RECOGNISING ACHIEVEMENT

Subject: Chemistry Practical 2
Code: 2816/03

Session: June
Year: 2002

Final Mark Scheme

MAXIMUM MARK	60

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2816/03
Practical Examination: June 2002
Mark Scheme

Skill P [16 marks]

(a) Identification tests: 10 marks (maximum)

2 marks are available for each of <u>five</u> valid compounds selected.
Award not more than 2 marks for A, B, C and E: not more than 4 for D.

In general <u>four</u> points are required for each compound to score both marks
- ***<u>One mark</u> is normally awarded for a test <u>and</u> essential conditions.***
- ***<u>One mark</u> is given for the observation made <u>and</u> an equation for the reaction.***
- ***Any two of these points given for a specific compound scores <u>one</u> mark***

Mark tests in a way which maximises the mark awarded.

The scheme below shows likely tests only. Many other chemical tests are suitable.

When marking equations
- *Structural (or unambiguous) formulae are acceptable in all cases*
- *Penalise poor ICT (eg C2H5OH) once only*
- *Penalise trivial error (eg missing out an H atom) once only*
- *Penalise a repeated error (eg C_2H_5 for "prop") once only*

*Other compounds such as an unsaturated alcohol **or** diol **or** a second ester are acceptable, provided that the candidate researches and describes a suitable test.*

Some candidates may begin by adding sodium metal or *potassium dichromate(VI) in order to divide their six compounds into two groups of three. Others will begin by using 2,4-DNP or Lucas test in a similar way.*
Then they will distinguish between the compounds within each group of two or three.

***Apply a penalty of one mark** for a test which, in the context quoted, is not conclusive.*
This means that the first mark otherwise earned is not awarded.
Example: if sodium is given to test for the alcohols <u>before</u> the candidate has eliminated the acid, then give maximum 3 (instead of four) if everything is otherwise correct.

<u>Propanoic acid</u> (2 marks)

A1 Add magnesium ***or*** a named metal carbonate ***or*** named indicator [1]

A2 Observation ***and*** correct equation for reaction of acid [1]
*$Mg + 2C_2H_5COOH \rightarrow (C_2H_5COO)_2Mg + H_2$ (**or** ionic equation)*
Do not accept "gas" or name as an observation

<u>Or</u>

A3 Add ethanol/methanol ***and*** heat in presence of concentrated sulphuric acid [1]
*Accept "heat with sulphuric acid" **or** "add concentrated sulphuric acid"*

A4 Sweet/fruity smell produced ***and*** an equation for the reaction [1]
$CH_3COOH + C_2H_5OH \rightarrow CH_5COOC_2H_5 + H_2O$

Propanal (2 marks)

B1 Warm with ammoniacal silver nitrate/diammine silver ions/Tollens reagent [1]
B2 Silver mirror/black precipitate formed [1]

Or

B3 Warm with [mixed] Fehling's solutions (= Benedict's reagent) [1]
B4 Brown/red precipitate formed [1]

Or

B5 Add Schiff's reagent [1]
B6 Gives a red colour [1]

Propanone (2 marks)

C1 Add a solution of 2,4-dinitrophenylhydrazine [1]
C2 Orange precipitate obtained
and m.p. of solid determined ***or*** correct equation researched [1]
$CH_3COCH_3 + C_6H_3(NO_2)_2N_2H_3 \rightarrow C_6H_3(NO_2)_2NHN{=}C(CH_3)_2 + H_2O$

Or

C3 Add concentrated aqueous sodium hydroxide followed by excess iodine
or potassium iodide and excess sodium chlorate(I) [1]
C4 Yellow precipitate formed ***and*** equation [1]
$CH_3COCH_3 + 3I_2 + 4NaOH \rightarrow CHI_3 + CH_3COONa + 3NaI + 3H_2O$

Propan-1-ol and propan-2-ol (4 marks)

D1 Heat with acidified potassium dichromate/ dichromate (VI) ions. [1]
*Accept either "warm" **and** "acidified" as the condition. Allow $KMnO_4$.*
D2 Both compounds give a colour change to green/turquoise
and a correct redox statement [1]

