

FACTFILE: GCE CHEMISTRY

ANSWERS TO AS2 FACTFILE QUESTIONS



ANSWERS

2.1 Formulae, percentage yield and atom economy

1. moles of butan-1-ol = $\frac{5.0}{74} = 0.06757 \text{ mol}$ [1]
moles of 1-bromobutane = 0.06757 mol
theoretical yield of 1-bromobutane = $0.06757 \times 137 = 9.26 \text{ g}$ [1]
% yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100 = \frac{6.4}{9.26} \times 100 = 69.1 \%$ [1] [3]
2. moles of C = $\frac{22.2}{12} = 1.85 \text{ mol}$
moles of H = $\frac{3.7}{1} = 3.7 \text{ mol}$
moles of Br = $\frac{74.1}{80} = 0.9263 \text{ mol}$
empirical formula = C₂H₄Br
molecular formula = C₄H₈Br₂
(as RMM of C₂H₄Br = 108 so $\times 2$ for 216)
all moles [1]
empirical formula [1]
molecular formula [1] [3]
3. moles of H₂O₂ = $\frac{50.0 \times 2}{1000} = 0.1 \text{ mol}$ [1]
moles of O₂ = $\frac{0.1}{2} = 0.05 \text{ mol}$ [1]
volume of oxygen = $0.05 \times 24000 = 1200 \text{ cm}^3$ (or 1.2 dm^3) [1] [3]
4. atom economy = $\frac{\text{mass of useful product}}{\text{total mass of products}} \times 100 = \frac{128}{172} \times 100$ [1] = 74.4 % [1] [2]

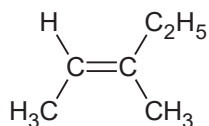
2.2 Nomenclature and isomerism

1. A [1]

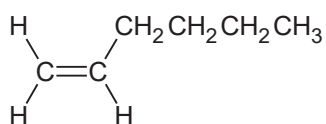
2.

(i) same structural formula [1]
non-superimposable/different 3D spatial arrangement [1] [2](ii) restricted rotation about C=C [1]
both carbons in C=C have two different atoms/groups attached [1] [2]

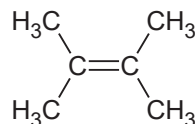
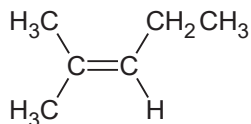
(iii)



[1]

(iv) any suitable with formula C₆H₁₂ for example: hex-1-ene; 2-methylpent-2-ene, 2,3-dimethylbut-2-ene [1]
correct structural formula:

correct structure [1]



[2]

3. B [1]

2.3 Alkanes

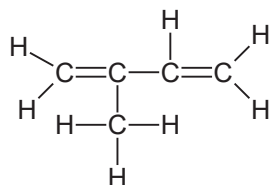
1. C [1]
- 2.(a) same molecular formula [1]
different structural formula [1] [2]
- (b) (2-)methylbutane [1]
(2,2-)dimethylpropane [1] [2]
- (c) VDW forces of attraction [1]
less effective/weaker in branched structures [1] [2]
- (d)(i) $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$ [2]
- (ii) $C_5H_{12} + 5\frac{1}{2}O_2 \rightarrow 5CO + 6H_2O$ [2]
3. B [1]
 $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$
2 moles of CO_2 and 2 moles of H_2O produced per mole of C_2H_4

2.4 Alkenes

1. A [1]

2.(a)

(i)



[1]

(ii) no because of =CH₂ [1]
groups the same (reference to both C=C) [1]

[2]

(b) 2-methylbut(a)-1,3-diene or 2-methyl-1,3-butadiene

[1]

(c)(i) C₅H₈ + 2H₂ → C₅H₁₂

[1]

(ii) nickel

[1]

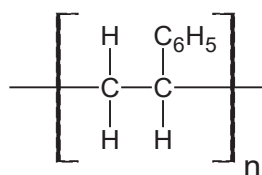
(iii) finely divided

[1]

3.(i) addition [1] polymerisation [1]

[2]

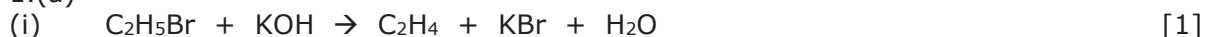
(ii)



[1]

2.5 Halogenoalkanes

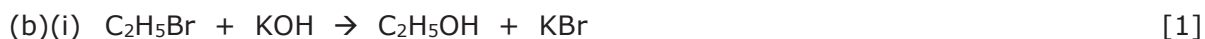
1.(a)



