edexcel

Mark Scheme (Results)
January 2012

GCE Chemistry (6CH04) Paper 01

General Principles of Chemistry I Rates Equilibria and Further Organic Chemistry

Edexcel and BTEC Qualifications
Edexcel and BTEC qualifications come from Pearson, the world's leading learning company. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information, please call our GCE line on 0844 576 0025, our GCSE team on 0844 576 0027, or visit our qualifications website at www.edexcel.com.

For information about our BTEC qualifications, please call 0844 576 0026, or visit our website at www.btec.co.uk.

If you have any subject specific questions about this specification that require the help of a subject specialist, you may find our Ask The Expert email service helpful.

Ask The Expert can be accessed online at the following link:
http://www.edexcel.com/Aboutus/contact-us/

Alternatively, you can contact our Science Subject Advisor directly by sending an email to ScienceSubjectAdvisor@EdexcelExperts.co.uk .

You can also telephone 0844 576 0037 to speak to a member of our subject advisor team.

(If you are calling from outside the UK please dial + 44 1204 770 696 and state that you would like to speak to the Science subject specialist).

Pearson: helping people progress, everywhere
Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

January 2012
Publications Code UA030266

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.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. Questions labelled with an **asterix (*)** are ones where the quality of your written communication will be assessed.

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:
- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.
( ) means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.
Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.
ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication
Questions which involve the writing of continuous prose will expect candidates to:
- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.
Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A (multiple choice)

Question Number	Correct Answer	Reject	Mark
1(a)	C		1

Question Number	Correct Answer	Reject	Mark
1(b)	A		1

Question Number	Correct Answer	Reject	Mark
2	D		1

Question Number	Correct Answer	Reject	Mark
3	A		1

Question Number	Correct Answer	Reject	Mark
4(a)	C		1

Question Number	Correct Answer	Reject	Mark
4(b)	A		1

Question Number	Correct Answer	Reject	Mark
5	A		1

Question Number	Correct Answer	Reject	Mark
6	B		1

Question Number	Correct Answer	Reject	Mark
7	B		1

Question Number	Correct Answer	Reject	Mark
8	D		1

Question Number	Correct Answer	Reject	Mark
9	A		1

Question Number	Correct Answer	Reject	Mark
10 (a)	B		1

Question Number	Correct Answer	Reject	Mark
10 (b)	B		1

Question Number	Correct Answer	Reject	Mark
11	D		1

Question Number	Correct Answer	Reject	Mark
12	D		1

Question Number	Correct Answer	Reject	Mark
13 (a)	C		1

Question Number	Correct Answer	Reject	Mark
13 (b)	D		1

Question Number	Correct Answer	Reject	Mark
14	B		1

Question Number	Correct Answer	Reject	Mark
15	D		1

Question Number	Correct Answer	Reject	Mark
16	C		1

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Acceptable Answers	Reject	Mark
17(a)	Orange/yellow **and** precipitate/ppt or solid or crystals ALLOW orange-red or red-orange for colour	Any other colour alone or in combination, e.g.red	**1**

Question Number	Acceptable Answers	Reject	Mark
17(b)	(Heat with) Benedict's/Fehling's (solution) **(1)** Ketone/X would remain blue/no change/no reaction **(1)** Aldehyde/Y would form red/brown **and** ppt/Cu_2O **(1)** ALLOW combinations of red or brown with orange OR (Heat with) Tollens' Reagent/ammoniacal silver nitrate **(1)** Ketone/X remains colourless/no change/no reaction **(1)** Aldehyde/Y forms a silver mirror or black/grey precipitate/Ag/silver **(1)** OR (Heat with) acidified dichromate((VI)) (ions) **(1)** Ketone/X remains orange/no change/no reaction **(1)** Aldehyde/Y goes green/blue **(1)** ALLOW *answer with acidified or alkaline* $KMnO_4$ Ketone/X remains purple/pink/no change/no reaction **(1)** Aldehyde/Y goes colourless (with acid)/goes green (with alkali) **(1)** Near miss on reagent (e.g. silver nitrate not ammoniacal silver nitrate) observations can score 2 ALLOW iodoform test with ketone identified (since X can only be butanone) (Aqueous) sodium hydroxide and iodine **(1)** Ketone/X forms yellow precipitate/solid/crystals **(1)** Aldehyde/Y no change/no reaction **(1)**	Just orange Ppt Just clear	**3**

