Version for Publication

A2 Practical 2816/03
January 2005: Mark Scheme

Skill P 16 marks (out of 19 available)

C Chemical tests (6 marks)

Mark each test by "notional half marks" if there are two small errors

C1 Test for sulphate: add barium nitrate/chloride to give a white precipitate. [1]
Reagent and observation required

C2 Any **two** of the points below are needed for mark C2
- Precipitate (barium sulphate) identified by name or formula
- Any correct "molecular"/ionic equation for the reaction
- Adding dilute hydrochloric/nitric acid as well as the barium ions [1]

C3 Test for NH_4^+ ions: <u>heat</u> with an alkali to obtain a gas that turns red litmus blue. [1]
Heat is necessary for this mark

C4 Gas is ammonia ***and*** a relevant equation given [1]

C5 Test for acidity: add a suitable metal ***and*** get fizzing/hydrogen [1]
Sodium and calcium (etc) are not suitable.
A specified metal carbonate (evolving CO_2) is suitable as alternative

C6 Test for H_2 gas ("pop" with flame) ***and*** an ionic ***or*** "molecular" equation given [1]
Lime water goes milky if metal carbonate was used
*Equation for lime water test (**or** burning hydrogen) is credited as an equation*

D Determination of concentration (9 marks)

D1 Makes up a "known"/standard solution of <u>any</u> relevant compound [1]
Weighing the solid, use of pure water to make up and a volumetric flask are all required.

D2 Calculates a suitable mass of iron(III) ammonium sulphate to make up a solution. [1]
The iron(III) ion solution must not be more concentrated than 0.1 mol dm^{-3}

D3 Makes up mixtures of aq Fe^{3+} with aq CNS^-
and measures absorbances using the colorimeter [1]

D4 Details of compositions of suitable mixtures given [1]
At least 6 mixtures must be used with detail of their make up.

D5 **Two** details of the colorimeter [1]
- *Sketch diagram **or** brief description of components of the instrument*
- *Use blue/green (or "complementary") filter for white light source*
- *Mixtures put into a cuvette/special cell for measurement*
- *Colour intensity is proportional to the absorbance*

D6 Complex produced is <u>red</u> ***and*** has formula $[Fe(H_2O)_5(SCN)]^{2+}$ [1]
An equation for the reaction showing $[Fe(SCN)]^{2+}$ scores the mark

D7 Background theory of ligand substitution ***or*** origin of colour [1]

D8 Shows a sketch graph of results
and interprets where the curve becomes horizontal/maximum
or reads off absorption of "unknown" iron(III) solution from a calibration curve [1]
The axes of the sketch graph in either case must be suitably labelled

D9 Shows how ***x*** in iron(III) salt is calculated from its concentration and mass. [1]

S 4 marks for safety, sources and QWC

S1 Hazards ***and*** safety stated for ***two*** "unsafe" chemicals used in the procedure [1]
Any "standard" precaution (such as wearing safety specs) is acceptable.
Penalise an overstatement of the hazard.

S2 References to two secondary sources quoted as footnotes ***or*** at end. [1]
- *Book references must have full title and page numbers*
- *Internet reference must go beyond the first slash of web address*
- *Accept one <u>specific</u> reference to a "Hazcard"*

S3 **QWC**: text is legible ***and*** spelling, punctuation and grammar are accurate [1]
Allow only five different errors in legibility, spelling, punctuation or grammar.

S4 **QWC**: information is organised clearly and coherently [1]
- *Is a word count given and within the limits 400 – 800 words?*
- *Is scientific language/terminology used correctly? (Allow one error)*
- *Are the descriptions presented logically and without undue repetition?*

Practical test (Part B)

Part 1 Mainly Skill I (12 marks)

Mass readings [1]

- Both mass readings must be listed with units shown (somewhere)
- All masses should be recorded to two (or three) decimal places
- Subtraction to give mass of **E** must be correct.

Presentation of titration data [2]

- Correctly labelled table used to record burette data
- Trial titre is shown ***and*** clearly labelled
- All "accurate" burette data are quoted to at least 0.05 cm^3 (i.e. 2 decimal places)
- All subtractions are correct

Self-consistency of titres [1]

- Candidate's two best titres should agree within 0.15 cm^3.
- Units, cm^3 or ml, are given somewhere (**once** in or alongside the table is sufficient)

Mean titre correctly calculated, with "cm^3 or ml" unit given [1]

Accuracy and Safety – 6 + 1 marks are available

Work out, using the steps below, what the adjusted candidate's titre (T) would have been if the candidate had used the same mass of Y as the supervisor.

***Adjusted titre, T* = candidate's mean titre x $^{\text{supervisor's mass}}/_{\text{candidate's mass}}$**

T is within 1.20 cm^3 of mean supervisor's value	[1 mark]
T is within 1.00 cm^3 of mean supervisor's value	[2]
T is within 0.80 cm^3 of mean supervisor's value	[3]
T is within 0.60 cm^3 of mean supervisor's value	[4]
T is within 0.40 cm^3 of mean supervisor's value	[5]
T is within 0.25 cm^3 of mean supervisor's value	[6 marks]

Spread penalty

If the two "best titres" have a spread > 0.40 cm^3, deduct 1 mark.
If the two "best titres" have a spread > 0.60 cm^3, deduct 2 marks.
If the two "best titres" have a spread > 0.80 cm^3, deduct 3 marks from accuracy (etc)

One **safety precaution** stated ***and*** explained briefly [1]

However, the precaution must be related to [one of] the irritant/harmful materials.

