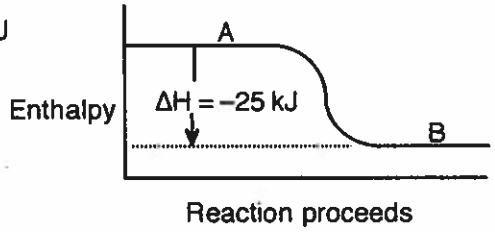
20. If the surface area of reactant A is increased, a given molecule of reactant B has a greater chance of striking a molecule of A so that more collisions can occur between A and B in a specified time. As a result, the reaction rate increases. Molecules of A which are INSIDE a chunk of solid A cannot react; only molecules at the surface can react.

21. (a) Decreases rate. The collisions are less energetic and there are fewer collisions at the lower temperature.
    (b) Increases rate. Greater frequency of collisions between O_2 and S.
    (c) No effect. Changing the amount of product will not affect the rate of collisions between reactants.
    (d) Increases rate. Greater surface area of S exposes more S atoms to collisions with O_2 molecules.
    (e) Decreases rate. Increasing the volume decreases the pressure and decreases the $[O_2]$, which decreases the frequency of collisions.

22. Kindling has a larger surface area and therefore a greater frequency of collision between oxygen molecules and the wood.

23. PE must increase (electrons must have sufficient energy to separate from one another and break the bond).

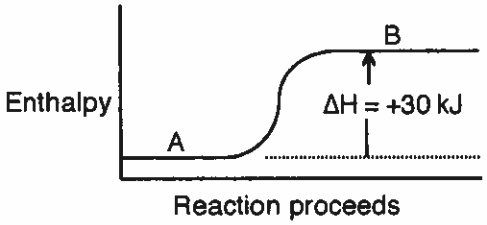
24. $A \longrightarrow B + 25\ kJ$



Since the system of reactants gives off energy to the surroundings, the surroundings feel warmer.

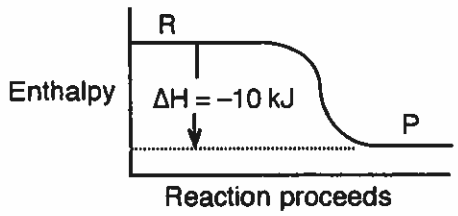
25. $\Delta H = +40\ kJ$

26. $\Delta H = +30\ kJ$. The products have more energy than the reactants.



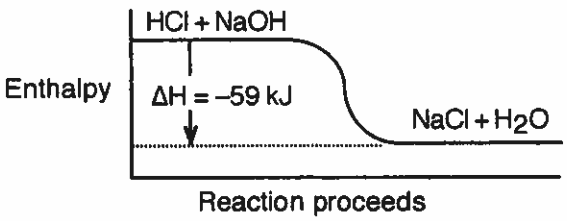
Since the system of reactants absorbs energy from the surroundings, the surroundings feel cooler.

27.



The surroundings will feel warmer.

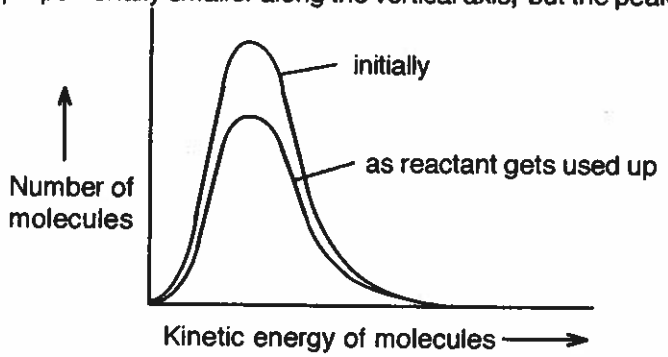
28.



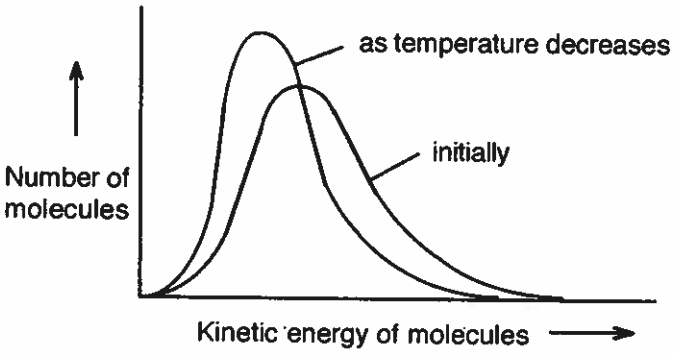
Since heat is absorbed by the surroundings, the system gave off heat.

