Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE
In Chemistry (8CH0) Paper 02
Core Organic and Physical Chemistry

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Question Number	Acceptable Answer	Mark
1	The only correct answer is A *B is incorrect because H_2O is a nucleophile – via lone pairs* *C is incorrect because NH_3 is a nucleophile – via lone pair* *D is incorrect because CN^- is a nucleophile – via lone pairs*	(1)

(Total for Question 1 = 1 mark)

Question Number	Acceptable Answer	Additional Guidance	Mark
2 (a)(i)	• converts temperature to Kelvin and pressure to Nm^{-2} (Pa) (1) • rearranging ideal gas equation and substituting their values (1) • evaluates answer to 2 SF and includes units (1)	Examples of calculation 60 °C = 333 K 500 kPa = 5 x 10^5 / 500 000 Pa $V = \frac{nRT}{P}$ V = 1 x 8.31 x 333/500 000 = 5.53446 x 10^{-3} = 0.0055 m^3/5.5 x 10^{-3} m^3 / 5.5 dm^3 / 5500 cm^3 allow TE answers to 2 SF only correct answer with no working scores 3 marks correct answer with incorrect working scores 2 marks max.	(3)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(a)(ii)	• calculates M_r to 2 or more SF (1) • identifies element X (1) •	Example of calculation: molar mass = mass in 24000 cm^3 = 1.42 x 24000/1000 = 34 (.08) (g mol^{-1}) ignore SF except 1 SF (X + (3 x 1)) = 34 X = 31 so P / phosphorus just 'phosphorus' with no working scores M2 only	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(b)(i)	• calculates moles of acid (1) • calculates moles of sodium carbonate (1) • recognises that (sodium) carbonate is in excess (1) • evidence for excess sodium carbonate in terms of moles (1) • correct volume of gas calculated with units (1)	<u>Example of calculation</u> moles of acid =10.0 x 0.400/1000 =4(.0) x 10^{-3} /0.004 (mol) moles of sodium carbonate =0.242/106.0 = 2.283 x 10^{-3}/0.002283 (mol) recognition of $HCl:Na_2CO_3$ = 2:1 gets M4 4.0 x10^{-3} mol acid requires 2.0 x 10^{-3} mol sodium carbonate OR 2.283 x 10^{-3} mol of sodium carbonate requires 4.566 x 10^{-3} mol of acid moles CO_2 = 2.0 x 10^{-3} (mol) volume of gas = 2.0 x 10^{-3} x 24 000 = 48 cm^3 /0.048 dm^3 TE on incorrect moles CO_2 correct answer with no working scores 1 mark if the moles of sodium carbonate are not calculated, only M1, M4 and M5 can be awarded. ignore SF except 1 for M5	(5)

Question Number	Acceptable Answer	Additional Guidance	Mark
2(b)(ii)	An answer that makes reference to the following reasons: • some gas escaped before the bung/delivery tube was replaced (1) • the gas / carbon dioxide is (slightly) soluble in water/ acid / solution (1)	ignore references to change in volume when the bung is pushed into the test tube allow 'temperature less than 25°C/298 K/room temperature' as alternative to either answer do not award an incomplete reaction do not award leaky apparatus/sticking syringe	(2)

(Total for Question 2 = 12 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(a)	• K_c expression (1) • units based on their K_c expression (1)	$(K_c =)\ \frac{[N_2(g)]^2\ [H_2O(g)]^6}{[NH_3(g)]^4[O_2(g)]^3}$ ignore missing state symbols do not award round brackets mol dm^{-3} or mol/dm^3	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(b)(i)	• calculates $\sum\Delta_f H$(products) (1) • $\sum\Delta_f H$(products) - $\Delta_r H$ (1) • calculates $\Delta_f H_{(NH3)}$ for 1 mol ammonia (1)	<u>Example of calculation</u> (+90.4 x 4) + (-241.8 x 6) = -1089.2 -1089.2 − (-904.8) = -184.4 -184.4/4 = -46.1 (kJ mol^{-1}) TE from M1 to M2 M3 can be awarded for an incorrect answer to M2 divided by 4 correct answer with no working scores 3 marks	(3)

