**M1.** (a) Gradient (or slope) (or draw a tangent)

**1**

(b) (i) Curve **X** is lower and starts at origin

**1**

And levels out at same volume as original curve

**1**

(ii) Curve **Y** is steeper than original and starts at origin

**1**

Then levels out at half the volume of the original

**1**

(c) (i) $2H_2O_2 \rightarrow 2H_2O + O_2$

**1**

(ii) Speeds up (alters the rate of) a chemical reaction

**1**

Remains unchanged (or not used up)

**1**

(iii) Remains unchanged (or not used up or not in the overall reaction equation)

**1**

Offers alternative reaction route (or acts as an intermediate)

**1**

**[10]**

**M2.** (a) Graph starts at origin

**1**

Graph skewed to left and has decreasing gradient to maximum

**1**

Graph after maximum decreases in steepness, never touches *x* axis, levels out less than 5 mm from *x* axis.

**1**



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(b) Minimum energy

**1**

To start a reaction (*or for a reaction to occur*)

**1**

(c) Molecules gain energy (*or always some molecules have $E > E_a$*)

**1**

Due to collisions

**1**

(d) Decreases

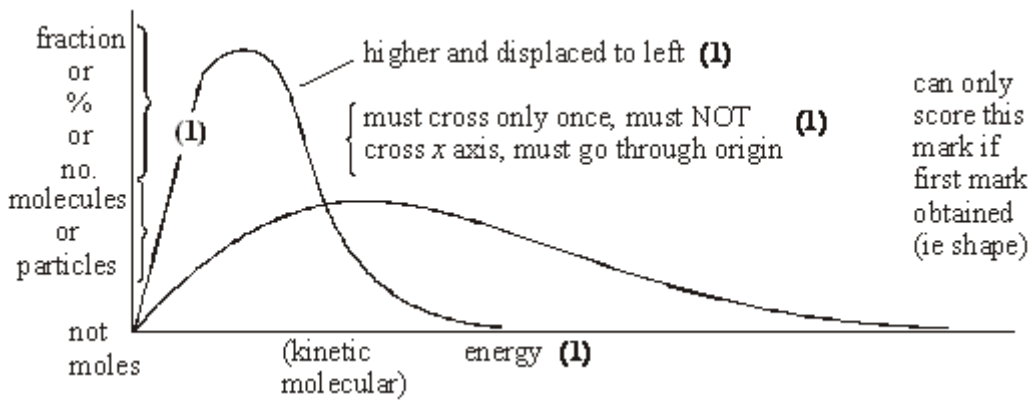
**1**

$E_a$ lowered **(1)**
By alternative route **(1)**
So more molecules have energy > $E_a$ **(1)**

**max 2**

**[10]**

**M3.** (a)




**2**



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(b) See above

**2**

(c) Energy < $E_a$ or must have enough energy (to react) **(1)**

**1**

(d) Increase concentration (or pressure) **(1)**

**1**

(e) Many **(1)** more molecules have E > $E_a$ / enough energy **(1)**
*NOT KE increases with T*