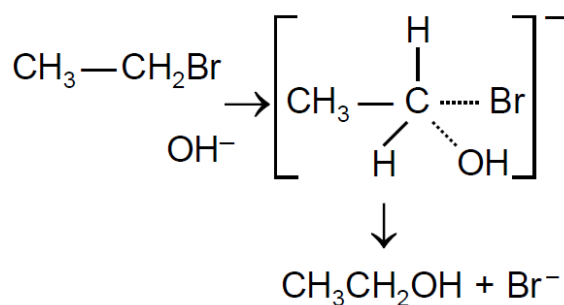
(ii) ethene [1]

(iii) bromine water [1]
goes colourless [1] [2]

(iv) gas is not one of the reactants [1]

(ii) a reaction in which one group or atom is replaced by another group or atom [1]
using an ion or molecule, with a lone pair of electrons, that attacks regions of low
electron density [1] [2]

(iii)



[3]

2.(a)

| Structure and name | Classification |
|---|----------------|
| | |
| | T [1] |
| $\begin{array}{cccc} & \text{H} & \text{CH}_3 & \text{H} \\ & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C}-\text{Br} \\ & & & \\ & \text{H} & \text{H} & \text{H} \end{array}$ <p>[1]</p> | P [1] |
| $\begin{array}{cccc} & \text{H} & \text{H} & \text{H} & \text{H} \\ & & & & \\ \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{C}-\text{H} \\ & & & & \\ & \text{H} & \text{H} & \text{Br} & \text{H} \end{array}$ <p>[1] 2-bromobutane [1]</p> | S [1] |

[6]

- (b)(i) distil and collect 1-bromobutane at its boiling point [1]
shake crude product with a solution of sodium carbonate
in a separating funnel [1]
released pressure [1]
separate the organic layer [1]
shake with a drying agent, e.g. anhydrous calcium chloride [1]
filter/decant [1]
- max [4]
- (ii) moles of butan-1-ol used = $\frac{11.1}{74} = 0.15 \text{ mol}$ [1]
theoretical yield of 1-bromobutane = $0.15 \times 137 = 20.55 \text{ g}$ [1]
percentage yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100 = \frac{12.3}{20.55} \times 100 = 59.9 \%$ [1]
- [3]
3. B [1]

2.6 Alcohols

1. A [1]
- 2.(i) A = 2-methylprop-1-ol [1]
B = 2-methylpropan-2-ol [1] [2]
- (ii) acidified potassium dichromate solution [1]
with A changes from orange to green [1]
with B remains orange [1] [3]
- (b) renewable/clean fuel/instead of a fossil fuel [1]
- (c) $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3 + \text{PCl}_5 \rightarrow \text{CH}_3\text{CHClCH}_2\text{CH}_3 + \text{POCl}_3 + \text{HCl}$ [2]
2-chlorobutane [1] [3]
- 3.(a)
- $$\begin{array}{ccccccc}
 & \text{H} & \text{H} & \text{CH}_3 & \text{H} & \text{H} & \\
 & | & | & | & | & | & \\
 \text{H} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{C} & -\text{OH} \\
 & | & | & | & | & | & \\
 & \text{H} & \text{H} & \text{H} & \text{H} & \text{H} &
 \end{array}$$
- [1]
- (b) $\text{C}_6\text{H}_{13}\text{OH} + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 7\text{H}_2\text{O}$ [2]
- (c) hexan-2-ol/3-methylpentan-2-ol/any other suitable [1]

2.7 Infrared spectroscopy

1. D [1]
2. A = ethanoic acid
B = ethyl ethanoate
C = ethanol
3 correct = [2]; 1 or 2 correct = [1] [2]
3. D [1]

2.8 Energetics

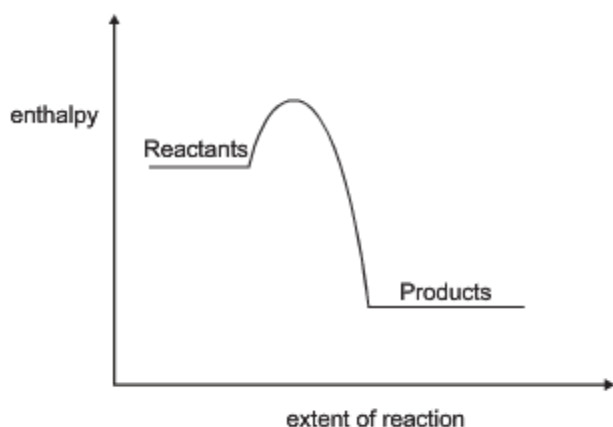
1.(a)

(i) The enthalpy change for a reaction is independent of the route taken, provided the initial and final conditions are the same [2]

(ii) The enthalpy change when one mole of a substance is completely burnt in oxygen under standard conditions [2]

(iii) $\Delta H = \sum \Delta_f H_{\text{products}} - \sum \Delta_f H_{\text{reactants}}$
 $= -394 - 2(286) - (-75) [1] = -891 [1] \text{ kJ mol}^{-1}$ [2]