Question Number	Answer Acceptable	Additional Guidance	Mark
3(b)(ii)	• correct expression (1) • correct evaluation of atom economy (1)	<u>Example of calculation</u> $\frac{4NO}{4NO + 6H_2O}$ OR $\frac{4NO}{4NH_3 + 5O_2}$ may be shown as numbers only $\frac{4(14 + 16)}{4(14 + 16) + 6(16 + 2)} \times 100$ OR $\frac{4(14 + 16)}{4(14 + 3) + 5(16 \times 2)} \times 100$ = 53/52.6(316)(%) allow answer to 2 or 3 SF only correct answer with no working scores 2 marks 0.53/0.526 scores M1 only	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(c)(i)	An answer that makes reference to the following points: • yield (of NO) decreases (1) • increase in pressure shifts equilibrium (position) to the side of fewer moles (of gas molecules) (1)	if M1 and M2 are contradictory then do not award any marks allow 9 mol on LHS and 10 mol on RHS, may be shown above the equation allow more moles of product allow fewer moles of reactant allow marking points in either order	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(c)(ii)	An answer that makes reference to the following points: (on increasing the pressure) • Rate increases because there are more molecules per unit volume (1) so increase in frequency of collisions (between reacting molecules) (1)	allow increase in concentration of (gas) molecules allow any implication of more particles in a given volume, e.g. particles are closer together allow more collisions per unit time ignore just 'more collisions'/'more successful collisions' with no reference to time allow answers based on a solid catalyst	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
3(c)(iii)	An answer that makes reference to: • heterogeneous: (the catalyst is in) a different phase/state to the reactants (1) • increases the rate of the forward and backward / reverse reactions (1)	ignore reference to products	(2)

Question Number	Acceptable Answer	Mark
3(d)	The only correct answer is B *A is not correct because there is no increase in number of particles* *C is not correct because distribution broadens as temperature rises, so peak is lower* *D is not correct because E_a is an intrinsic property of the reaction, not the applied temperature*	(1)

(Total for Question 3 = 14 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(a)(i)	Reagent • (concentrated) NaOH/KOH (1) Conditions • ethanol (solvent) <u>and</u> heat/warm (1)	do not award OH^- or just 'hydroxide' do not award M1 if 'acidified' allow reflux M2 is dependent on M1 except for a near miss e.g. OH^-	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(a)(ii)	• Reagent: KCN/NaCN /potassium cyanide / sodium cyanide (1) • Reason: increases the number of carbon atoms in the carbon chain/ length of carbon chain (1)	ignore any mention of the solvent (aq ethanol) and conditions (reflux) do not award just CN^-/cyanide/HCN	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(a)(iii)	An explanation that makes reference to the following: • heating increases rate (of reaction) (1) • no sealed tube would result in loss of ammonia (gas)/ reactants / gas (1)	ignore reference to activation energy/ starting the reaction/ reaction is endothermic ignore toxicity of reactants	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
4(a)(iv)	$CH_3—CH_2—CH_2—OH$	allow displayed/structural/skeletal formula ignore name do not award just C_3H_7OH	(1)

