IB Chemistry – SL

Topic 10 Answers

1. A

[1]

2. D

[1]

3. C

[1]

4. C

[1]

5. D

[1]

6. B

[1]

7. B

[1]

8. B

[1]

9. D

[1]

10. B

[1]

11. C

[1]

12. B

[1]

13. D

[1]

14. D

[1]

15. C

[1]

16. A

[1]

17. D

[1]

18. D

[1]

19. A

[1]

20. A

[1]

21. C

[1]

22. A

[1]

23. C

[1]

24. A

[1]

25. D

[1]

26. B

[1]

27. B

[1]

28. B

[1]

29. C

[1]

30. A

[1]

31. B

[1]

32. A

[1]

33. (i) butane;
$C_4H_{10}(g) + \frac{13}{2} O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$;
(ignore state symbols, accept balancing using $13O_2$)
[1] *for all formulas and* ***[1]*** *for balancing equation.*
CO produced;
CO is poisonous/combines with hemoglobin/*OWTTE*;

or
C;
which causes respiratory problems; 5

(ii) add Br_2 (water);
valid test needed to score further marks.

A – no effect;
B – would decolorise Br_2 (*do not accept discolour*); 3

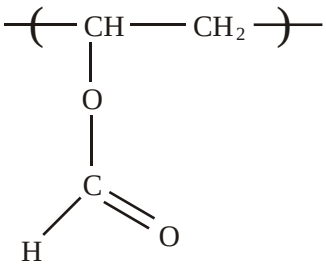
(iii) $CH_3CH{=}{=}CHCH_3 + HBr \rightarrow CH_3CHBrCH_2CH_3$; 3
[1] *for HBr in balanced equation,* ***[1]*** *for structure of product.*

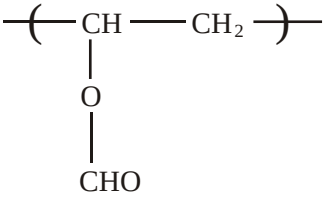
addition;

[11]

34. (i) II reacts with Br_2
II is an alkene/has unsaturated R group/C═C present, I contains only saturated R groups; 2

(ii) addition polymerization;

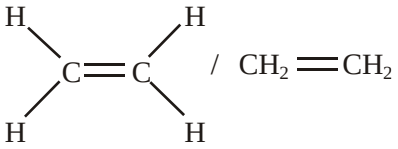




accept 2

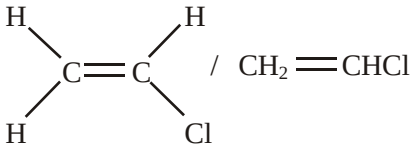
[4]

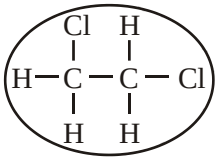
35. (a) ethene; 2



(b) **A** addition/hydration;
H_2O/water/steam;
B oxidation;
acidified $K_2Cr_2O_7$
Accept acidified $KMnO_4$. 4

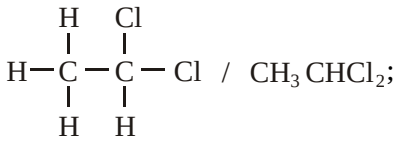
(c)





The compound formed directly may be circled or indicated by some other means. Accept any other structure showing a Cl atom on each C atom. 3

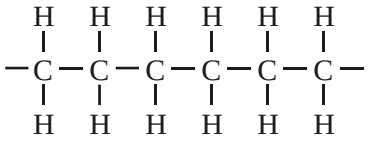
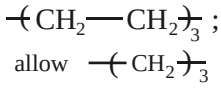
(d)

 / CH_3CHCl_2;

addition across a double bond occurs at both C atoms/*OWTTE*; 2

*If 1,1-dichloroethane is given in (c) accept 1,2-dichloroethane as the isomer as ECF but Award **[1]** max;*

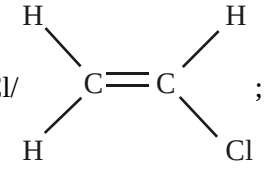
(e) addition polymer; 2

 /  ;

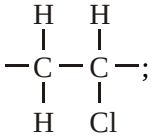
allow

(f) condensation polymer;
polyesters;
polyamides; 3

[16]

36. (i) $CH_2CHCl/CH_2 = CHCl/$  ; 1

(ii) addition (polymerization);
(carbon-carbon) double bond/unsaturation/*OWTTE*; 2

(iii)  ; 1

(iv) monomers have smaller molecules/surface area than polymers;
with weaker intermolecular/Van der Waals' forces; 2

Accept opposite argument for polymers.