D3 Positive test for acid/aldehyde produced from primary alcohol. [1]
Accept any sensible attempt to test even if it would prove difficult to do.
Product (acid or aldehyde) must match conditions used.
D4 Propan-2-ol oxidises to give a ketone/propanone ***and*** equation
$CH_3CH(OH)CH_3 + [O] \rightarrow CH_3COCH_3 + H_2O$ [1]

Or

D5 Add small pieces of sodium metal to both alcohols [1]
Accept "cleaned/freshly cut/equal size" as an alternative to "small"
D6 Both fizz/give hydrogen ***and*** one equation [1]
$2C_3H_7OH + 2Na \rightarrow 2C_3H_7ONa + H_2$
D7 Propan-1-ol gives the faster reaction [1]
D8 Quantitative comparison of rate [1]
Eg compare volumes of gas evolved in (say) 30 s, using a gas syringe.

Or

D9 Add phosphorus pentachloride to dry sample [1]
Alternative reagents are acceptable: "dry" must be stated
***No** marks if this test is used to distinguish between propan-1- and -2-ol*

D10 Steamy/acidic fumes ***and*** equation [1]
$C_3H_7OH + PCl_5 \rightarrow HCl + POCl_3 + C_3H_7Cl$

Or

D11 Add concentrated hydrochloric acid and zinc chloride [1]
D12 Propan-2-ol goes cloudy [more] quickly [1]
D13 Propan-1-ol goes cloudy slowly ***and*** equation [1]
$C_3H_7OH + HCl \rightarrow H_2O + C_3H_7Cl$

Methyl ethanoate *or* ethyl methanoate (2 marks)

*If an incorrect ester is selected (eg methyl propanaote) penalise by **one** mark.*

E1 Heat strongly/boil/reflux with aqueous sodium hydroxide [1]
***Both** conditions are needed for the mark*
*Accept alternative reagents, including HCl **or** water and acid*

E2 Suitable observation to prove reaction has occurred ***and*** equation [1]
$CH_3COOCH_3 + NaOH \rightarrow CH_3COONa + CH_3OH$

(b) Safety and Sources etc – 6 marks available

S1 A specific and significant hazard stated for two of the materials or tests [1]
Mark S1 and S2 as a pair: one hazard + one linked measure = 1 mark

S2 Appropriate specific safety measure(s) to reduce/eliminate these two hazards [1]
Possibilities include:
- *having propan-2-ol available to dispose of any Na spilled*
- *use of water bath **or** electric heating **or** reflux conditions for flammables*
- *fume cupboard (for acrid fumes produced by PCl_5)*

No mark for "routine" precautions such as safety specs or wearing lab coa]
Two different types of hazard must be discussed for both S1 and S2

S3 Uses of least two sources, with specific references
which may include a data book to research [quoted] physical data [1]
Book references must show chapter or page number
Internet address must go at least as far as the first forward slash

S4 Good use of language and QWC, and of length within 500 – 1100 words [1]
*A word count must be given every 200 words **or** as a final total.*
QWC: award S4 if there are no more than three or four slips, including spelling, ICT slips in text, poor scientific language and grammar.

S5 A logical ordered sequence of tests is clearly described [1]
Did the candidate list six correct compounds at/near the start?
Does the account flow logically – or were tests in a hit and miss fashion?

S6 Flow chart of reactions given [1]
The sequence must identify all six compounds adequately

One **safety precaution** stated ***and*** explained briefly [1]
*Accept any sensible idea, such as safety specs/ pipette filler, related to harmful/ irritant/ corrosive acid **or** a suitable precaution when heating/using hot liquid.*

Marks on Pages 4 and 5: Skill A - [15 marks]

A correct answer generally scores the mark for the working leading to it.
Mark are awarded "error carried forward (ecf)" between parts whenever possible.
The total mark on pages 4 and 5 is entered on the answer book as "Question 2"

(a) *Mr* of $KMnO_4$ = 158 [1]
$[KMnO_4] = {}^{3.50}/_{158} = 0.0221(5)$ mol dm^{-3} [1]
Accept 2, 3 or 4 sig fig. No ecf mark from wrong Mr on this part.
No units needed. Answer only scores 2 marks.

