Q6.26 to Q6.28 These questions refer to the labels for the arrows marked 4 to 6 in Figure 6.3. In each case, you are asked to select the *one* **correct** label from the key.

KEY for Q6.26 to Q6.28

A Activation energy for physical adsorption.

B Activation energy for chemical adsorption.

C Activation energy for desorption of X_2 molecules from the metal surface.

D Enthalpy change for chemical adsorption.

E Enthalpy change for physical adsorption.

F Dissociation energy of the chemical bond between a metal surface site and an adsorbed X atom.

G Bond dissociation energy of $X_2(g)$.

Q6.26 Select from the key for Q6.26 to Q6.28 the label for the arrow marked 4 in Figure 6.3.

Q6.27 Select from the key for Q6.26 to Q6.28 the label for the arrow marked 5 in Figure 6.3.

Q6.28 Select from the key for Q6.26 to Q6.28 the label for the arrow marked 6 in Figure 6.3.

Q6.29 The heterogeneously catalysed reaction

$$A(g) + B(g) = C(g) + D(g)$$

occurs by an Eley–Rideal mechanism in which the rate-limiting step is the reaction between A in the gas phase and adsorbed B. Assuming that the products of the reaction are desorbed as quickly as they are formed, select from the key the expression for the theoretical rate equation for this reaction, where k_θ is the theoretical rate constant, and p_X and b_X are, respectively, the partial pressure and adsorption coefficient of the species X.

KEY for Q6.29

A $r = \dfrac{k_\theta b_A p_A b_B p_B}{(1 + b_A p_A + b_B p_B + b_C p_C + b_D p_D)^2}$

B $r = \dfrac{k_\theta b_A p_A b_B p_B}{(1 + b_B p_B)^2}$

C $r = \dfrac{k_\theta b_A p_A b_B p_B}{(1 + b_A p_A)^2}$

D $r = \dfrac{k_\theta b_B p_A p_B}{(1 + b_B p_B)^2}$

E $r = \dfrac{k_\theta b_B p_A p_B}{(1 + b_B p_B)}$

F $r = \dfrac{k_\theta b_A p_A p_B}{(1 + b_A p_A)}$

G $r = \dfrac{k_\theta b_B p_A p_B}{(1 + b_A p_A + b_B p_B + b_C p_C + b_D p_D)}$

Q6.30 The statements in the key refer to the discussion of emission control catalysts for petrol-driven vehicles in Topic Study 2, Part 1. Examine the statements in the key, and then select *two* that are **correct**.

KEY for Q6.30

A Dual-bed catalysts require an extra supply of air to be injected into the exhaust ahead of the oxidation catalyst in the second bed.

B When the engine in a petrol-driven vehicle is operating under fuel-lean conditions, high levels of hydrocarbons and carbon monoxide are produced in the engine.

C In the three-way catalytic converter, the water-gas shift reaction is the most important reaction for removing carbon monoxide under fuel-lean conditions.

D In the Pt–Rh/CeO_2–Al_2O_3 three-way catalyst, platinum is the component that is mainly responsible for removing NO_x.

E In the Pt–Rh/CeO_2–Al_2O_3 three-way catalyst, the *only* role of the ceria (CeO_2) is to act as a structural promoter to prevent sintering of the precious metal components.

F Sulfur is stored by the three-way catalyst under fuel-lean conditions, and released under fuel-rich conditions.

PART G *(Block 6)*

Q6.31 In the X-ray photoelectron spectrum of a clean vanadium surface, a peak due to $V(2p_{3/2})$ emission is observed at a binding energy 512.2 eV. Oxidation of the surface by heating in an oxygen atmosphere causes this peak to shift to 515 eV. With a bulk sample of the oxide V_2O_3, the corresponding peak occurs at 516 eV. Select from the key the *two* statements that are **incorrect.**

KEY for Q6.31

A Changing the energy of the X-ray source would alter the measured kinetic energy of the $V(2p_{3/2})$ peak for the clean surface.

B Changing the energy of the X-ray source would alter the binding energy of the vanadium 2p electrons in the clean surface.

C The complete XPS spectrum from the clean surface will contain two peaks due to vanadium 2p emission.

D Heating the oxidized sample in vacuum to cause diffusion of oxygen from the surface layers into the bulk would definitely *not* alter the intensity of the O(1s) peak, which occurs at 529 eV.

E The change in the $V(2p_{3/2})$ binding energy observed on oxidation shows that, in the process, negative charge has been transferred from vanadium to oxygen.

F The smaller $V(2p_{3/2})$ chemical shift for the oxidized film compared with the shift for bulk V_2O_3 indicates that the oxidation state of vanadium in the oxidized film is likely to be less than +3.