Question Number	Acceptable Answers	Reject	Mark
17(c)(i)	**Both** $CH_3CH_2CH_2CHO$ And $(CH_3)_2CHCHO$ ACCEPT displayed or skeletal formulae if structural formulae not given	COH unless shown correctly in a displayed or skeletal formula	**1**

Question Number	Acceptable Answers	Reject	Mark
17(c)(ii)	Recrystallization IGNORE solvent	Just crystallization	**1**

Question Number	Acceptable Answers	Reject	Mark
17(c)(iii)	Measure melting temperature / point **(1)** Compare with literature/database / known value **(1)** Second mark can only be awarded if first mark scored	Just boiling temperature	**2**

Question Number	Acceptable Answers	Reject	Mark
18(a)	Hazard – **methanol/alcohol** is flammable **(1)** IGNORE flammability of vegetable/diesel oils Precaution – use electrical heating source/water bath /avoid naked flames **(1)** OR Hazard – **methanol/alcohol** is toxic **(1)** Precaution – Use in well-ventilated area/fume cupboard/store away from children/wear gloves **(1)** OR Hazard – **NaOH/reaction mixture** is corrosive /burns (the skin)/damages the eyes **(1)** IGNORE references to (strong) alkali(ne) Precaution – wear gloves/goggles ALLOW any 2 hazards but the precaution must be associated with the appropriate hazard If the Hazard is not clearly identified but the precaution is appropriate then allow one mark, e.g. "Use of flammable substances so avoid naked flames" = **(1)** mark	Just volatile Just dangerous /harmful Just irritant	4

Question Number	Acceptable Answers	Reject	Mark
18(b)	**Any two from:** Reuses/reduces waste (vegetable) oil/ lessens need to dispose of (vegetable) oil **(1)** Could lessen use of (non-renewable/non-sustainable) crude oil/fossil fuels OR vegetable oil/biodiesel/reactants renewable/ sustainable **(1)** Plants grown for vegetable oil could offset some CO_2 emissions **(1)** IGNORE references to transport/temperature/ energy savings cost/profit/high yield/ biodegradability/greenhouse gases	Just methanol is renewable Just carbon neutral/just reduces carbon footprint	**2**

Question Number	Acceptable Answers	Reject	Mark
19(a)(i)	Sodium/potassium dichromate((VI))/potassium manganate ((VII))/$Na_2Cr_2O_7$/$K_2Cr_2O_7$/$KMnO_4$ IGNORE references to acid	Just $Cr_2O_7^{2-}$ /MnO_4^-	**1**

Question Number	Acceptable Answers	Reject	Mark
19(a)(ii)	(Heat under) reflux **(1)** Use excess/sufficient oxidizing agent/reagent named in (a)(i), even if incorrect **(1)** IGNORE references to (excess) acid Stand alone marks		**2**

