

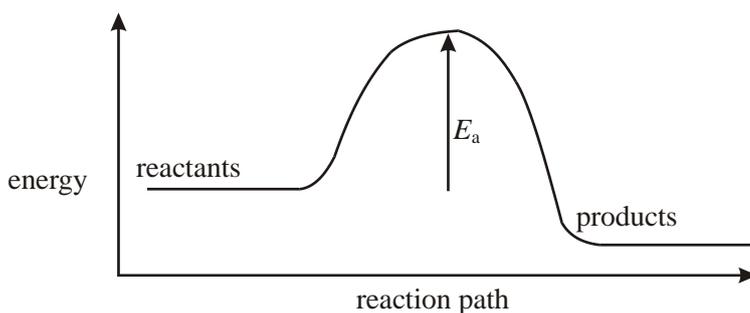


**IB Chemistry SL
Topic 5 Answers**

1. D
2. C
3. B
4. D
5. B
6. A
7. B
8. A
9. C
10. C
11. D
12. B
13. A
14. A
15. D
16. D
17. C
18. B
19. C
20. C
21. A
22. D
23. A
24. C
25. C
26. C
27. A



28. C
29. A
30. B
31. B
32. A
33. D
34. C
35. C
36. B
37. (a) activation energy \square = **minimum** energy required for a reaction to occur; 1
- (b) curve moved to the right;
peak lower, 2
Deduct [1] if shaded area smaller at T_2 or if T_2 line touches the x-axis
- (c) rate increased;
as more molecules with energy $\geq E_a$; 2
- [5]
38. (a) energy for the conversion of a gaseous molecule into (gaseous) atoms;
(average values) obtained from a number of similar bonds/compounds/OWTTE;
 $\text{CH}_4(\text{g}) \rightarrow \text{C}(\text{g}) + 4\text{H}(\text{g})$; 3
State symbols needed.
- (b) (bond breaking) = 1890/654;
(bond formation) = 2005/769;
enthalpy = $-115(\text{kJ mol}^{-1})$ 3
Award [3] for correct final answer.
Penalize [1] for correct answer with wrong sign.
- (c) molecules have insufficient energy to react (at room temperature)/
wrong collision geometry/unsuccessful collisions;
extra energy needed to overcome the activation energy/ E_a for the reaction; 2
- (d)



exothermic shown;

activation energy/ E_a shown;

2

[10]

39. (a) exothermic because temperature rises/heat is released; 1
- (b) to make any heat loss as small as possible/so that all the heat will be given out very quickly; 1
Do not accept "to produce a faster reaction".
- (c) heat released = mass \times specific heat capacity \times temp increase/ $q = mc\Delta T = /$
 $100 \times 4.18 \times 3.5;$
 $= 1463 \text{ J}/1.463 \text{ kJ};$ (*allow 1.47 kJ if specific heat = 4.2*)
 amount of KOH/HCl used = $0.500 \times 0.050 = 0.025 \text{ mol};$
 $\Delta H = (1.463 \div 0.025) = -58.5 \text{ (kJ mol}^{-1}\text{)};$ (*minus sign needed for mark*) 4
Use ECF for values of q and amount used.
Award [4] for correct final answer.
Final answer of 58.5 or +58.5 scores [3].
Accept 2,3 or 4 significant figures.
- (d) heat loss (to the surroundings);
 insulate the reaction vessel/use a lid/draw a temperature versus time graph; 2
- (e) 3.5°C /temperature change would be the same;
 amount of base reacted would be the same/excess acid would not react/
 KOH is the limiting reagent; 2

[10]

40. (a) $\Delta T = 23.70 - 23.03 = 0.67 \text{ (}^\circ\text{C/K)};$ 1
- (b) $n = \left(\frac{0.4385 \text{ g}}{342.34 \text{ g mol}^{-1}} \right) = 1.281 \times 10^{-3};$ 1
- (c) (i) $\Delta H_c = (C \Delta T)/n = \frac{-[(10.114 \text{ kJ K}^{-1})(0.67 \text{ K})]}{(1.281 \times 10^{-3} \text{ mol})} = -5.3 \times 10^3 \text{ kJ mol}^{-1};$ 1
Use ECF for values of ΔT and n .
- (ii) Percentage experimental error = $\left[\frac{(-5.3 \times 10^3) + (5.6 \times 10^3)}{(-5.6 \times 10^3)} \right] \times 100 = 5.4\%;$ 1
Use ECF for values of ΔH_c .