[6]

37. $(CH_3)_3CI \rightarrow (CH_3)_3C^+ + I^-$;

$(CH_3)C^+ + OH^- \rightarrow (CH_3)_3COH$; 2

Do not allow S_N2 reaction.

[2]

38. (a) replacement of atom/group (in a molecule)/*OWTTE*;

Do not accept substitution.

by a species with a lone pair of electrons/species attracted to an electron-deficient carbon atom; 2

(b) correct structure of $(CH_3)_3CBr$;
curly arrow showing C—Br bond fission;

correct structure of $(CH_3)_3C^+$;

curly arrow showing attack by OH^- on correct C atom;
correct structure of $(CH_3)_3COH$; 4

*Award **[1]** each for any four.*

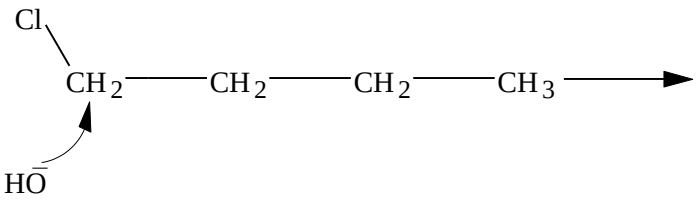
(c) correct structure of $CH_3CH_2CH_2CH_2Br$;
curly arrow showing C—Br bond fission;
correct structure of transition state showing charge and all bonds;
curly arrow showing attack by OH^- on correct C atom;
correct structure of $CH_3CH_2CH_2CH_2OH$; 4

*Award **[1]** each for any four.*

(d) *secondary*
$CH_3CHBrCH_2CH_3$;
2-bromobutane;
other primary
$(CH_3)_2CHCH_2Br$;
1-bromo-2-methylpropane; 4

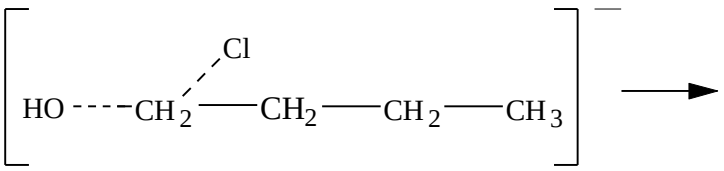
[14]

39. (i) (S_N2 *mechanism*) 3



;

curly arrow must start from O or negative charge



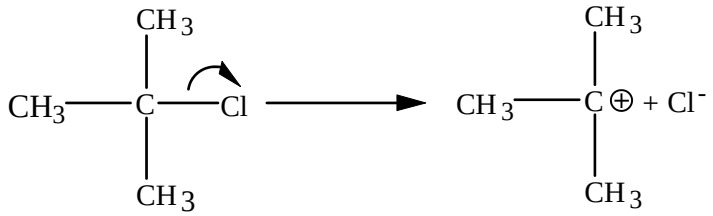
;

Intermediate structure showing overall negative charge and partial bonds.

Accept negative charge to be indicated as delocalised between the HO-CH_2-Cl.

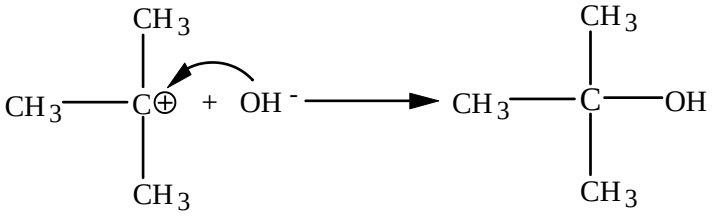
$\rightarrow HO - CH_2CH_2CH_2CH_3 + Cl^-$;

(ii) (S_N1 *mechanism*) 2



;

formation of carbocation / loss of Cl^-



;

carbocation + OH^-

[5]

40. butan-1-ol: butanal;
butanoic acid;

butan-2-ol: butanone;

2 methylpropan-2-ol: no oxidation;

Also accept correct structures. Where both name and structure given structure must be correct and name largely correct.

