LABORATORY VALIDATION TEST

Name: .....

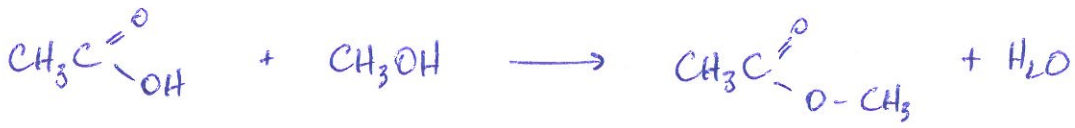
1. A student is attempting to conduct an esterification reaction by combining concentrated ethanoic acid with methanol and placing it in a hot water bath (60°C) for about 15 minutes.

[2] (a) Name the third chemical required for this reaction and state its function in the reaction.

sulfuric acid ✓

catalyst ✓

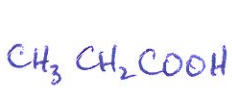
[1] (b) Write the chemical equation for the reaction.



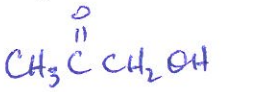
[1] (c) Write the name of the organic product of this reaction.

methyl ethanoate

[2] (d) Draw and name an isomer of this compound that is ***not*** an ester.


propanoic acid

OR

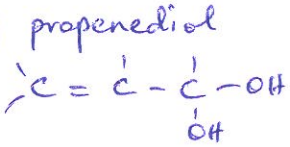

hydroxypropanone

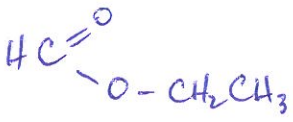
OR


2(or 3)-hydroxypropanal.

[2] (e) Draw and name an isomer of this compound that ***is*** an ester.

any propenediol




ethylmethanoate

[1] (f) Describe the observation that would indicate that esterification had occurred.

sweet / fruity odour

2. (a) Describe how a student could prepare a sample of 3-pentanone. The description should include the names the starting materials and a brief description of the reaction conditions.

[3] [2]

- Start with 3-pentanol + $KMnO_4$ or $K_2Cr_2O_7$
- acidic conditions (H_2SO_4)
- warm water bath

½ each

(b) Write a balanced chemical equation for the reaction.

[2]

$CH_3CH_2\overset{OH}{C}HCH_2CH_3 \rightarrow CH_3CH_2\overset{O}{C}CH_2CH_3 + 2H^+ + 2e^-$ ×5

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ ×2

or $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$.

OR $5\,CH_3CH_2CHOHCH_2CH_3 + 2MnO_4^- + 6H^+ \rightarrow 5\,CH_3CH_2COCH_2CH_3 + 2Mn^{2+} + 8H_2O$

OR $3\,CH_3CH_2CHOHCH_2CH_3 + Cr_2O_7^{2-} + 8H^+ \rightarrow 3\,CH_3CH_2COCH_2CH_3 + 2Cr^{3+} + 7H_2O$.

3. Four chemicals are to be tested for their reaction (or lack of reaction) with sodium metal. The four compounds to be tested are

- propanoic acid,
- propanone,
- 2-methyl-2-propanol and
- 1-propanol.

(a) Not all of these compounds will react with the sodium. Name the compound(s) that show no reaction.

[1] propanone

(b) Which of the compounds that ***do*** react will show the ***slowest*** rate of reaction?

[1] 2-methyl-2-propanol

(c) At least two of the four compounds will react with the sodium. Write a balanced chemical equation for any compound that does react.

[2] any one

$2\,CH_3CH_2CH_2OH + 2Na \rightarrow 2\,CH_3CH_2CH_2ONa + H_2$

$2\,CH_3CH_2COOH + 2Na \rightarrow 2\,CH_3CH_2COONa + H_2$

$2\,CH_3-\overset{OH}{\overset{|}{C}}(CH_3)-CH_3 + 2Na \rightarrow 2\,CH_3-\overset{O\,Na}{\overset{|}{C}}(CH_3)-CH_3 + H_2$

(d) Write the name of the main (organic) compound produced.

[1] sodium propoxide sodium propanoate

Consistent with part (c)

sodium 2-methyl-2-propoxide.

4. Describe tests that would allow you to distinguish between the following pairs of chemical. Include in your answer the observations (including 'no visible change' if applicable) that would be made. (NOTE: The chemical to be used for the test in part (b) is given.)

(a)
[3]

ethanoic acid and ethanal	
TEST	OBSERVATIONS
Universal Indicator Add Na Add $KMnO_4$	ethanoic acid: UI → red Na → c'less, o'less gas MnO_4^- → NVR ethanal: UI → green Na → NVR MnO_4^- → purple sol^n turns c'less

✓ ✓ ✓

(b)
[2]

2-methyl-2-butanol and 1-butanol	
TEST	OBSERVATIONS
Acidified $KMnO_4$ is added	2-methyl-2-butanol: NVR 1-butanol: MnO_4^- decolorized.

✓ ✓

(c) With reference to the test in part (b) above, write the half equations and the full redox reaction for the reaction of acidified potassium permanganate with the 1-butanol.

[2]

$CH_3CH_2CH_2CH_2OH + H_2O \rightarrow CH_3CH_2CH_2COOH + 4H^+ + 4e^-$ ×5

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ ×4

$5CH_3CH_2CH_2CH_2OH + 4MnO_4^- + 12H^+ \rightarrow 5CH_3CH_2CH_2COOH + 4Mn^{2+} + 11H_2O$

✓ ✓

OR.

$CH_3CH_2CH_2CH_2OH \rightarrow CH_3CH_2CH_2CHO + 2H^+ + 2e^-$ ×5

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$ ×2

$5CH_3CH_2CH_2CH_2OH + 2MnO_4^- + 6H^+ \rightarrow 5CH_3CH_2CH_2CHO + 2Mn^{2+} + 8H_2O$

✓ ✓