

- M1. (a) the minimum energy; 1
- Energy required for a reaction to occur;
(or to start a reaction or for successful collisions) 1
- (b) axes labelled:- y: number (or fraction or %) of molecules (or particles)
x: energy (or KE); 1
- curve starts at origin; 1
- skewed to right; 1
- approaches x axis as an asymptote;
(penalise a curve that levels off > 10% of max peak height or
a curve that crosses the energy axis) 1
- second curve displaced to the left (and does not cross T_1 curve
for a second time) 1
- and peak higher; 1
- many fewer molecules; 1
- fewer molecules have $E > E_a$;
(can score this mark from suitably marked curves) 1
- (c) molecules (or particles or collisions) do not have enough energy;
(or orientation may be wrong) 1
- increase the pressure; 1
- (or increase the concentration or reduce the volume)
increases the collision frequency;
(or more collisions)
(do not allow if stated to be due to increase in energy implied
by temperature increase) 1

add a catalyst; 1

lowers activation energy (or E_a) (Q of L mark); 1

[15]

M2. (a) (i) Z (1) 1

(ii) Collisions (1)

Cause some molecules to slow down or lose energy (1) 2

(b) Curve starts at origin and is displaced to the right (1)

Curve lower and does not touch energy axis (1) 2

(c) (i) Only a small percentage/very few collisions have $E > E_a$ (1) 1

(ii) Add a catalyst (1)

Lowers E_a (1)

More collisions/molecules have energy $> E_a$ (1) 3

[9]

M3. (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

(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]