Question Number	Acceptable Answers	Reject	Mark
19(a)(iii)	CH_3CH_2CN/C_2H_5CN **(1)** ACCEPT displayed or skeletal formulae $CH_3CH_2CN + H^+ + 2H_2O \rightarrow CH_3CH_2COOH + NH_4^+$ OR $CH_3CH_2CN + HCl + 2H_2O \rightarrow CH_3CH_2COOH + NH_4Cl$ **(2)** If equation is incorrect then presence of H^+ or acid in equation/or above arrow **and** water on LHS scores (1) Mark cq on formula of nitrile ALLOW one mark for the following equation without H^+. $CH_3CH_2CN + 2H_2O \rightarrow CH_3CH_2COOH + NH_3$ ALLOW two marks for either of the following with H^+ above the arrow $CH_3CH_2CN + 2H_2O \rightarrow CH_3CH_2COOH + NH_3$ $CH_3CH_2CN + 2H_2O \rightarrow CH_3CH_2COOH + NH_4^+$ ALLOW answers for alkaline hydrolysis **followed by** acidification $CH_3CH_2CN + OH^- + H_2O \rightarrow CH_3CH_2COO^- + NH_3$ **(1)** Then $CH_3CH_2COO^- + H^+ \rightarrow CH_3CH_2COOH$ **(1)** If propanamide, $CH_3CH_2CONH_2$ is given initially then ALLOW the two equation marks for the hydrolysis $CH_3CH_2\ CONH_2 + H^+ + H_2O \rightarrow CH_3CH_2COOH + NH_4^+$ If no acid is used then only one mark $CH_3CH_2\ CONH_2 + H_2O \rightarrow CH_3CH_2COOH + NH_3$	Hydroxynitriles	**3**

Question Number	Acceptable Answers	Reject	Mark
19(b)	Reagent - Propanoyl chloride/CH_3CH_2COCl **(1)** **Any two from:** C-Cl bond is weaker (than C- 0) **(1)** Cl^-/chloride (ion) is a better leaving group **(1)** Carbonyl carbon is more positive/more δ+/more attractive to nucleophiles **(1)** OR Reagent - Propanoic anhydride/$(CH_3CH_2CO)_2O$ **(1)** CH_3COO^-/propanoate (ion) is a better leaving group **(1)** Carbonyl carbon is more positive/more δ+/more attractive to nucleophiles **(1)** IGNORE references to eversible/equilibrium/ catalysts IGNORE bond polarity	Propyl chloride Just Cl is more electronegative	**3**

Question Number	Acceptable Answers	Reject	Mark
19(c)(i)	Radio waves/radio frequency	Just radio	**1**

Question Number	Acceptable Answers	Reject	Mark
19(c)(ii)	**Any two from:** Protons/nuclei/they have a property called spin/ have a magnetic moment/ have a magnetic field/ are aligned with the external magnetic field **(1)** **which** flips/changes **(1)** align against the external magnetic field (when radiation is absorbed) **(1)**	starts to spin just dipole moment polarity flips any reference to electrons or molecules scores zero	**2**

Question Number	Acceptable Answers	Reject	Mark
19(c)(iii)	Quartet **(1)** ALLOW quadruplet/indication of four (peaks) Value from 0.1 to 1.9 (ppm) inclusive **(1)** ACCEPT any range within the above range		**2**

Question Number	Acceptable Answers	Reject	Mark
20(a)	(Greater yield) as fewer moles/molecules (of gas) on RHS OR 3 moles/molecules on left but only 1 on right **(1)** ALLOW arguments in terms of K_p remaining constant Disadvantage: Extra cost of (building) equipment (to withstand higher pressure)/ thicker pipes/compressor/maintaining equipment **(1)** OR Higher cost **of energy** needed for compression **(1)** IGNORE references to explosion	Just (higher) cost	**2**

Question Number	Acceptable Answers	Reject	Mark
20(b)(i)	(Reaction is exothermic) so the value of $\Delta S_{surroundings}$ becomes more positive/larger (at 100 °C) **(1)** Therefore ΔS_{total} becomes more positive/larger/less negative(at 100 °C) **(1)** Second mark consequential on first		**2**

Question Number	Acceptable Answers	Reject	Mark
20(b)(ii)	(Higher temperature gives a) faster rate of reaction /more particles have $E \geq E_a$ (ALLOW more successful collisions (per second) IGNORE references to yield		**1**

