Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education

Life and Health Sciences

Assessment Unit AS 3

assessing

Aspects of Physical Chemistry in
Industrial Processes

[SZ031]

Assessment

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.

AVAILABLE MARKS

1 **(a)** **(i)** Gas/gaseous [1]

(ii) Reversible [1]

(b) **(i)** Yield of ethanol will increase [1]

Increase in pressure favours RHS because it has the least number of moles of gas [1] [2]

(ii) Yield of ethanol will remain the same/no effect [1]

(iii) Whether the reaction is exothermic or endothermic/value for ∆H [1]

(c) **(i)** 46 [1]

(ii) ecf from **(c)(i)** 105 000/28 = 3750 [1]
1:1 ratio [1]
3750 × 46 = 172 500 g
= 172.5 kg [1]
= 173 kg (3 sig fig) [1] [4]

(iii) ecf from **(c)(ii)** 125/173 × 100 [1]
72.3% [1] [2]

(iv) Side reactions [1]
reaction does not go to completion [1] [2] 15

2 **(a)** **(i)** CO_2 + NO [1]

(ii) Platinum/palladium/rhodium [1]

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

(iv) (lead) Poisons the catalyst/makes catalyst ineffective [1]
By blocking the active sites/sites for adsorption [1] [2]

(b) **(i)** Axes labelled correctly – enthalpy [1] and reaction progress [1]
Reactants higher than products [1] [3]

(ii) Two curves drawn – lower activation energy labelled as catalysed [1]
If both lines are dashed/solid then line must be labelled
If original solid + catalysed dashed without label - accept if correctly drawn

(c)

Chemical	Name of process	Catalyst	Temperature/ °C	Pressure/ atm
Ammonia	**Haber [1]**	Iron	400–500	**200–300 [1]**
Sulfuric acid [1]	Contact	Vanadium(V) Oxide	**400–500 [1]**	1–2
Nitric acid	Ostwald	**Platinum Rhodium [1]**	800–1000	4–10

[5] 14

				AVAILABLE MARKS
3	**(a)** Bonds broken = 432 + (413 × 2) + 838 = 2096 [1] Bonds made = 612 + (413 × 3) + 346 = 2197 [1] Enthalpy change = 2096 – 2197 [1] Enthalpy change = –101 [1]		[4]	
	(b) Bond enthalpies are averaged over a range of compounds		[1]	5
4	**(a)**	**(i)** Pipette	[1]	
		(ii) Rinse with distilled water [1] Rinse with sodium hydroxide solution [1] Ensure jet is filled/no air bubbles [1] Fill to 0 cm^3 using **meniscus** [1] ensure meniscus is at 0 cm^3	[4]	
	(b) Phenolphthalein [1] Colourless [1] to pink [1] [1] if wrong way round		[3]	
	(c)	**(i)** moles = 0.25 × 0.028 = 0.007	[1]	
		(ii) 0.007 ecf from **(c)(i)**	[1]	
		(iii) Concentration = 0.007/0.025 = 0.28 M ecf from (ii)	[1]	
	(d) Liquids lost during transfer/spillages/standard solution inaccurately made/interpretation of end point is subjective (as indicator works over a range of pH)		[1]	12

AVAILABLE MARKS

5 (a) **Correct diagram including labels.**
- (Conical) flask with reactants labelled [1]
- Gas syringe attached to flask using delivery tube and bung labelled [1]
- Stopwatch labelled [1] [3]

or other suitable alternative
penalise missing labels once only

(b) **Concentration**
- Rate should decrease as concentration decreases [1]
- Fewer particles present in a given volume [1]
- So less successful collisions per unit time [1]

Catalyst
- Rate should increase when catalyst is used [1]
- Catalyst provides an alternative pathway with lower activation energy [1]
- More particles with energy greater than the activation energy and so more successful collisions per unit time [1] [6] 9

6 **(a)** The enthalpy change of a reaction is independent of the route taken [1] providing the starting and finishing conditions remain the same [1] [2]

AVAILABLE MARKS

(b) **(i)** $\Delta H_1 = \Delta H_2 + \Delta H_3$ or alternative correct [1]

(ii) $\Delta H_1 = -42 - 57 = -99\,\text{kJ mol}^{-1}$ [1]

(c) Use a calorimeter/polystyrene cup [1]
Measure a known volume/mass of acid [1]
Measure a known volume/mass of alkali [1]
Add reactants (acid + alkali) to cup/calorimeter and place lid on [1]
Measure starting temperature [1]
Stir [1]
Measure highest temperature [1]
Use $Q = mc\Delta T$ to calculate Q [1]
Use value of Q to find a molar value for ΔH [1]

Level of response	Marking Criteria	Marks
Excellent	Candidates articulate clearly how to determine experimentally a value for enthalpy change of neutralisation. They use excellent spelling, punctuation and grammar and the form and style are of an excellent standard using 7 or more indicative points.	**[7]–[8]**
Very Good	Candidate provides a good description for enthalpy of neutralisation. They use good spelling, punctuation and grammar and the form and style are of a good standard using 5–6 indicative points.	**[5]–[6]**
Good	Candidate provides a reasonable description of enthalpy of neutralisation. They use good spelling, punctuation and grammar and the form and style are of a reasonable standard using 3–4 indicative points.	**[3]–[4]**
Basic	Candidates provide a limited description of enthalpy of neutralisation. They use limited spelling, punctuation and grammar and the form and style are of basic standard using 1–2 indicative points.	**[1]–[2]**
Not Worthy	This response is not worthy of credit.	**[0]**

[8]

(d) **100 kPa** and **298 K** [1] 13

	AVAILABLE MARKS
7 (a) Comparison to include any two of the following (accept converse)	
Industrial • larger scale/higher yield • more cost effective • more health and safety considerations • easier to automate • more difficult to alter process • more consideration needed for waste disposal • more consideration needed of environmental issues • more consideration needed when constructing/siting plant **or other suitable** [2]	
(b) (i) A capital cost is any cost incurred in the set-up/starting up of a chemical plant [1] Example: Cost of land/machinery or equipment/utilities set-up/ construction/buildings/designing or engineering costs [1] [2]	
(ii) A direct cost is any cost associated with the production or costs linked to the chemical process (not set-up) [1] Example: raw materials (reactants and catalysts)/fuel/packaging/ transport [1] [2]	
(c) As production costs increase selling price will increase/selling price higher than production cost (or converse) [1]	7
Total	**75**