- (d) enthalpy change of combustion of sucrose > TNT, and therefore not important;
rate of reaction for TNT is greater than that of sucrose, so this is valid;
amount of gas generated (in mol) for sucrose > than that of TNT
(according to the given equation), so this is not important;

3

[7]

41. (a) The amount of energy needed to break 1 mole of (covalent) bonds;
in the gaseous state;
average calculated from a range of compounds;
max

2

Award [1] each for any two points above.

- (b) Bonds broken
(612) + (2×348) + (8×412) + (6×496)/7580 (kJ mol⁻¹);
Bonds made
(8×743) + (8×463) / 9648 (kJ mol⁻¹);
 $\Delta H = -2068$ (kJ mol⁻¹);

3

Award [3] for the correct answer.

Allow full ECF.

Allow kJ but no other incorrect units.

*Even if the first two marks are lost, the candidate can score [1]
for a clear correct subtraction for ΔH .*

[5]

42. $C(s) + 2F_2(g) \rightarrow CF_4(g)$ $\Delta H_1 = -680$ kJ;
 $4F(g) \rightarrow 2F_2(g)$ $\Delta H_2 = 2(-158)$ kJ;
 $C(g) \rightarrow C(s)$ $\Delta H_3 = -715$ kJ;

Accept reverse equations with + ΔH values.



$$\text{so average bond enthalpy} = \frac{-1711}{4}$$

$$= -428 \text{ kJ mol}^{-1};$$

4

Accept + or - sign.

*Lots of ways to do this! The correct answer is very different
from the value in the Data Booklet, so award [4] for final
answer with/without sign units not needed, but deduct [1] if
incorrect units. Accept answer in range of 427 to 428 without
penalty for sig figs.*

If final answer is not correct use following;

*Award [1] for evidence of cycle or enthalpy diagram or adding
of equations.*

Award [1] for $2F_2(g) \rightarrow 4F(g)$ 2×158 seen.

Award [1] for dividing 1711 or other value by 4.

[4]

43. (a) (i) standard enthalpy (change) of reaction;
(temperature) increase;
reaction is exothermic/sign of ΔH° is negative;

3



(ii) more (negative);
heat given out when gas changes to solid/solid has less enthalpy than
gas/*OWTTE*; 2

(iii) -389 kJ; 1

[6]

44. (i) the energy needed to break one bond;
(in a molecule in the) gaseous state;
value averaged using those from similar compounds; 3

(ii) it is an element/no other species with just a Br-Br bond/*OWTTE*; 1

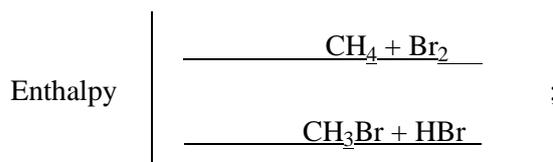
(iii) (sum bonds broken \Rightarrow) $412 + 193 = 605$;
(sum bonds formed \Rightarrow) $276 + 366 = 642$;
(ΔH^θ \Rightarrow) -37 kJ; 3

Award [3] for correct final answer.

Award [2] for “+ 37”.

Accept answer based on breaking and making extra C-H bonds.

(iv)



2

Award [1] for enthalpy label and two horizontal lines, [1] for reactants higher than products.

ECF from sign in (iii), ignore any higher energy level involving atoms.