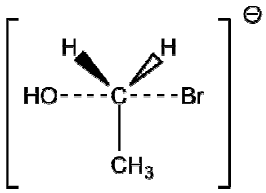
Question Number	Acceptable Answers	Reject	Mark
20(c)	Remove methanol/the product (as it is formed) **(1)** Recycle/reuse **unreacted** reactants **(1)** IGNORE references to catalyst and increasing amounts of reactants		**2**

Question Number	Acceptable Answers	Reject	Mark
21(a)(i)	k = (1.54 x 10^{-6}) ÷ (0.1 x 0.15) **(1)** (= 1.0267 x 10^{-4}) = 1.03 x 10^{-4} **(1)** must be to 3 SF dm^3 mol^{-1} s^{-1} **(1)** Unit mark is stand alone and units can be in any order Correct answer with units but no working **(3)** marks	 1.02 x 10^{-4}	**3**

Question Number	Acceptable Answers	Reject	Mark

21(a)(ii)	If correct unrounded answer to (a) (i) stored in calculator then
	4.1067 x 10^{-8} = 4.1 x 10^{-8} (mol dm^{-3} s^{-1})
	
	OR
	
	If 1.0267 x 10^{-4} used then
	4.1068 x 10^{-8} = 4.1 x 10^{-8} (mol dm^{-3} s^{-1})
	
	OR
	
	If 1.03 x 10^{-4} used then
	4.12 x 10^{-8} = 4.1 x 10^{-8} (mol dm^{-3} s^{-1})
	
	IGNORE sf except 1sf
	
	IGNORE units even if incorrect
	TE from (a)(i)
			1

Question Number	Acceptable Answers	Reject	Mark
21(b)(i)	2(nd)/second/two/(1 + 1) = 2 (order)		**1**

Question Number	Acceptable Answers	Reject	Mark
21(b)(ii)	 Structure **(1)** ALLOW structure without wedged bonds Dotted bonds must be shown and OH and Br must be on opposite sides with a C-C or C-H bond between them Charge **(1)** Charge mark can be awarded for a near miss with a single error in the structure (e.g. one hydrogen atom missing) ALLOW –ve charge shown as δ− on both OH and Br Brackets not essential ALLOW –ve charge to be anywhere on the structure IGNORE δ+ on carbon atom		**2**

Question Number	Acceptable Answers	Reject	Mark
21(c)(i)	3.00×10^{-3} **(1)** IGNORE sf for 1/T −5.58 **(1)** IGNORE sf except 1sf	-5.60	**2**

Question Number	Acceptable Answers	Reject	Mark
21(c)(ii)	Appropriate scale **(1)** Plotted points **must** cover at least half of the graph paper on each axis. Points plotted correctly **and** straight line drawn **(1)** through all points Gradient = —10230 ± 500 **(1)** Example E_a = 10230 x 8.31**(1)** allow TE from incorrect gradient E_a = (+) 85.0 kJ(mol^{-1})/(+) 85 000 J (mol^{-1}) **(1)** 3 sf E_a range from 80.9 to 89.2 kJ mol^{-1} ALLOW TE from incorrect gradient IGNORE SF except 1	K^{-1}	**5**

TOTAL FOR SECTION B = 49 MARKS

Section C

Question Number	Acceptable Answers	Reject	Mark
22 (a)(i)	(+)186.2 (J mol^{-1} K^{-1})		**1**

Question Number	Acceptable Answers	Reject	Mark
22(a)(ii)	(266.9 + 186.2) – 310.1 **(1)** **=** + 143 (J mol^{-1} K^{-1}) **(1)** – 143 scores (1) Correct answer with sign and no working scores (2) marks ALLOW TE from (i)		**2**

Question Number	Acceptable Answers	Reject	Mark
22(a)(iii)	Yes, as reaction produces 2 molecules/moles from one/more molecules/moles **(1)** (and) all products are gases **(1)** IGNORE references to volumes More moles/molecules of **gas produced** scores (2) OR Yes, (as the reaction is endothermic) $\Delta S_{surroundings}$ is negative **(1)** Since the reaction takes place/goes (spontaneously) ΔS_{total} is positive and therefore ΔS_{system} is positive **(1)** ALLOW TE from (a)(ii) i.e. 'No, as….'		**2**