$n(KMnO_4)$ in mean titre = ${}^{0.0221 \times titre}/_{1000}$ [1]
Candidate correctly calculates $n(KMnO_4)$ in mean titre [1]
n should work out to be approximately 0.0006 – 0.0007 mol
This answer must be quoted to 3 sig fig to earn the fourth mark
Do not award the fourth mark for a "calculator speak" answer, 6^{-4}

(b) Correct half-equation: $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ [2]
*Award **one** mark if the **only** error is the 5 electrons*
Mn(VII) + $5e^- \rightarrow$ Mn(II) scores one mark
Clear explanation of mole ratio by linking number of moles of electrons [1]
$MnO_4^- + 2.5\ H_2X + 3H^+ \rightarrow 2.5\ X + Mn^{2+} + 4H_2O$ scores the mark
No penalty if hydrogen ions were not cancelled (8 and 5)

(c) $n(\mathbf{H_2X})$ in 25 cm^3 = 2.5 x $n(KMnO_4)$ = 2.5 x "a" [1]
$n(\mathbf{H_2X})$ in 250 cm^3, correctly calculated *(= 25 "a" = 0.015 mol, approx)* [1]
Correct answer only scores both marks

(d) $M_r = {}^{\text{mass of acid used}}/_{\text{moles in 250 cm3}}$ [1]
The candidate may use his/her own figures or the expression above
Mr calculated correctly. [2]
Correct answer alone does not score the "working" mark here.
*Note – these marks are for a correct calculation, **not** for accuracy*

(e) *Mr* of anhydrous acid = 90 [1]
w (moles of water) correctly deduced (w = 2), with some working [2]
Allow ecf to wrong Mr in "d" but not to wrong anhydrous Mr

Marks on Pages 7 and 8: Skill E - [14 marks, maximum]

Part (a) - 5 marks

Award ecf marks between each complete part of the question

A1 Mass loss = 78.54 + 5.20 + 100.0 +10.5 – 191.02 = 3.22 g [1]
A2 $n(CO_2) = {}^{3.22}/_{44} = 0.0732$ mol [1]

A3 Explanation of mole ratio: 1 mole CO_2 is produced by 0.5 mole H_2X [1]
*Statement that H_2X is dibasic **or** a "molecular equation" are acceptable*

A4 $n(\mathbf{H_2X}) = 0.5 \times n(CO_2) = 0.0366$ [1]
*Award of mark A4 does **not** earn A3 unless the mole ratio is explained.*

A5 M_r of $\mathbf{H_2X} = {}^{5.20}/_{0.0366} = 142$ [1]

***Part (b) - Maximum of 3 marks** (out of 4 available)*

B1 Cotton wool plug is to prevent loss of water/acid spray [2]
Do not award B1 if there is any suggestion of keeping gas in the flask
A vaguer statement, such as "to prevent loss of reagents" scores one mark.

B2 It stops dust getting in [1]

B3 [Unlike a bung] it allows the gas/carbon dioxide to get out [1]

***Part (c) - Maximum of 5 marks** (out of 9 available)*

C1 The reaction is slow because the acid is weak ***or*** dilute [1]

C2 Heating speeds the reaction up. [1]

C3 This would make sure that the reaction was completely finished
or an explanation of the rate increase in terms of collision frequency/energy. [1]

C4 Some CO_2 dissolves in water in the flask [1]

C5 Heating reduces the solubility of gases in water [1]

C6 Heating might cause some water to evaporate [1]

C7 Loss of water increases the measured mass loss. [1]

C8 Sodium hydrogen carbonate decomposes when heated [1]

C9 This decomposition would produce extra carbon dioxide [1]

***Part (d) - Maximum of 5 marks:** (out of 9 available)*

D1 The experiment was not were not repeated/ done only once [1]

D2 They should take repeats until consistent
or they should repeat the experiment and calculate the mean value
or taking repeats eliminates experimental error/anomalous results [1]
Award of D2 also earns D1

D3 Some carbon dioxide dissolves in the water in the flask [1]

D4 Some carbon dioxide is left/trapped in flask after experiment [1]

D5 This is because CO_2 is denser than air [1]

D6 The $NaHCO_3$ experiment involves measuring five masses [1]

D7 This leads to significant cumulative inaccuracy in the mass loss. [1]
or the mass loss is relatively small, resulting in high % inaccuracy

D8 The reaction may not have finished [1]

D9 Keep weighing until the total mass stays constant [1]

Any marking points not already earned can be awarded in an answer to (d) provided that the maximum for earlier parts is not exceeded.