(b)(i)



[1]

(ii) energy required to break one mole of a given bond averaged over many compounds [2]

(iii) bonds broken = $4\text{C-H} + 2\text{O}=\text{O} = 4\text{C-H} + 2(496) = 4\text{C-H} + 992$
 bonds formed = $2\text{C}=\text{O} + 4\text{O-H} = 2(743) + 4(463) = 3338$
 $4\text{C-H} + 992 - 3338 = -698$
 $4\text{C-H} = 1648$ so $\text{C-H} = 412 [1] \text{ kJ mol}^{-1}$
 (each error [-1]) [3]

2. B [1]

$$q = mc\Delta T = 200 \times 4.2 \times 28.2 = 23688 \text{ J}$$

$$\text{moles of hydrocarbon} = 23688/2220000 = 0.01067 \text{ mol}$$

$$\text{molar mass} = \text{mass}/\text{moles} = 0.47/0.01067 = 44$$

3.(a)

(i) $q = mc\Delta T = 100 \times 4.2 \times 0.9 = 378 \text{ J}$ [2]

(ii) $\text{moles} = \frac{\text{mass (g)}}{\text{RFM}} = \frac{5.0}{80} = 0.0625 \text{ mol}$ [1]

(iii) $\frac{378}{0.0625} = 6048 \text{ (J mol}^{-1}\text{)}$ [1]

(b) $q = mc\Delta T = 120 \times 4.2 \times 25 = 12600 \text{ J}$

$$6048 \times \text{moles} = 12600$$

$$\text{moles} = 2.083 \text{ mol}$$

$$\text{mass} = 2.083 \times 80 = 166.67 \text{ g}$$

or

5 g produces 0.9 °C change
 $\frac{5}{0.9} \times 25 = 138.89$ g produces 25 °C
 $138.89 \times 1.2 = 166.67$ g

(each error [-1])

[2]

2.9 Kinetics

1. C [1]
- 2.(a) peak shifts to right and peak is lower [2]
other drawing errors [-1] [2]
- (b) number of molecules with energy greater than E_a [1] increases [1] [2]
- (c) catalyst provides an alternative route [1]
of lower activation energy E_a [1]
more molecules have energy greater than E_a [1]
number/frequency of successful collisions (between SO_2 and O_2 molecules)
increases [1] [4]
3. A [1]

2.10 Equilibrium

1. B [1]
- 2.(a) rate of forward reaction = rate of reverse reaction [1]
the amount of any given reactant or product remains constant [1] [2]
- (b) increase [1]
3 moles (g) LHS 2 moles (g) RHS so equilibrium shifts to RHS to oppose the change [1] [2]
- (c) decrease [1]
(Forward) reaction is exothermic so equilibrium shifts to LHS to oppose the change/cool the system [1] [2]
- (d) no effect on yield [1]
increases the rate of the forward and reverse reactions equally [1] [2]
- (e)(i) 400–500 °C [1]
200–300 atm [1] [2]
- (ii) compromise between rate and yield [1]

2.11 Group II elements and compounds

1. C [1]
- 2.(a) more stable than BeCO_3 , MgCO_3 [1]
less stable than SrCO_3 / BaCO_3 [1] [2]
- (b) the size of cation increases down Group
charge density decreases down Group
polarisation power decreases down Group
max of 2 [2]
- (c) produces CO_2 $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ [1]
and CO_2 from combustion of fossil fuels [1] [2]
- (d)(i) $\text{CaO} + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O}$ [2]
- (ii) $\text{CaO} + \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2$ [1]
- (e) add Ca(OH)_2 to water
stir/until no more dissolves
filter
blow CO_2 through limewater/collect CO_2 in pipette/
add to container of CO_2 seal and shake
goes milky
max of [4] [4]
- (f) $\text{Ca(OH)}_2(\text{aq}) + \text{CO}_2(\text{g}) \rightarrow \text{CaCO}_3(\text{s}) + \text{H}_2\text{O}(\text{l})$ [2]
- 3.(a) outer shell electrons are in the s-subshell/orbital/shell [1]
- (b)(i) $\text{Mg}(\text{g}) \rightarrow \text{Mg}^+(\text{g}) + \text{e}^-$
(equation [1], state symbols [1]) [2]
- (ii) first ionisation energy decreases going down the group [1]
increased shielding (from inner electrons) [1]
outer electrons further from the nucleus [1] [3]
- (c)(i) $\text{Ca(OH)}_2 \rightarrow \text{CaO} + \text{H}_2\text{O}$ [1]
- (ii) Mg(OH)_2 less stable than Ba(OH)_2 [1]
 Mg^{2+} smaller/high charge density [1]
polarisation of OH^- /comparison in size to $\text{O}^{2-}/\text{OH}^-$ [1] [3]

