IB Chemistry – SL
Topic 6 Answers

1. C

2. B

3. B

4. C

5. B

6. D

7. C

8. C

9. C

10. D

11. A

12. B

13. A

14. A

15. C

16. B

17. B

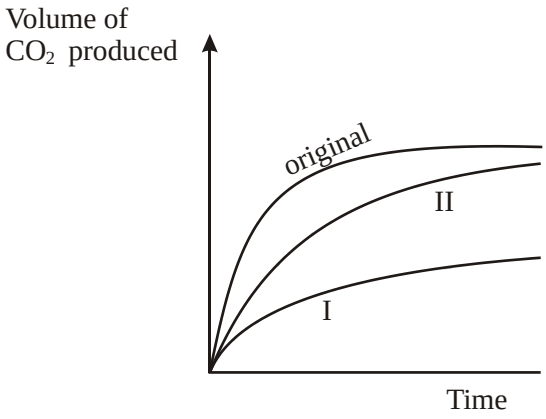
18. A

19. (i) $CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$ 1

States not required, accept molecular equation.

(ii) rate decreases with time;
as concentration decreases so fewer (successful) collisions;
draw tangent to the curve at time *t*;
rate = slope or gradient; 4

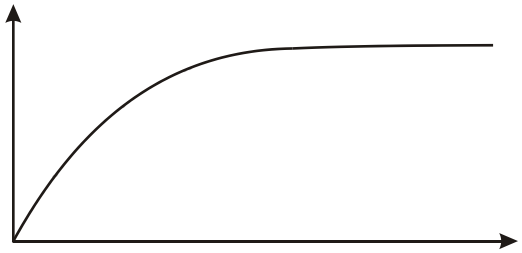
(iii)



I. (less CO_2 because) amount of HCl is limiting and half the orginal/OWTTE;

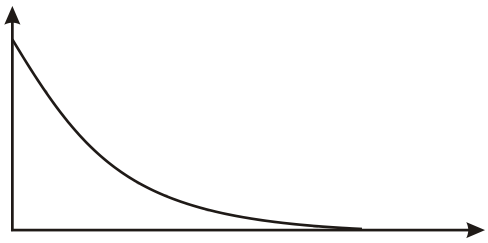
II. (same amount of CO_2 because) amount of HCl is the same;
curve less steep because less frequent *(accept fewer)* collisions 5

20. (a) measure volume of carbon dioxide/CO_2/gas produced/measure pH; 4



starts at origin and levels off

measure mass of chemicals/apparatus;



starts high and decreases

Graph should show increase as reaction progresses (as HCl is consumed).

(b) *Method* 1
use powdered $MgCO_3$/*OWTTE*;
particles collide more frequently/increased surface area/*OWTTE*;

Method 2
increase (reaction) temperature/heat/warm;
more of the collisions are successful/more particles with $E > E_a$/*OWTTE*;

Method 3
increase acid concentration;

more frequent (reactant) collisions;

Method 4
add catalyst;
lowers activation energy/E_a/*OWTTE*; 6 max

*Award **[2]** each for any three methods*

(c) (i) stays the same;
$MgCO_3$ was already in excess; 2

(ii) stays the same;
same quantities of reactants used; 2

[14]

21. (i) reversible reaction/reaction may proceed in either direction
(depending on reaction conditions) equilibrium/dynamic equilibrium; 1

(ii) no effect;
catalyst will speed up both forward and reverse reactions (equally)/
increase the rate at which equilibrium is achieved; 2

(iii) acidity: no effect;
equilibrium shifts to the right;
K_c: no change; 3

[6]