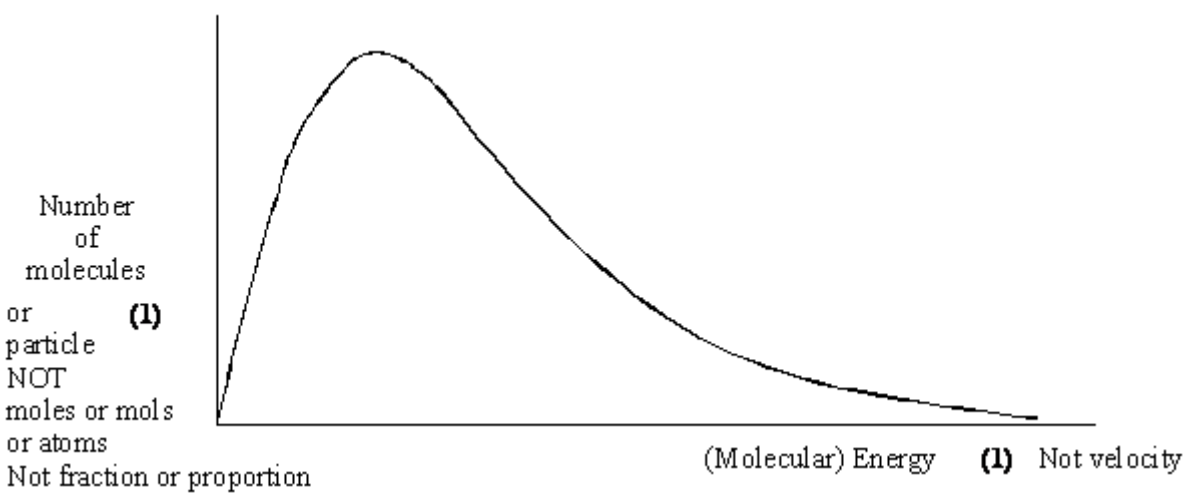
**2**

(f) Lowers $E_a$ **(1)**
alternative route **(1)**

**2**

**[10]**

**M4.** (a) (i)




(ii) The total number of particles (or molecules) in the sample



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*OR the number of molecules present*

(iii) No molecules have no energy

*OR all molecules have some energy*

*Do not allow "if there are no molecules there is no energy"*

**4**

(b) (i) The minimum energy required **(1)**

for a reaction to occur **(1)**

*OR to start reaction or for a successful collision*

(ii) Changes: Catalyst **(1)**

Explanation: Alternative route **(1),** with a lower activation energy **(1)**

*OR a lower activation energy (1)*
*so more molecules can react (1)/more molecules have this energy*

*If change incorrect CE = 0*

*Allow answers anywhere in b (ii)*

**5**

**[9]**

**M5.** (a) <u>minimum</u> energy **(1)**
required before a reaction can occur or go or start **(1)**

**2**

(b) speeds up (changes) reaction rate **(1)**
without being (chemically) changed **(used up) (1)**

**2**

(c) provides alternative reaction route **(1)**
with a lower activation energy **(1)**



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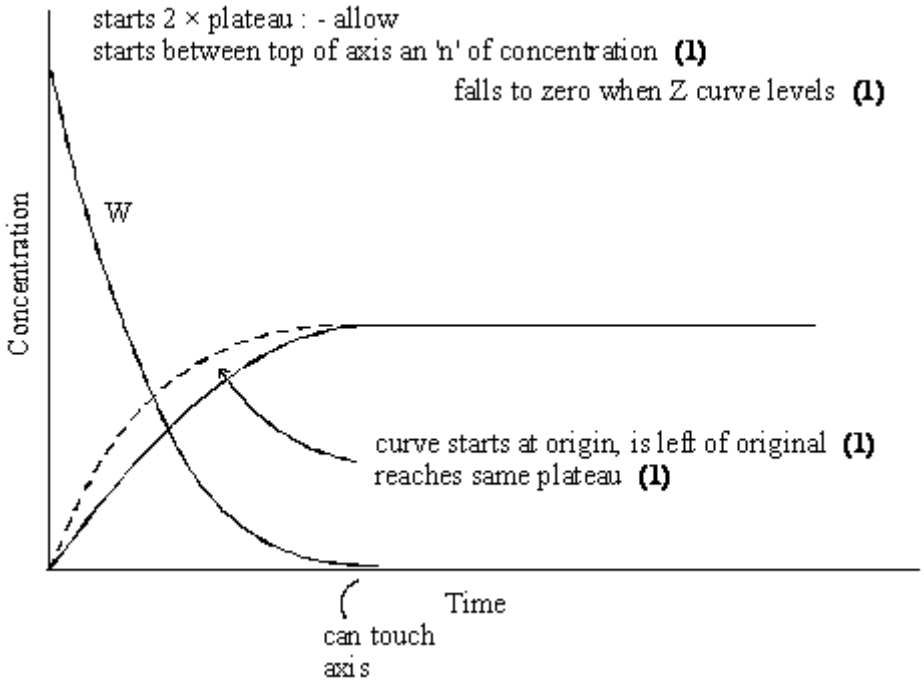
*in (b) and (c) reward 4 marks for 4 points wherever found*

**2**

(d) (i)

(ii)




(iii) fewer collisions **(1)**
W used up **(1)**

*or reactants*
*or reagents*
*or fewer particles*

**6**

**[12]**



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