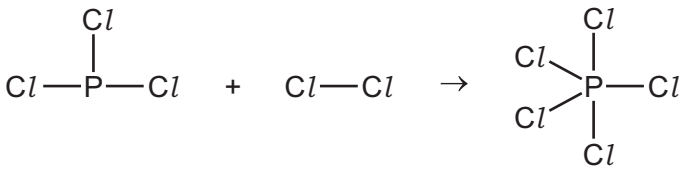
BOND ENERGY CALCULATIONS

1 Gaseous phosphorus(III) chloride, PCl_3, reacts with gaseous chlorine to form gaseous phosphorus(V) chloride, PCl_5.

$$PCl_3(g) + Cl_2(g) \rightarrow PCl_5(g)$$

The chemical equation for this reaction can be represented as shown.



(i) Use the bond energies in the table to calculate the energy change, in kJ/mol, of the reaction.

bond	bond energy in kJ/mol
P–Cl	326
Cl–Cl	243

- Energy needed to break bonds.

..... kJ

- Energy released when bonds are formed.

..... kJ

- Energy change of reaction.

energy change = ... kJ/mol
[3]

(ii) Deduce whether the energy change for this reaction is exothermic or endothermic. Explain your answer.

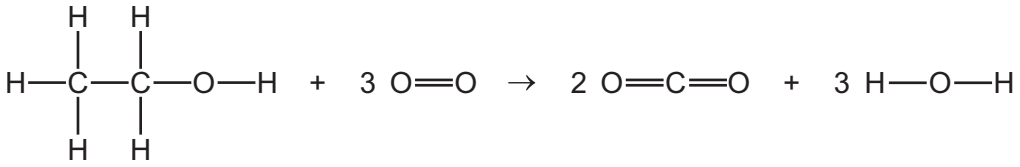
.....

..... [1]

MARKING SCHEME:

(i)	**method 1** ∞ (bond breaking) = 1221 or (326 × 3) + 243 (1) ∞ (bond forming) = 1630 or (326 × 5) (1) ∞ energy change = –409 kJ (1) negative sign essential **OR** **method 2** (ignoring 3 P–Cl bonds on both sides) ∞ bond breaking = 243 .(1) ∞ bond forming = 652 or 326 × 2 (1) ∞ energy change = –409 kJ (1) negative sign essential	**3**
(ii)	exothermic **AND** energy released when bonds form is greater than energy absorbed to break bonds **OR e**xothermic **AND** overall energy change has a negative sign	**1**

2 The equation for the complete combustion of ethanol is shown.



Use the bond energies in the table to calculate the energy change, in kJ / mol, for the complete combustion of ethanol.

bond	bond energy in kJ / mol
C–C	347
C–H	413
C–O	358
C=O	805
O–H	464
O=O	498

- Energy needed to break bonds.

..... kJ

- Energy released when bonds are formed.

..... kJ

- Energy change for the complete combustion of ethanol.

energy change = ... kJ / mol

[3]

MARKING SCHEME:

	(energy to break bonds) = 4728 (1) (energy released by making bonds) = 6004 (1) –1276 (1)	**3**