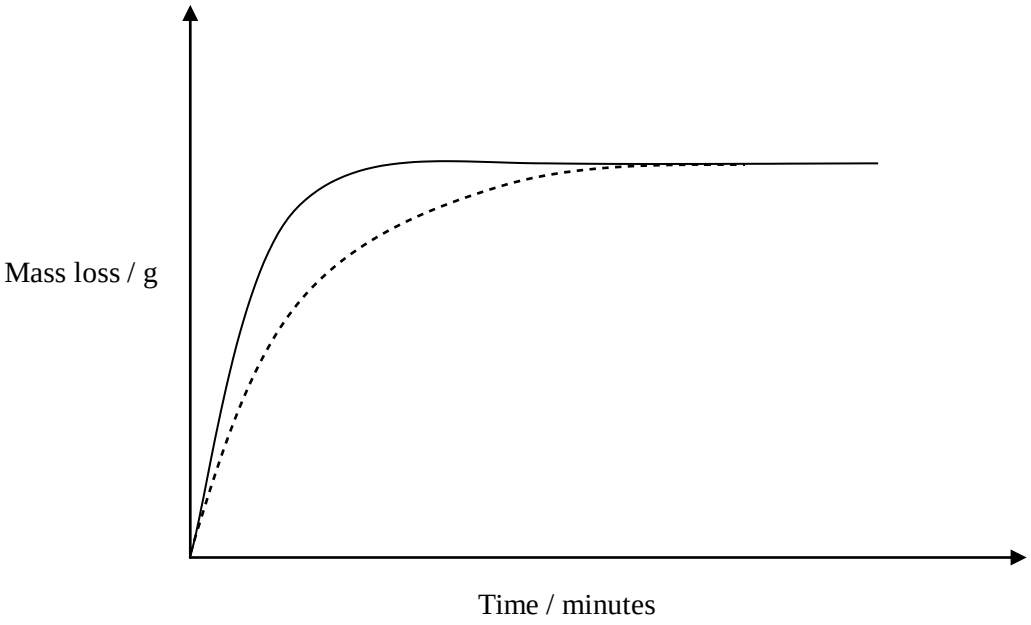
22. (a) change of concentration/mass/amount/volume/of a reactant/product with time; 1

Do not accept "substance".

(b) all the $CaCO_3(s)$ has been consumed/no further $CO_2(g)$ is produced/reaction
is complete; 1

Do not accept reaction has stopped or all reactants used up.

(c) line on graph should be initially less steep/a smaller gradient **and** should
plateau at the same mass loss; 1

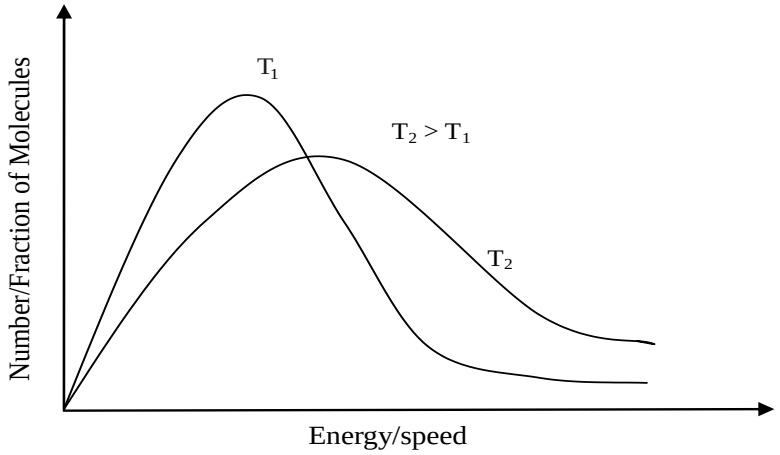


(d) there are more particles with KE greater than or equal to E_a;
collisions <u>more frequent</u>/more collisions per unit time/more successful/forceful collisions per unit time;
the rate increases; 3

(e) 1.00×10^{-3} (mol cm^{-3} s^{-1}) 1
Ignore units even if wrong.
Apply –1(sf).