[4]

41. (a) UV light/sunlight (present); 1

(b) Throughout accept radical with or without •
initiation reaction(s):

$Cl_2 \rightarrow 2Cl•$; 1

propagation reactions:

$Cl• + CH_3CH_3 \rightarrow CH_3CH_2• + HCl$;
$CH_3CH_2• + Cl_2 \rightarrow CH_3CH_2Cl + Cl•$; 2

termination reactions:

$CH_3CH_2• + Cl• \rightarrow CH_3CH_2Cl$;
$2Cl• \rightarrow Cl_2$;
$2CH_3CH_2• \rightarrow CH_3CH_2CH_2CH_3$; 1

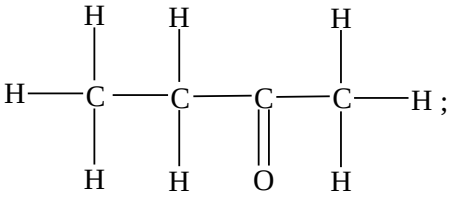
*Award **[1]** for any termination reaction.*

If initiation, propagation, termination not labelled or

*incorrectly labelled award **[3]** max.*

[5]

42.



higher;

[2]

43. (i) $C_4H_8 + Br_2 \rightarrow C_4H_8Br_2$;
*Equation scores **[1]**.*

$CH_3CHBrCHBrCH_3$; 2
Accept more detailed formula.

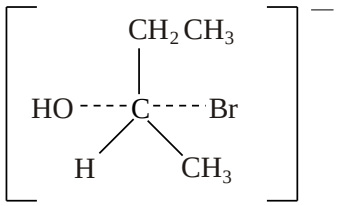
(ii) addition; 1

[3]

44. propan-2-ol;
Accept 2-propanol.
oxidation/redox;
(potassium/sodium) dichromate(VI)/potassium manganate(VII);
Accept just dichromate, permanganate, $KMnO_4$, MnO_4^- , $K_2Cr_2O_7$, $Cr_2O_7^{2-}$.
(sulfuric) acid;
heat under reflux;

[5]

45. (i)

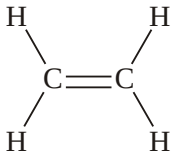


all five groups around C correct;
negative charge and dotted lines to OH and Br correct; 2
Do not award 2nd mark if bond from OH (i.e. OH-----).

(ii) $CH_3CH_2CH(CH_3)Br \rightarrow CH_3CH_2CH(CH_3)^+ + Br^-$;
$CH_3CH_2CH(CH_3)^+ + OH^- \rightarrow CH_3CH_2CH(CH_3)OH$; 2
Accept C_4H_9 instead of $CH_3CH_2CH(CH_3)$ throughout.

[4]

46. (a)



;

Allow $CH_2=CH_2$.

a hydrocarbon that contains at least one C=C (or C≡C)/carbon-carbon double bond (or triple bond)/carbon to carbon multiple bond; 2

Do not accept just "double bond".

(b) $C_2H_4 + H_2O \rightarrow C_2H_5OH$;
addition/hydration reaction; 2

(c) heat under reflux;

EITHER

potassium dichromate(VI)/$K_2Cr_2O_7$/$Cr2O_7^{2-}$and acidified/H^+;
orange to green;

OR

potassium permanganate/manganate(VII)/$KMnO_4$/MnO_4^- and acidified/H^+;
purple to colourless;

Penalize wrong oxidation state, but not missing oxidation state.

ethanoic acid; 4

(d) $CH_3COOH + C_2H_5OH \rightarrow CH_3COOCH_2CH_3 + H_2O$;

Accept $CH_3COOC_2H_5$

sulfuric acid/H_2SO_4/(ortho)phosphoric acid/H_3PO_4;
ethyl ethanoate;
solvent/flavouring/perfumes/plasticizers;. 4

[12]

47. (a) a hydrocarbon that contains at least one C=C (or C≡C)/carbon-carbon double bond (or triple bond)/carbon to carbon multiple bond; 1

Do not accept just "double bond".