Question Number	Acceptable Answers	Reject	Mark
22(a)(iv)	$\Delta S_{surr} = -\Delta H/T$ **(1)** $= -71900/700$ $= -102.7$ **J** K^{-1} mol^{-1}/$-$ 0.1027 **kJ** K^{-1} mol^{-1} **(1)** Correct answer and sign with no working scores (2) — 0.103 **J** K^{-1} mol^{-1} scores (1) **Third mark** So ΔS_{total} is positive (so reaction is feasible) **(1)** OR ΔS_{total} = **+**40.3 J K^{-1} mol^{-1} (so reaction is feasible) **(1)** ALLOW TE from (a)(ii)	1 or 2 sf	**3**

Question Number	Acceptable Answers	Reject	Mark
22(a)(v)	$\Delta S_{total} = 0$ OR $\Delta S_{surroundings}$ = —143 **(1)** $T = \Delta H \div \Delta S_{surroundings}$ OR T = (—) 71900 ÷ (—)143 **(1)** = 502.8 (K) **(1)** IGNORE sf except 1sf Correct answer with no working scores (3) ALLOW 0.5028 (K) for (2) marks ALLOW — 502.8 (K) for (2) marks ALLOW — 0.5028 (K) for (1) mark ALLOW TE from (a)(ii) If the calculation is not based on $\Delta S_{total} = 0$ then a maximum of (2) marks can be awarded if done correctly		**3**

Question Number	Acceptable Answers	Reject	Mark
22(b)	The catalyst is in a different state/phase to the reactants **(1)** IGNORE references to products **Any two from** It provides an alternative (reaction) route/mechanism/gases adsorbed on catalyst surface **(1)** Of lower activation energy/weakens bonds in reactants **(1)** Greater proportion of molecules have E ≥ Ea **(1)**		**3**

Question Number	Acceptable Answers	Reject	Mark
23 (a)(i)	(Ka =) $[H^+][C_6H_5COO^-]/[C_6H_5COOH]$ Penalise missing charges ALLOW $[H_3O^+]$ in place of $[H^+]$ IGNORE state symbols and units even if incorrect	Ka = $[H^+]^2/[C_6H_5COOH]$	**1**

Question Number	Acceptable Answers	Reject	Mark
23(a)(ii)	$[H^+] = \sqrt{(6.3 \times 10^{-5} \times 0.0025)}$ (1) pH = − log $\sqrt{(6.3 \times 10^{-5} \times 0.0025)}$ = 3.4 **(1)** Answer without working scores (2) marks 6.8 scores (1) IGNORE sf except 1	answer if units given	**2**

Question Number	Acceptable Answers	Reject	Mark
23(b)	(pH) range (of indicator) 3.8 to 5.4 OR pK_{in} = 4.7 **(1)** Bubble bath is (initially yellow since) pH less than 3.8 / is 3.4 **(1)** Adding of water/dilution (of acid) causes pH to rise/ means $[H^+]$ decreases **(1)** Hence pH rises to ≥ 5.4 so blue/changes colour **(1)** If a(ii) pH>3.8 and <5.4 then loses second marking point but can score other marking points. If a(ii) pH>5.4 then can score first and third marking points only	Water neutralizes acid	**4**

TOTAL FOR SECTION C = 21 MARKS

TOTAL FOR PAPER = 90 MARKS

Further copies of this publication are available from
International Regional Offices at www.edexcel.com/international

For more information on Edexcel qualifications, please visit
www.edexcel.com

Alternatively, you can contact Customer Services at
www.edexcel.com/ask or on + 44 1204 770 696

Pearson Education Limited. Registered company number 872828
with its registered office at Edinburgh Gate, Harlow, Essex CM20 2JE

Ofqual

Llywodraeth Cynulliad Cymru
Welsh Assembly Government

Rewarding Learning