (e.g. 1-min intervals) (until no change in mass)
5. Repeat experiment with the other fizzy drink
6. Plot a graph of the mass of the conical flask and its contents against time
7. for both fizzy drinks on the same axes / calculate (initial) gradients
8. The graph with a steeper (initial) gradient is the drink with a higher concentration of phosphoric acid

Category	Specific details	Tick	Mark
Quantity	excess (solid) $NaHCO_3$	☐	
	known/ fixed volume of fizzy drink	☐	
Apparatus	stopwatch	☐	
	burette/ pipette/ measuring cylinder	☐	
	conical flask (R: beaker)	☐	
	mass (electronic) balance	☐	
	cotton wool	☐	
Measurement	mass of the conical flask and its contents at fixed time intervals	☐	
	until no change in mass (R: until end of reaction/ reaction is complete, no more effervescence is seen)	☐	
Conclusion	plot a graph of the mass of the conical flask and its contents against time	☐	
	plot both graphs on the same axes/ calculate initial gradient	☐	
	graph with steeper initial gradient is the one with higher concentration of phosphoric acid	☐	

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	mass (electronic) balance	☐	
	cotton wool	☐	
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Q1a(i) Titration table & values		Tick	Mark
T	Table containing headings with correct units Final/ initial (burette) readings/ cm^3	☐	
	Volume (of P) / cm^3	☐	
R	Burette readings recorded to nearest 0.05 cm^3	☐	
	Correct volume of P calculated	☐	
A	Teachers' reading = 20.60 cm^3 Within $\pm$ 0.20 cm^3 of teachers' (20.40 – 20.80cm^3)	☐	
	Or within $\pm$ 0.30 cm^3 of teachers' (20.30 – 20.90cm^3)	☐	
C	Consistent readings within 0.20 cm^3 of each other	☐	

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C	Consistent readings within 0.20 cm^3 of each other	☐	

Q3a Graph Plotting		**Tick**	**Mark**
Axes	Axes labelled + units highest temperature reached / ^{o}C	□	
	against total volume of B (added)/ cm^3	□	
Scale	Appropriate scale (2cm to 5 ^{o}C) Students do not need to start from 0 for y-axis	□	
	Every 10 small squares marked	□	
	Plotted points take up more than 50% of graph grid	□	
Plots	Plot all points correctly within half of the smallest square	□	
Line	One best fit line drawn using data from 0 to 20 cm^3	□	
	2nd best fit line drawn using data from 30 to 40 cm^3.	□	
	Extrapolate the two lines so that they intersect.	□	

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	Plotted points take up more than 50% of graph grid	□	
Plots	Plot all points correctly within half of the smallest square	□	
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Name: _____ ( ) Class: _____

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C	Consistent readings within 0.20 cm^3 of each other	□	
		Total	**/5**

Q3a Graph Plotting		Tick	Mark
Axes	Axes labelled + units highest temperature reached / ^oC	□	
	against total volume of B (added)/ cm^3	□	
Scale	Appropriate scale (2cm to 5 ^oC) Students do not need to start from 0 for y-axis	□	
	Every 10 small squares marked	□	
	Plotted points take up more than 50% of graph grid	□	
Plots	Plot all points correctly within half of the smallest square	□	
Line	One best fit line drawn using data from 0 to 20 cm^3	□	
	2nd best fit line drawn using data from 30 to 40 cm^3.	□	
	Extrapolate the two lines so that they intersect.	□	
		Total	**/4**

Q4 Planning		Tick	Mark
Quantity	excess (solid) $NaHCO_3$	□	
	known/ fixed volume of fizzy drink	□	
Apparatus	stopwatch	□	
	burette/ pipette/ measuring cylinder	□	
	conical flask (R: beaker)	□	
	mass (electronic) balance	□	
	cotton wool	□	
Measurement	mass of the conical flask and its contents at fixed time intervals	□	
	until no change in mass (R: until end of reaction/ reaction is complete, no more effervescence is seen)	□	
Conclusion	plot a graph of the mass of the conical flask and its contents against time	□	
	plot both graphs on the same axes/ calculate initial gradient	□	
	graph with steeper initial gradient is the one with higher concentration of phosphoric acid	□	
		Total	**/4**

average volume	b(i) 4sf	b(i) 3sf	b(ii) 4sf	b(ii) 3sf	b(iii) 4sf	b(iii) 3sf
20.10	0.002010	0.00201	0.001005	0.00100	0.04020	0.0402
20.15	0.002015	0.00201	0.001007	0.00101	0.04030	0.0403
20.20	0.002020	0.00202	0.001010	0.00101	0.04040	0.0404
20.25	0.002025	0.00202	0.001012	0.00101	0.04050	0.0405
20.30	0.002030	0.00203	0.001015	0.00101	0.04060	0.0406
20.35	0.002035	0.00203	0.001017	0.00102	0.04070	0.0407
20.40	0.002040	0.00204	0.001020	0.00102	0.04080	0.0408
20.45	0.002045	0.00204	0.001022	0.00102	0.04090	0.0409
20.50	0.002050	0.00205	0.001025	0.00102	0.04100	0.0410
20.55	0.002055	0.00205	0.001027	0.00103	0.04110	0.0411
20.60	0.002060	0.00206	0.001030	0.00103	0.04120	0.0412
20.65	0.002065	0.00206	0.001032	0.00103	0.04130	0.0413
20.70	0.002070	0.00207	0.001035	0.00103	0.04140	0.0414
20.75	0.002075	0.00207	0.001037	0.00104	0.04150	0.0415
20.80	0.002080	0.00208	0.001040	0.00104	0.04160	0.0416
20.85	0.002085	0.00208	0.001042	0.00104	0.04170	0.0417
20.90	0.002090	0.00209	0.001045	0.00104	0.04180	0.0418
20.95	0.002095	0.00209	0.001047	0.00105	0.04190	0.0419
21.00	0.002100	0.00210	0.001050	0.00105	0.04200	0.0420