29. (a) ii
(b) No, there would be little effect on the rate; the "doubling of rate with a 10°C increase in temperature" rule of thumb ONLY applies to SLOW reactions – this is a fast reaction.

30. (a) The curve is proportionally smaller along the vertical axis, but the peak is still at the same KE value.

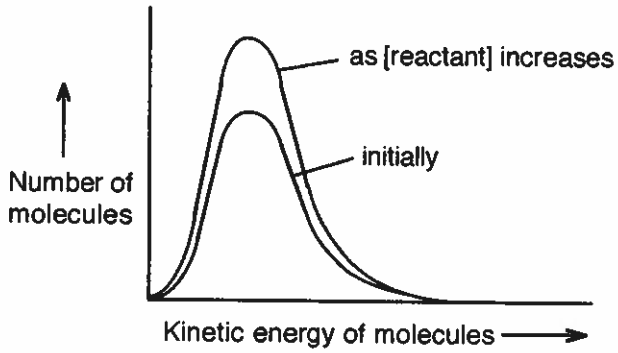


(b) The peak is at lower KE values, and a bit higher on the vertical axis.



(c) No effect. Increasing the surface area has no effect on the energies of the molecules; it just makes more molecules available for reaction.

(d) The overall height of the curve is proportionally larger (a greater concentration of reactants means there will be more molecules at all energies), but the peak is still at the same KE value.

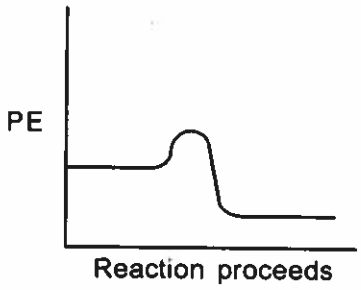


31. Since the rate doubles for every 10°C temperature increase, and since the final temperature is 20°C higher than the original temperature, there are TWO doublings of the rate and the new rate will be:
$2 \times 2 \times 1.0 \times 10^{-7}$ mol/s = 4.0×10^{-7} mol/s.

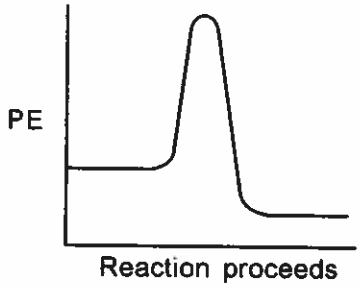
32. Since the temperature has been raised by 30°C, the new rate will be:
$2 \times 2 \times 2 \times 2.0 \times 10^{-4}$ mol/s = 1.6×10^{-3} mol/s.

33. The activation energy for the reaction is very large, so that the rate is impossibly slow (luckily).

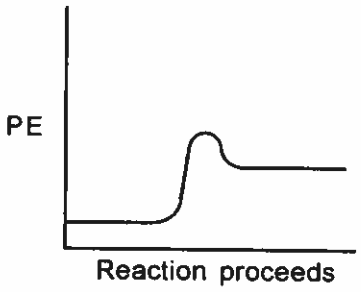
34. (a)



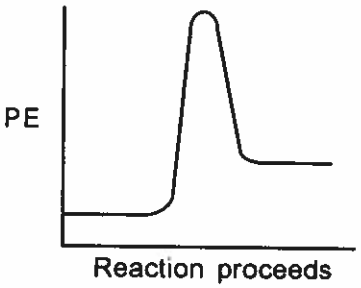
(b)



(c)



(d)



(e) The smaller the hill, the more molecules will have sufficient energy to get over the hill.

35. Not necessarily. Although sufficient KE is available, a favourable geometry is also required.

36. (a) (i) KE decreases: the repulsion of their outer electrons slows down their approach to each other.
(ii) PE increases: the KE lost is gained as PE.
(b) $(KE + PE)_{BEFORE} = (KE + PE)_{AFTER}$; that is, the total energy before equals the total energy after

37. (a) The activation energy would be increased.
(b) The formation of a bond results in the decrease of PE.
(c) exothermic
(d) $A_2 + B_2 \longrightarrow 2\,AB + 70$ kJ
(e) $120 - 80 = 40$ kJ

38. The activation energy for the reaction involving F_2 will be less than that for the reaction involving I_2. Because I_2 has more electrons than F_2, it experiences more repulsion from the electrons on the approaching H_2. Overcoming this greater repulsion requires a greater input of energy.

