Multiple Choice Answers

Q1: B
Q7: D
Q9: B
Q11: C
Q12: A
Q15: A
Q16: C
Q19: D
Q40: D

Multiple Choice Answers

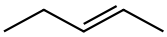
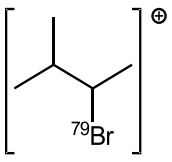
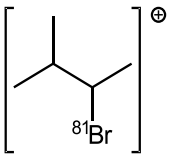
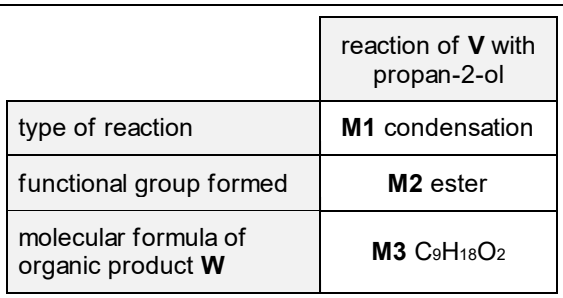
Q38: D

Multiple Choice Answers

Q3: B
Q5: A

1(a)(i)	24 protons 28 neutrons 24 electrons
1(a)(ii)	(^{54}Cr has two) more neutrons (than ^{52}Cr)
1(a)(iii)	(relative) abundance (of each isotope)
1(a)(iv)	The fourth isotope has any value of RIM less than 51.996
1(b)(i)	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ (3d^5\ 4s^1)$
1(b)(ii)	6
1(c)(i)	Cr / $Cr_2O_7^{2-}$ **AND** it gains electrons
1(c)(ii)	(+)4
1(c)(iii)	*Due to an issue with question 1(c)(iii), the question has been removed from the question paper.*
1(c)(iv)	**M1** CO_2 has only instantaneous / temporary dipole–induced dipole forces **AND** methanal has permanent dipole–permanent dipole (and id-id) forces **M2** IMF's in methanal are stronger than IMF's in CO_2
1(d)(i)	rate of forward and backward (reaction) are the same / equal **OR** concentrations of reactants and products are constant
1(d)(ii)	closed system
1(d)(iii)	**M1** (mixture becomes more) orange **M2** forward reaction is endothermic **M3** (mixture becomes more) orange **M4** equilibrium moves (forwards/right) to compensate for extra acid / H^+
1(e)	**M1** hydrolysis **M2** $CrF_4 + 2H_2O \rightarrow CrO_2 + 4HF$

2(a)	**M1** Al_2O_3 is ionic **M2** P_4O_{10} is a (simple) molecule **M3** ionic bonds are stronger than intermolecular forces
2(b)(i)	$mol^{-2}\ dm^6$
2(b)(ii)	**M1** at equilibrium: moles of CO = 0.120 **AND** moles of H_2 = 0.240 **M2** $[CH_3OH]$ = 0.056 **AND** [CO] = 0.024 **AND** $[H_2]$ = 0.048 **M3** use of K_c with correct evaluation = 1.01×10^3
2(b)(iii)	no effect **AND** K_c is not affected by pressure
2(c)(i)	increases rate by providing a different mechanism with a lower activation energy
2(c)(ii)	$2CH_3OH \rightarrow CH_3OCH_3 + H_2O$
2(c)(iii)	$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$

4(a)(i)	**M1** (molecules with the) same molecular formula / same number of atoms of each element **M2** different structural formulae/structures
4(a)(ii)	**M1**  **M2** restricted / lack of / no rotation about C=C
4(a)(iii)	electrophilic addition
4(a)(iv)	**M1** $CH_3COCH_3 + CH_3COOH$ as products **M2** $(CH_3)_2C = CHCH_3 + 3[O] \rightarrow CH_3COCH_3 + CH_3COOH$
4(a)(v)	**M1** (reaction proceeds via a) more stable intermediate / carbocation **M2** because of greater positive inductive effect of more alkyl groups
4(a)(vi)	**M1**  **M2** 
4(b)(i)	KCN in ethanol (and heat)
4(b)(ii)	$(C_2H_5)_2CHCN + 2H_2O + HCl \rightarrow (C_2H_5)_2CHCOOH + NH_4Cl$
4(b)(iii)	