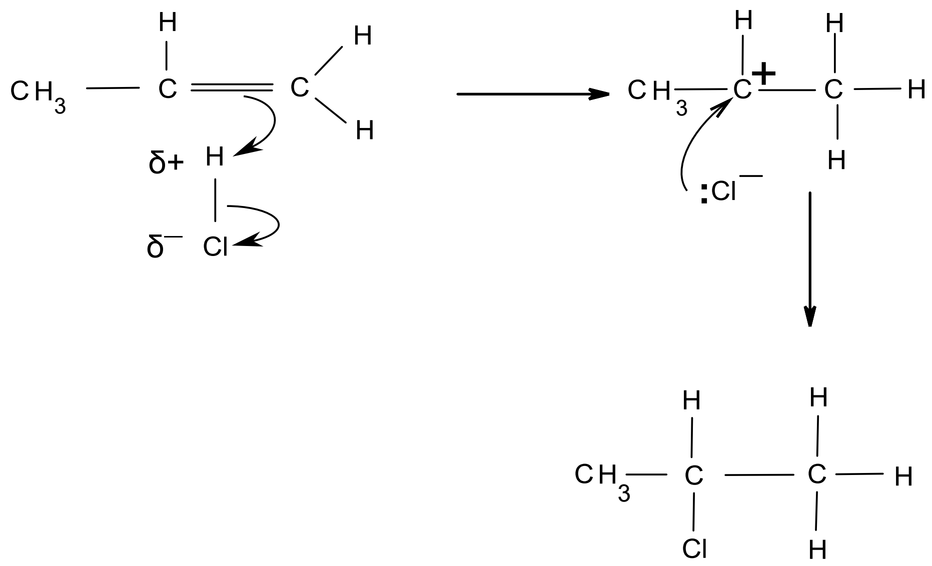
Question Number	Acceptable Answer	Mark
4(b)	The only correct answer is B *A is not correct because Z (3rd) is tertiary (fastest)* *C is not correct because Y (2nd) is primary (slower than X, secondary)* *D is not correct because X (1st) is secondary (slower than Z, tertiary)*	(1)

(Total for Question 4 = 8 marks)

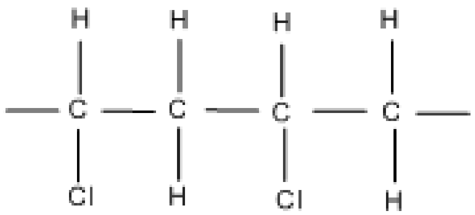
Question Number	Acceptable Answer	Mark
5(a)(i)	The only correct answer is B *A is not correct because reaction is not substitution* *C is not correct because reaction is not substitution, nor nucleophilic* *D is not correct because reaction is not nucleophilic*	(1)

Question Number	Acceptable Answer	Mark
5(a)(ii)	The only correct answer is C *A is not correct because no C=C present* *B is not correct because no C=C present* *D is not correct because these are not stereoisomers*	(1)

Question	Acceptable Answer	Additional Guidance	Mark

Number			
5(a)(iii)	An answer which shows the following: • curly arrow from double bond to H atom of HCl/space between double bond and H atom of HCl (1) • correct dipole on HCl molecule <u>and</u> curly arrow from H-Cl bond to Cl atom (1) • intermediate with + charge shown on correct carbon (1) • curly arrow from <u>lone pair</u> on chloride ion to correct carbon (1)	<u>Example of mechanism</u>  incorrectly drawn starting molecule loses M1, e.g. missing H or pentavalent carbon. incorrect starting molecule, e.g. butene will lose M3. if product is 1-chloropropane M3 only is lost. Other errors in end product lose M4 use of HBr in place of HCl loses M2 only use of H^+ and Cl^- loses M1 and M2	(4)

Question	Acceptable Answer	Additional Guidance	Mark

Number			
5(b)(i)		must show two repeat units fully displayed allow head to head, head to tail, tail to tail, syndiotactic and isotactic stuctures do not award any other type of formula ignore brackets and n	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(b)(ii)	An explanation that makes reference to the following: • (incineration produces) HCl/chlorinated molecules (1) • which are corrosive/toxic /cause acid rain (1)	M2 is dependent on M1 allow chlorine ignore carbon dioxide and its consequences allow adverse effect on ozone layer	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
5(b)(iii)	An answer that makes reference to the following: any appropriate precautions to deal with toxic vapours/use fume cupboard etc.	allow good ventilation required allow gas mask/respirator do not award just mask ignore gloves, lab coat	(1)

Question	Acceptable Answer	Additional Guidance	Mark

Number			
5(c)(i)	An answer that makes reference to the following: • at lower temperatures (below 50°C) the reaction will be slow (1) • at higher temperatures (above 80°C) yield will be lower because (forward) reaction is exothermic (1)	allow reverse argument allow other products produced at higher temperatures	(2)

Question Number	Acceptable Answer	Mark
5(c)(ii)	The only correct answer is A *B is not correct because separating funnel is inappropriate for an industrial process* *C is not correct because not a separation process* *D is not correct because both will react with alkaline solution*	(1)