Part 2 Calculation (11 marks)

(a) *M*r of $KMnO_4$ = 158 [1]

$[KMnO_4] = {}^{3.00}/_{158}$ = 0.0190 mol dm^{-3} [1]

$n(KMnO_4) = {}^{0.0190 \times titre}/_{1000}$ = 4.4 x 10^{-4} mol (0.00044 approx) [1]
Correct answer only (if no working is shown) scores 2 marks

(b) $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ [1]

(c) $Fe^{2+} - e^- \rightarrow Fe^{3+}$ (***or*** $Fe^{2+} \rightarrow Fe^{3+} + e^-$) [1]

Clear explanation of 1:5 mole ratio
or combined equation: $MnO_4^- + 8H^+ + 5Fe^{2+} \rightarrow 5Fe^{3+} \rightarrow Mn^{2+} + 4H_2O$ [1]

(d) $n(Fe^{2+})$ in 250 cm^3 = 50 x "a" = 0.022 mol (approx) [1]

(e) *M*r = ${}^{mass}/_{moles}$ (formula quoted ***or*** numbers substituted) [1]

*M*r calculated correctly from data obtained (should be 392) [1]

(f) Mr of **x**H_2O = 392 (***or*** answer **"e"**) – 152 – 132 *(or 380 – 152 – 132)* [1]
380 is the "rescue" answer suggested on the question paper

x = ${}^{108}/_{18}$ *(or* ${}^{96}/_{18}$*)* = 6.00 *(or 5.33)* [1]

Part 3 Test tube tests (7 marks max)

(a) **2 marks**

Green precipitate/solid formed [1]

$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$ [1]

(b) **3 marks**

Green precipitate [1]

Precipitate/mixture goes brown at the top/on the surface
or [slight] fizzing/bubbles of gas [1]

Iron(II) carbonate [1]
Carbon dioxide is acceptable if "gas" observation is quoted

(c) **2 marks**

Observation: no change
or pale pink/orange/yellow colour formed [1]

Fe^{3+} ions are not present
or SCN^- ions are used to test for Fe^{3+} [1]
If pink colour was observed, this answer must be "Fe^{3+} ions are present"

4. Evaluation (14 marks, max)

(a) 3 marks

$n(BaSO_4) = {}^{0.22}/_{233}$ [= 0.00094(4) mol] [1]

n(**E**) = 0.5 x 00094 = 0.00047(2) mol [1]

M_r of **E** = ${}^{0.17}/_{0.00047}$ = 360 [1]
Answer = 180/181 will normally score 2 marks (ecf) if some working is shown

(b) 4 marks

% accuracy = ${}^{0.01 \text{ or } 0.02}/_{0.22}$ x 100 [1]
Two weighings are normally done, so 0.02 is cumulative error

Inaccuracy = 9.09% [1]

Use a greater mass of solid
or use a balance reading to 3 (or more) decimal places [1]

Correct calculation of new % error, for modification suggested [1]

(c) Maximum of 9 marks awarded on answers to (c) and (d)

A ***Completeness of drying***

A1 Residue (or paper) may not be dry ***or*** water may still be present [1]

A2 Heat [residue and paper] for a longer period ***or*** heat them more strongly [1]

A3 Keep heating and weighing until two consecutive weighings are equal
or the residue should be heated to <u>constant mass</u> [1]

B ***Filtration problems (2 marks only)***

B1 Some solid may pass through [pores in the] filter paper
or residue on the filter paper needs to be washed [1]

B2 Warm prior to filtration to coagulate precipitate *(reason required)*
or cool to reduce solubility *(reason required)*
or use finer filter paper ***or*** thicker/multiple paper. [1]

C ***Ensuring that the reaction has been completed***

C1 Not all of **E** might have reacted
or not all barium sulphate might have been precipitated [1]

C2 Use more barium chloride [1]

C3 <u>Excess</u> barium chloride must be used [1]

D ***Repeated readings***

D1 Repeat the experiment [1]

D2 Take mean of readings ***or*** obtain consistent readings [1]

D3 Consistent/averaged readings are evidence of reliability [1]

(d)

*Any marking points **not** already earned in (b) or (c) can be awarded in part (d).*

E1 The burette/pipette is accurately calibrated/manufactured [1]
A reference to tolerances scores E1

E2 % error of one piece of equipment correctly calculated [1]
Pipette tolerance is 0.04/0.06 cm^3: burette tolerance is 0.05/0.1 cm^3

E3 End point colour change for the titration reaction is sudden/sharp/easy to see [1]

E4 Correct discussion of cumulative errors from multiple readings
– all gravimetric measurements are subject to high % error [1]