(b) $C_2H_4 + H_2O \rightarrow C_2H_5OH$;
addition/hydration reaction; 2

(c) heat under reflux;

EITHER

potassium dichromate(VI)/$K_2Cr_2O_7$ / $Cr_2O_7^{2-}$ and acidified/H^+;
orange to green;

OR

potassium permanganate/manganate(VII)/$KMnO_4$ / MnO_4^- and acidified/H^+;
purple to colourless;
Penalize wrong oxidation state, but not missing oxidation state.

ethanoic acid; 4

(d) $CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOCH_2CH_3 + H_2O$;
accept equations including H^+.
Reversible arrow not required for the mark.

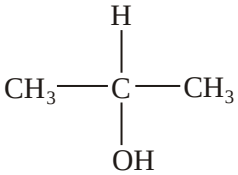
sulfuric acid/H_2SO_4/(ortho)phosphoric acid/H_3PO_4;
Z – ethyl ethanoate;
solvent/flavouring/perfumes/plasticizers; 4

[11]

48. ultraviolet light causes Cl–Cl bond to split;
$Cl_2 \rightarrow 2Cl\bullet$;
$Cl\bullet + CH_3CH_3 \rightarrow CH_3CH_2\bullet + HCl$;
$CH_3CH_2\bullet + Cl_2 \rightarrow CH_3CH_2Cl + Cl\bullet$
$CH_3CH_2\bullet + Cl\bullet \rightarrow CH_3CH_2Cl$/other correct termination step; 5
Penalize missing • symbol once only.
*If different alkane used, then deduct **[1]**.*
*No penalty for not labelling steps, but deduct **[1]** if any wrongly labelled.*

[5]

49. (i)



/ $CH_3CH(OH)CH_3$;

1

Allow bond to HO rather than OH or halfway between the two

(ii) secondary; 1

(iii) CH_3COCH_3/propanone/acetone; 1
Allow ECF from a different alcohol drawn in (i)

[3]

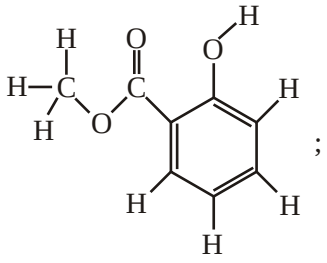
50. (a) S_N2 / bimolecular; 1

(b) (i) reaction slower;
neutral/uncharged/less polar/electrons donated less easily in H_2O; 2

(ii) reaction faster;
less bulky group/reduced steric hindrance; 2

[5]

51. (i) (Empirical formula =) $C_8H_8O_3$;



;

2

Allow double bonds on arene in alternate positions, or allow delocalized representation (of pi electrons).

(ii) the bond at <u>0.1373 nm</u> is a <u>double</u> bond **and** the bond at <u>0.1424 nm</u> is a <u>single</u> bond;
in CO_2(g) both bonds are double bonds **and** would have a value around 0.137 nm; 2

(iii) Ester;
Arene/benzene ring;
Alcohol; 2

*Award 2 for any three correct, award **[1]** for any two correct.*
Do not accept alkane as a type of functional group in this molecule.

[6]

52. (i) boiling point increases as the number of carbons increases/*OWTTE*;
Greater M_r **and** hence greater van der Waals'/London/dispersion forces present; 2

(ii) $CH_4 + Cl_2 \xrightarrow{hv/\text{UV light}} CH_3Cl + HCl$;

Do not award mark if hv/uv light is not given.

Initiation step:
$Cl_2 \xrightarrow{hv/\text{UV light}} 2Cl\bullet$;

Do not award mark if hv/uv light is not given.
Penalize once only.

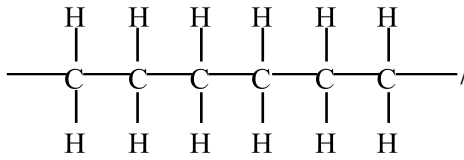
Propagation step:
$CH_4 + Cl\bullet \rightarrow CH_3\bullet + HCl$;
$CH_3\bullet + Cl_2 \rightarrow CH_3Cl + Cl\bullet$;
Termination step:
$Cl\bullet + Cl\bullet \rightarrow Cl_2$ or $Cl\bullet + CH_3\bullet \rightarrow CH_3Cl$ or $CH_3\bullet + CH_3\bullet \rightarrow CH_3CH_3$; 5

Allow fish-hook half-arrow representations i.e. use of ↼.
Penalize use of full curly arrows once only.
Penalize missing dots on radicals once only.