(Total for Question 5 = 13 mark)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(i)	Reagent: • B is hydrogen / H_2 (gas) (1) Condition: • nickel/ Ni (catalyst) (1)	mark independently allow any other suitable transition metal catalysts eg Pt, Pd ignore additional information relating to the support for the catalyst ignore references to heating/pressure/UV	(2)

Question Number	Acceptable Answer	Mark
6(a)(ii)	The only correct answer is C A is not correct because water is not involved B is not correct because there is no increase in number of oxygen atoms D is not correct because no substitution has taken place	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
6(a)(iii)	margarine	allow <u>liquid</u> coal allow butter substitute do not award just butter	(1)

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr>
<td>*6(b)</td>
<td>
This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.
Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.
The following table shows how the marks should be awarded for indicative content.
<table>
<tr><th>Number of indicative marking points seen in answer</th><th>Number of marks awarded for indicative marking points</th></tr>
<tr><td>6</td><td>4</td></tr>
<tr><td>5-4</td><td>3</td></tr>
<tr><td>3-2</td><td>2</td></tr>
<tr><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td></tr>
</table>
The following table shows how the marks should be awarded for structure and lines of reasoning.
<table>
<tr><th></th><th>Number of marks awarded for structure and sustained lines of reasoning</th></tr>
<tr><td>Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.</td><td>2</td></tr>
<tr><td>Answer is partially structured with some linkages and lines of reasoning.</td><td>1</td></tr>
<tr><td>Answer has no linkages between points and is unstructured.</td><td>0</td></tr>
</table>
</td>
<td>
Guidance on how the mark scheme should be applied:

The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points that is partially structured with some linkages and lines of reasoning, scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning).

If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).

In general it would be expected that 5 or 6 indicative points would get 2 reasoning marks, and 3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning.

If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).

Comment: Look for the indicative marking points first, then consider the mark for the structure of the answer and sustained line of reasoning.
</td>
<td>(6)</td>
</tr>
</table>

	Indicative content: • calculate approximate mass of solute to be weighed out • details of how to weigh out required mass • transfer solute to beaker/conical flask <u>and</u> add distilled/deionised water <u>and</u> dissolve • transfer to (250 cm^3) volumetric flask • add washings from beaker • make up to mark/line <u>and</u> shake/invert (to mix).	Ignore anything to do with oxidation even if incorrect <u>example of calculation</u> 0.050 mol dm^{-3} = 0.050 x 118 g dm^{-3} =5.90 g dm^{-3} =1.47(5) g in 250 cm^3 do not award just 'weigh by difference' transfer of solute directly to volumetric flask gets IP3 and IP4 but must mention dissolving for IP3 any mention of volumetric/graduated flask scores IP4 direct transfer from weighing container to volumetric flask must mention washing of solute into the flask (e.g. through funnel). mix on its own is insufficient	

(Total for Question 6 = 10 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
7(a)(i)	• ticks under titration numbers 2, 3, 4 (1) • 17.65 (cm^3) (1)	ignore X under Titration 1 example of calculation $\frac{17.60 + 17.70 + 17.65}{3} = 17.65$ scroll down as mean titre value may be written below (i) rather than in the table units not required must be 2 dp TE from M1 if Titration 1 has been ticked (17.74)	(2)

