Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2022

Life and Health Sciences

Assessment Unit AS 3

assessing

Aspects of Physical Chemistry in Industrial Processes

[SZ031]

THURSDAY 9 JUNE, AFTERNOON

MARK SCHEME

General Marking Instructions

Introduction

Mark schemes are published to assist teachers and students in their preparation for examinations. Through the mark schemes teachers and students will be able to see what examiners are looking for in response to questions and exactly where the marks have been awarded. The publishing of the mark schemes may help to show that examiners are not concerned about finding out what a student does not know but rather with rewarding students for what they do know.

The Purpose of Mark Schemes

Examination papers are set and revised by teams of examiners and revisers appointed by the Council. The teams of examiners and revisers include experienced teachers who are familiar with the level and standards expected of students in schools and colleges.

The job of the examiners is to set the questions and the mark schemes; and the job of the revisers is to review the questions and mark schemes commenting on a large range of issues about which they must be satisfied before the question papers and mark schemes are finalised.

The questions and the mark schemes are developed in association with each other so that the issues of differentiation and positive achievement can be addressed right from the start. Mark schemes, therefore, are regarded as part of an integral process which begins with the setting of questions and ends with the marking of the examination.

The main purpose of the mark scheme is to provide a uniform basis for the marking process so that all the markers are following exactly the same instructions and making the same judgements in so far as this is possible. Before marking begins a standardising meeting is held where all the markers are briefed using the mark scheme and samples of the students' work in the form of scripts. Consideration is also given at this stage to any comments on the operational papers received from teachers and their organisations. During this meeting, and up to and including the end of the marking, there is provision for amendments to be made to the mark scheme. What is published represents this final form of the mark scheme.

It is important to recognise that in some cases there may well be other correct responses which are equally acceptable to those published: the mark scheme can only cover those responses which emerged in the examination. There may also be instances where certain judgements may have to be left to the experience of the examiner, for example, where there is no absolute correct response – all teachers will be familiar with making such judgements.

COVID-19 Context

Given the unprecedented circumstances presented by the COVID-19 public health crisis, senior examiners, under the instruction of CCEA awarding organisation, are required to train assistant examiners to apply the mark scheme in case of disrupted learning and lost teaching time. The interpretation and intended application of the mark scheme for this examination series will be communicated through the standardising meeting by the Chief or Principal Examiner and will be monitored through the supervision period. This paragraph will apply to examination series in 2021–2022 only.

					AVAILABLE MARKS
1	**(a)**	**(i)**	Maxwell–Boltzmann (distribution) [1]		
		(ii)	The minimum amount of energy [1] required for a reaction/successful collision to happen [1] [2]		
		(iii)	Area under the curve shaded to the right of E_A [1]		
	(b)	**(i)**	Curve drawn that is the same shape [1] the peak is higher [1] and the peak is to the left of the original (T_1) [1] [3]		
		(ii)	Less particles have the activation energy for the reaction to occur [1] the area under the curve to the right of E_A is smaller [1] [2]		
		(iii)	Decrease in pressure [1]		10
2	**(a)**	**(i)**	Iron [1]		
		(ii)	**Pressure**: 200 atm [1] **Temperature**: 400–450 °C [1] [2]		
	(b)		Bonds broken: 946 + 3(436) = 2254 [1] bonds made: 6 × 389 = 2334 [1] Enthalpy change: –80 kJ mol^{-1} [1] [3]		
	(c)		Axes correctly labelled: Energy and reaction progress [2] Line drawn for reactants higher than that for products [1] [3]		
	(d)	**(i)**	$\rightleftharpoons$ [1]		
		(ii)	Dynamic equilibrium is when the rate of the forward reaction is equal to that of the reverse reaction [1] and the concentrations of reactants and products remain constant [1] [2]		
	(e)		$2NH_3 + H_2SO_4 \longrightarrow \mathbf{(NH_4)_2\,SO_4}$ [1]		13
3	**(a)**		Workforce/infrastructure/availability of raw materials [1]		
	(b)		Air/water/land [1]		
	(c)		A capital cost is any cost involved in the setting up of a chemical plant [1] Any correctly named capital cost, e.g. cost of land/buildings [1] [2]		4