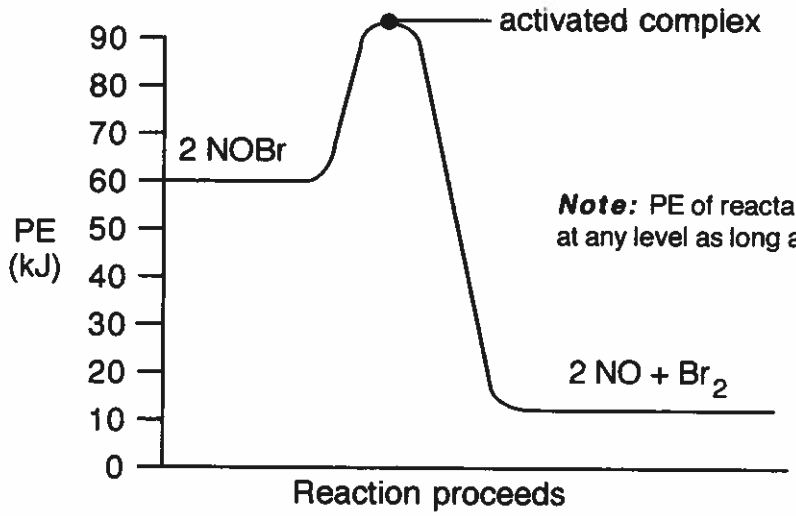
39. The reaction has a very large activation energy.

40. The kinetic energy decreases when the potential energy increases, and vice versa. Therefore, since the products have less KE then they must also possess more PE and this reaction is endothermic.

41. 55 kJ

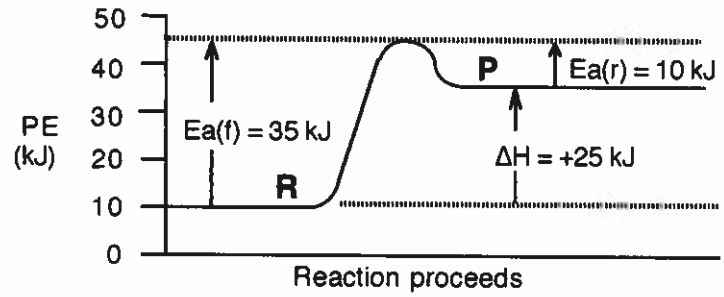
42. endothermic ($\Delta H = +25$ kJ)

43.

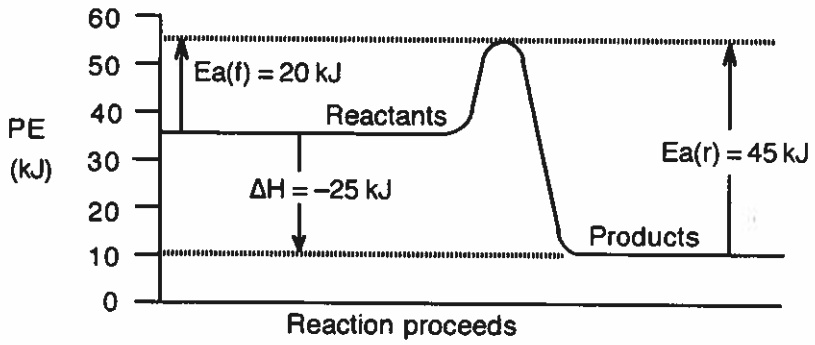


Note: PE of reactants and products can be at any level as long as the difference is 50 kJ.

44.



45.



46. (a) $2\,NO + 2\,H_2 \longrightarrow N_2 + 2\,H_2O$
(b) $[H_2O_2]$ will remain small (H_2O_2 is used up as fast as it is made)
(c) Step 1 is rate–determining
(d) NO is used in the rate–determining step and therefore the overall rate would increase.
(e) Little or no effect: speeding up a step which is not rate–determining will have little effect on the rate of the overall reaction.
(f) First step = $H_2N_2O_2$; Second step = H_4O_2 (The formulae are found by simply adding up every atom and charge found in the reactants for the step.)
(g) 2 (there are 2 steps in the mechanism)

47. An ***activated complex*** is a short–lived, unstable species which only exists after the reactants have received an energy equal to the activation energy.

A ***reaction intermediate*** is an ordinary chemical species which is produced during one step of a reaction and used up in a subsequent step of the reaction.