(v) (about) the same/similar;
same (number and type of) bonds being broken and formed; 2

[11]

45. (a) (Amount of energy required to break bonds of reactants)
 $8 \times 412 + 2 \times 348 + 612 + 6 \times 496/7580$ (kJ mol^{-1});

(Amount of energy released during bond formation)

$4 \times 2 \times 743 + 4 \times 2 \times 463/9648$ (kJ mol^{-1});

$\Delta H = -2068$ (kJ or kJ mol^{-1}); 3

ECF from above answers.

Correct answer scores [3].

Award [2] for (+)2068.

If any other units apply $-1(U)$, but only once per paper.

(b) exothermic and ΔH^θ is negative/energy is released; 1
Apply ECF to sign of answer in part (a).



Do not mark if no answer to (a).

[4]

46. $-1 \times \Delta H_1 / 676$;
 $1 \times \Delta H_2 / -394$;
 $2 \times \Delta H_3 / -484$;
 $\Delta H_4 = -202 \text{ (kJ mol}^{-1}\text{)}$;

4

Accept alternative methods.

Correct answers score [4].

Award [3] for (+)202 or (+)40 (kJ/kJ mol⁻¹).

-1(U) if units incorrect (ignore if absent).

[4]

47. (a) energy needed to break (1 mol of) a bond in a gaseous molecule;
averaged over similar compounds;

2

- (b) bonds broken identified as C–O and N–H;
bonds formed identified as C–N and O–H;
 $\Delta H = 748 - 768 \text{ (kJ)}$;

$= -20 \text{ kJ/kJ mol}^{-1}$ (units needed for this mark);

4

If wrong bonds identified apply ECF to 3rd and 4th marks.

Accept answer based on breaking and making all bonds.

Award [4] for correct final answer.

Award max [3] if only one bond missed.

Answer of 20 or +20 kJ (mol⁻¹) scores [3].

[6]

48. (a) amount of energy needed to break one mole of (covalent) bonds;
in the gaseous state;
average calculated from a range of compounds;

2

Award [1] each for any two points above.

- (b) bonds broken: $161 + 2 \times 348 + 8 \times 412 + 6 \times 496 / 7580 \text{ kJ mol}^{-1}$;

bonds made: $8 \times 743 + 8 \times 463 / 9648 \text{ kJ mol}^{-1}$;

(bonds broken – bonds made =) $\Delta H = -2068 \text{ (kJ mol}^{-1}\text{)}$;

3

Award [3] for the correct answer.

Allow full ECF – 1 mistake equals 1 penalty.

Allow kJ but not other wrong units.

- (c) same/equal, because the same bonds are being broken and formed;

1

- (d) products more stable than reactants;
bonds are stronger in products than reactants/ $H_P < H_R$ /enthalpy/stored
energy of products less than reactants;

2

[8]



49. (a) (i) $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$; 1
State symbols not required for mark
- (ii) products more stable than reactants/reactants less stable than products;
products lower in energy/reactants higher in energy; 2
- (iii) (overall) bonds in reactants weaker/(overall) bonds in product stronger
/all bonds in product are σ bonds/weaker π bond broken and a
(stronger) σ bond formed;
less energy needed to break weaker bonds/more energy produced
to make stronger bonds (thus reaction is exothermic)/*OWTTE*;
- OR**
- bond breaking is endothermic/requires energy and bond making is
exothermic/releases energy;
stronger bonds in product mean process is exothermic overall; 2
- [5]
50. (i) energy required to break (a mole of) bonds in the gaseous state
/energy given out when (a mole of) bonds are made in the
gaseous state;
average value from a number of similar compounds; 2
- (ii) $(\Delta H^\ominus_{\text{reaction}} = (\sum BE_{\text{break}} - BE_{\text{make}}))$
 $= [(837) + 2(436)] - [(348 + 4(412))];$
 $= -287(\text{kJ/kJ mol}^{-1});$ 2
Award [1 max] for 287 or +287.
- (iii) (BE): $C-Cl > C-Br > C-I/C-X$ bond becomes weaker;
halogen size/radius increases/bonding electrons further away from
the nucleus/bonds become longer; 2
- [6]