AVAILABLE MARKS

4 **(a)** The enthalpy change of a reaction is independent of the route taken [1] provided the initial and final conditions remain unchanged [1] [2]

(b) The enthalpy change when one mole of a substance undergoes complete combustion [1] under standard conditions [1] [2]

(c) **(i)** 2(250.0) + 16 (–393.5) + 18 (–286.0) = [1]
500 – 6296 – 5148 = [1]
–10944 [1] kJ
(ii) –5472 [1] $kJ\,mol^{-1}$ [4]

(d) **(i)** Platinum/palladium/rhodium [1]

(ii) Increase the surface area/increase the rate of reaction/use less metal catalyst [1]

(iii) The catalyst is in a different physical state to the **reactants** [1]

(iv) Indicative content:

- a catalyst alters the reaction rate by providing a pathway with lower activation energy
- process of chemisorption
- reactants adsorb to the surface
- bonds are weakened
- react and then desorb
- poisoning occurs when a substance adsorbs to the active site/catalyst surface and blocks it
- the poison does not desorb/it deactivates the catalyst

Level of response	Marking Criteria	Marks
Excellent	Candidates articulate clearly how a catalytic convertor works. They use good spelling, punctuation and grammar and the form and style are of an excellent standard using 6 of the indicative points.	[5]–[6]
Good	Candidates provide a good description of how a catalytic convertor works. They use good spelling, punctuation and grammar and the form and style are of a good standard using 4–5 of the indicative points.	[3]–[4]
Basic	Candidates provide a limited description of how a catalytic convertor works. They use limited spelling, punctuation and grammar and the form and style are of basic standard. Using 1–3 of the indicative points.	[1]–[2]
	This response is not worthy of credit.	[0]

[6]

(e) **(i)** The engine has not warmed up enough for the catalyst to be efficient/the catalyst efficiency is 0% at lower temperatures [1]

(ii) As exhaust temperature increases the efficiency increases [1] until maximum efficiency is reached at 375 °C [1] [2]

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				AVAILABLE MARKS
5	**(a)**	Pipette/burette	[1]	
	(b)	It is a better insulator/reduce heat loss	[1]	
	(c)	**(i)** 10.4 °C	[1]	
		(ii) Q = 50 × 4.2 × 10.4 [1] – [1] 2184 [1] J	[3]	
		(iii) $\frac{0.32}{65}$ = 0.005	[1]	
		(iv) $\frac{2184}{0.005}$ [1] $\frac{436\,800}{1000}$ = –436.8 kJ [1]	[2]	
		(v) Add a lid to the polystyrene cup/stir during the reaction/extra insulation	[1]	10
6	**(a)**	**(i)** It is important to know the exact concentration of the solution	[1]	
		(ii) mass = 0.1 [1] × 40 4 [1] g	[2]	
		(iii) Wear gloves/use tongs	[1]	
		(iv) Any **six** from: • weigh out NaOH • dissolve the NaOH in a small amount of deionised water and stir • rinse the stirring rod and add washings to beaker • transfer to 500 cm^3 volumetric flask • rinse beaker/glass rod and add to flask • add deionised water to the flask to the mark • use bottom of the meniscus • insert stopper and shake/invert	[6]	
	(b)	**(i)** Using a (strong acid) and strong alkali	[1]	
		(ii) colourless [1] pink [1]	[2]	
	(c)	**(i)** 37.6 [1] cm^3	[1]	
		(ii) Reliability/identify anomalies	[1]	
		(iii) moles = 0.2 × 0.0376 = 0.00752	[1]	
		(iv) $\frac{0.00752}{2}$ = 0.00376	[1]	
		(v) conc = $\frac{0.00376}{0.025}$ = 0.1504 mol dm^{-3}	[1]	18
			Total	**75**