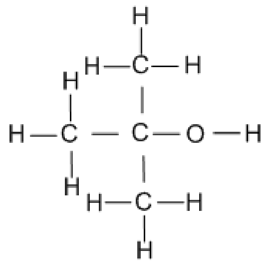
Question Number	Acceptable Answer	Additional Guidance	Mark
7(a)(ii)	• Phenolphthalein/ methyl orange (1) • colourless to pink / red to orange (1)	M2 depends on M1 allow any indicator other than litmus or universal indicator allow minor errors in spelling of phenolphthalein but not phenyl…. do not award red/pink-red for phenolphthalein nor yellow for methyl orange allow correct colour change for other indicators	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
7(a)(iii)	• converts [acid] from g dm^{-3} to mol dm^{-3} (1) • calculates moles of acid in 25 cm^3 (1) • calculates moles of sodium hydroxide in titre cm^3 (1) • converts moles of sodium hydroxide in titre to mol dm^{-3} and gives the answer 3 SF (1)	<u>Example of calculation</u> 3.80/90.0 = *4.22 x 10^{-2} (mol dm^{-3}) ans to M1 x 25 x 10^{-3} 25 x 10^{-3} x *4.22 x 10^{-2} = **1.0556 x 10^{-3} (mol) allow M1 and M2 in any order one mark only if not divided by 90.0 ans to M2** x 2 = 1.0556 x 10^{-3} x 2 = ***2.111 x 10^{-3} (mol) = ans to M3*** x 1000/17.65 = 0.1196 = 0.120 (mol dm^{-3}) correct answer with no working scores 4 marks	(4)

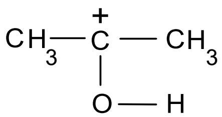
Question Number	Acceptable Answer	Additional Guidance	Mark
7(b)(i)	• burette uncertainty (1) • pipette uncertainty (1)	<u>Example of calculations</u> 0.05 x 2 x 100/ 17.65 = (±)0.567/0.57/0.6(%) 0.06 x 100/25 = (±)0.24/0.2(%) ignore addition of the two uncertainties ignore SF	(2)

Question Number	Acceptable Answer	Mark
7(b)(ii)	The only correct answer is B *A is not correct because the volume of NaOH needed is divided by 4, uncertainty is x4* *C is not correct because moles of acid is the same and uncertainty is the same.* *D is not correct because moles of acid halved and uncertainty doubled.*	(1)

(Total for Question 7 = 11 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(a)		display all three methyl groups allow −OH do not award C-H-O	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(b)(i)	An answer that makes reference to one of the following: molecular ion/molecule fragments/is unstable		(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(b)(ii)		allow + charge on any part of the ion/outside the structure but + must be shown allow displayed/structural/skeletal/ molecular formulae or any combination of these.	(1)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(c)(i)	• calculation for bonds broken in the alcohol (*) (1) • calculation for bonds broken in oxygen and total energy for bonds broken(**) (1) • calculation for bonds made(***) (1) • calculation of $\Delta_c H$ (2-methylpropan-2-ol) with sign (1)	Example of calculation 3(C-C) + 9(C-H) + (C-O) + (O-H) =(3x347) + (9x413) + 358 + 464 = (+)5580 (kJ mol^{-1}) 6(O=O) = (6 x 498) = (+)2988 (kJ mol^{-1}) total = + 5580 + 2988 = (+)8568 (kJ mol^{-1}) TE from ans * M1 + 2988 = 8(C=O) + 10(O-H) = (8x805) + (10x464) = -11080 (kJ mol^{-1}) = +8568 − 11080 = -2512 (kJ mol^{-1}) allow TE for answer(**) + answer(***) units not required but if given they must be correct correct final answer with no working scores 4 marks	(4)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(c)(ii)	An explanation that makes reference to the following points: • incomplete combustion (1) • $\Delta_c H$ (2-methylpropan-2-ol) will be less negative /less exothermic than data book value (1)	mark independently do not award just lower/smaller/decreases/ more positive allow reduce the magnitude (of the value)	(2)

Question Number	Acceptable Answer	Additional Guidance	Mark
8(c)(iii)	An answer that makes reference to the following points: $\Delta_c H$ figures are at 298 K /data book bond energies refer to gaseous state and water and/or 2-methylpropan-2-ol are/is (both) liquid(s) (at 298 K)	allow just liquid involved do not award data book bond energies are mean (values)/not specific to 2-methylpropan-2-ol	(1)

Question Number	Acceptable Answer	Mark
8(d)	The only correct answer is D *A is not correct because tertiary alcohol is not oxidised* *B is not correct because this is incorrect colour change for acidified dichromate* *C is not correct because this is incorrect colour change for these reagents*	(1)

(Total for Question 8 = 11 marks)