[7]

53. (i) A. = $CH_3(CH_2)_7CHO$;
B. = $CH_3(CH_2)_7COOH/CH_3(CH_2)_7CO_2H$;
C. = $(CH_3)_3COH$;
D. = $(CH_3)_2CO$;
E. = $BrCH_2CH_2Br$; 5
Allow correct structural formulas.

(ii) addition;



/-$(CH_2$-$CH_2)_3$-/-$(CH_2)_6$-; 2

[7]

54. (a) same general formula/C_nH_{2n};
formulas of successive members differ by CH_2;
similar chemical properties/same functional group;
gradation/gradual change in physical properties; 3
*Award **[1]** each for any three.*

(b) but-2-ene;
Accept 2-butene.

strongest intermolecular/van der Waals' forces;
largest (molecular) mass/size/surface area/area of contact; 3

(c) $CH_2CHCH_2CH_2CH_3/CH_3CHCHCH_2CH_3$/any correct branched structure;
Accept more detailed formula.

pent-1-ene/pent-2-ene; 2
Name must match formula.
Accept 1-pentene/2-pentene.

(d) $C_4H_8 + HBr \rightarrow CH_3CH_2CHBrCH_3$;
*Award **[1]** for all molecular formulas correct and **[1]** for correct product structure.*
*Award **[1]** for completely correct equation starting with but-1-ene.*

addition; 3

(e) oxidation/redox;
(potassium) dichromate(VI)/ $Cr_2O_7^{2-}$;
(sulfuric) acid;
distilling off propanal as it is formed;
heating under reflux (to obtain propanoic acid); 5

(f) (propan-1-ol) hydrogen bonding;
(propanal) dipole-dipole attractions;

(propanoic acid) hydrogen bonding;
propanoic acid > propan-1-ol > propanal; 4

[20]

55. (a) same general formula;
successive members differ by CH_2;
Do not allow elements or just "they".
similar chemical properties;
Allow same/constant.
gradual change in physical properties;
Do not allow change periodically.
same functional group; 2
*Award **[1]** each for any two.*

(b) add bromine (water);
alkanes – no change/stays or turns brown;
Allow red-brown or any combination of brown, orange or yellow.
alkenes – bromine (water) decolorizes;
Do not allow clear or discoloured.

or

add (acidified) $KMnO_4$;
alkanes – no change;
alkenes – $KMnO_4$ decolorizes/brown/black; 3

[5]

56. (a) $(CH_3)_2CHBr$/more detailed formula;

secondary/2° because two alkyl groups attached to C with Br; 2

(b) nucleophilic substitution;
bimolecular/molecularity of two/two species in rate-determining step;
Accept second order.

rate = k $[(CH_3)_2CHBr][OH^-]$; 3
No penalty for incorrect halogenoalkane formula.

(c) $(CH_3)_2CH^+$/more detailed formula; 1

[6]

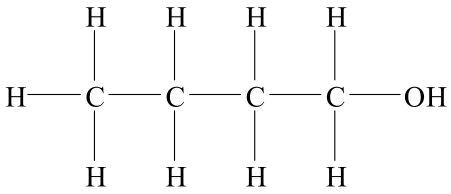
57. (a) one general formula/same general formula;
differ by CH_2;
similar chemical properties;
gradual change in physical properties; 1
*Award **[1]** for any two of the above characteristics.*

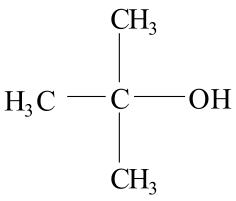
(b) ethanol lower/ethanoic acid higher;

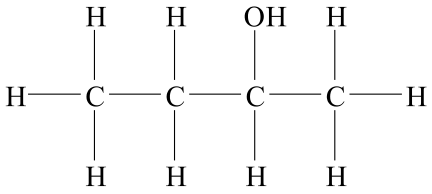
due to larger mass of ethanoic acid/stronger van der Waals'/ London/dispersion forces;
due to stronger hydrogen bonding/2 hydrogen bonds per molecule; 2

Accept either answer

(c)







2

Allow condensed structural formulas such as $CH_3CH_2CH_2CH_2OH$.

*Award **[2]** for all three correct isomers, **[1]** for any two correct isomers.*

[5]