[7]

23. (i)



T_2 peak lower/T_1 higher;
T_2 peak at higher energies/T_1 curve at lower energies; 2
*Maximum **[1]** if axes not labeled correctly*

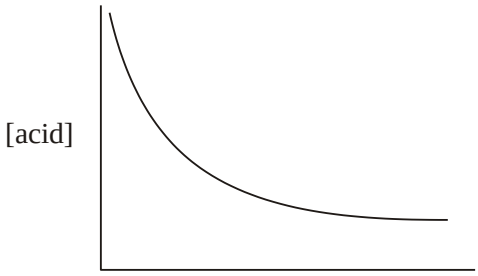
(ii) minimum energy required to react/energy difference between reactants and transition state; 1

(iii) makes the reaction go faster;
because it lowers the activation energy/E_a; 2

[5]

24. (i) a curve showing concentration decreases with time; 1

i.e.



No penalty if curve reaches x axis
Do not accept a straight line

(ii) slope decreases; 1

(iii) rate decreases;
fewer collisions per unit time; 2

[4]

25. (a) (i) it is decreasing;
less frequent collisions/fewer collisions per second or (unit) time; 2

(ii) reactant(s) used up/reaction is complete; 1
Do not accept reaction reaches equilibrium.

(b) (i) it would increase; 1
Accept a quantitative answer such as "doubles".

(ii) more frequent collisions;
collisions or molecules have more
energy (*OWTTE*); more molecules with energy ≥ E_a; 3

(iii) rate would be lower;
smaller surface area; 2

[9]

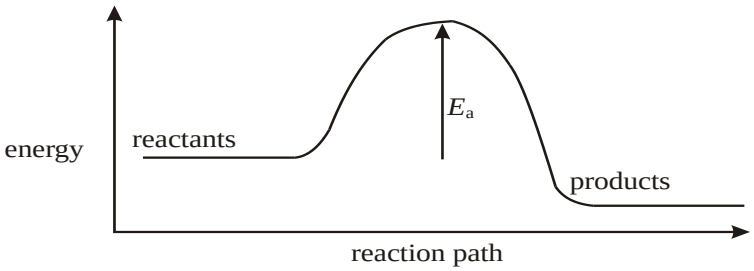
26. (a) energy for the conversion of a gaseous molecule into (gaseous) atoms;
(average values) obtained from a number of similar bonds/compounds/*OWTTE*;
$CH_4(g) \rightarrow C(g) + 4H(g)$; 3
State symbols needed.

(b) (bond breaking) = 1890/654;
(bond formation) = 2005/769;
enthalpy = –115(kJ mol^{-1}) 3
Allow ECF from bond breaking and forming.

*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
Allow ECF from (b).

[10]

27. (a) molecules must have sufficient/minimum energy/energy ≥ activation energy;
appropriate collision geometry/correct orientation; 2

(b) increased frequency of collisions/collisions more likely;
Not just "more collisions", there must be a reference to time.

increased proportion of molecules with sufficient energy to react/$E \geq E_a$;
Not "activation energy is reduced".

Proportion of molecules with $E \geq E_a$ is more important;
(dependent on correct second marking point); 3

28. (a) increase in product concentration per unit time/decrease in reactant concentration per unit time; 1
Accept change instead of increase or decrease.

(b) (i) high activation energy/not enough molecules have E_a/*OWTTE;*
incorrect collision geometry/*OWTTE;*
infrequent collisions; 2
*Award **[1]** for any two reasons.*

(ii) more energetic collisions/more molecules have (energy ≥) E_a;
more <u>frequent</u> collisions/collide more often; 2

(iii) add a catalyst;
increase the (total) pressure/decrease the volume of the container;
increase the concentration of C (or D); 2
Do not accept surface area.

*Award **[1]** for any two.*

[7]

29. ([A] against time) - straight line with negative gradient;
Accept any decreasing curve

([B] against time) - decreasing curve;
*Award **[1]** unless half - lives clearly not constant*

(rate against [A]) - any horizontal straight line;
(rate against [B]) - straight line through origin;
*Award **[3]** for all four correct, award **[2]** for any three correct and **[1]** for any two correct.*