2(a)	**I** Six correct headings with units in results space • (Mass) crucible + lid / g • (Mass) crucible + lid + **FA 4** / g • (Mass) crucible + lid + residue / contents after first heating / g • (Mass) crucible + lid + residue after second heating / g • (Mass) **FA 4** (used) / g • (Mass) residue / g Display of units: / g, (g), in g, in gram(me)s or in (column) heading covering all entries
	II Four readings in space provided • All four weighings recorded to same decimal places (either to two or to three) • Reading after 2nd heating within + 0.02 and − 0.05 of reading after 1st heating
	II Correct subtractions • Correct calculations of mass **FA 4** and residue **AND** • Mass of **FA 4** is between 2.90 and 3.40 g.
	IV and V Accuracy Theoretical value = 1.78 Calculate and record candidate's mass ratio = mass **FA 4** / mass of residue. Award **IV** if 1.51 ⩽ candidate's mass ratio ⩽ 2.05 Award **V** if 1.60 ⩽ candidates mass ratio ⩽ 1.96
2(b)(i)	Correctly uses **M1** Amount $ZnSO_4$ = mass residue / 161.5 mol **AND** answer given to 2 – 4 sf Correctly calculates **M2** Amount H_2O = mass water lost / 18 mol **AND** answer given to 2–4 sf
2(b)(ii)	**M1** y = moles H_2O / moles $ZnSO_4$ **M2** Expression evaluated and y correctly calculated quoted as integer
2(c)	The (anhydrous ethanedioic) acid would decompose (on heating) / is flammable

<table>
<tr><td>2(a)</td><td>To ensure no air / other gas remains in the syringe</td></tr>
<tr><td>2(b)(i)</td><td>
<table>
<tr><td>$\sqrt{\frac{1}{Mr}}$</td><td>0.707</td><td>0.500</td><td>0.222</td><td>0.158</td><td>0.109</td></tr>
<tr><td>Rate of effusion /cm^3s^{-1}</td><td>4.63</td><td>3.27</td><td>1.45</td><td>1.26</td><td>0.71</td></tr>
</table>
</td></tr>
<tr><td>2(b)(ii)</td><td>Time (taken).</td></tr>
<tr><td>2(b)(iii)</td><td>size of hole</td></tr>
<tr><td>2(c)</td><td>M1 all 5 points plotted correctly.

M2 Straight line of best fit drawn</td></tr>
<tr><td>2(d)</td><td>Point most anomalous to the plotted line of best fit circled.

AND

If point above LOBF
(Measured rate of effusion is higher than the true rate predicted by LOBF.)
for this point …
measured / recorded (effusion) time < true / actual time

OR
If point below LOBF
(Measured rate of effusion is lower than the true rate predicted by LOBF.)
for this point …
measured / recorded (effusion) time > true / actual time</td></tr>
<tr><td>2(e)</td><td>Yes AND The graph / LOBF…
is a straight-line AND it goes through the origin.</td></tr>
<tr><td>2(f)</td><td>The results are not reliable as there is an anomalous result.</td></tr>
<tr><td>2(g)(i)</td><td>M1 Effusion rate = 50/31.6 = (1.58)
Correct value for $\sqrt{\frac{1}{Mr}}$ read from x-axis</td></tr>
<tr><td></td><td>M2 Value correctly converted to M.</td></tr>
<tr><td>2(g)(ii)</td><td>If calculated M > 16
(The average) M (of the other components) is greater than 16 / calculated value for g(i).</td></tr>
<tr><td>2(h)</td><td>(Rate of effusion) increases
AND
(At higher temperature) gas particles move more quickly.</td></tr>
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