Higher Chemistry: Revision Calculation
8th May 2018

Please attempt the following questions in preparation for the online session on 8th May.

1. A mixture of sodium chloride and sodium sulfate is known to contain 0.6 moles of chloride ions and 0.2 mol of sulfate ions.

How many moles of sodium ions are present?

A. 0.4

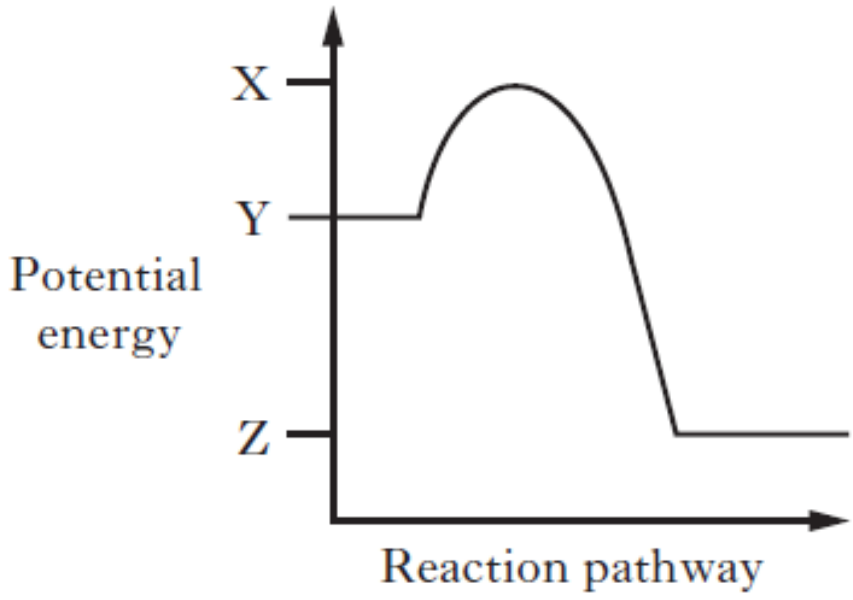
B. 0.5

C. 0.8

D. 1.0

(1)

2. A reaction has the following potential energy diagram.



The activation energy for the forward reaction is

A. X − Y

B. Y − X

C. Y – Z

D. Z − Y

(1)

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3. Excess iron was added to 100cm^3 of 1mol l^{-1} copper (II) sulfate releasing 3.1 kJ of energy.

$$Fe(s) + CuSO4(aq) \rightarrow Cu(s) + FeSO4\ (aq)$$

What is the enthalpy change, in kJ mol^{-1}for the above reaction?

A. -0.31

B. -3.1

C. -31

D. -310

(1)

4. $C(graphite) + O2(g) \rightarrow CO2(g)\ \Delta H = -394\ kJ\ mol^{-1}$

$C(diamond) + O2(g) \rightarrow CO2(g)\ \Delta H = -395\ kJ\ mol^{-1}$

What is the enthalpy change, in kJ mol^{-1}, for the conversion of one mole of graphite into one mole of diamond?

A. +789

B. +1

C. −1

D. −789

(1)

5. 4·6 g of sodium is added to 4·8 litres of oxygen to form sodium oxide.
When the reaction is complete, which of the following statements will be true?
(Take the volume of 1 mole of oxygen to be 24 litres.)

A. 0·10 mol of oxygen will be left unreacted.

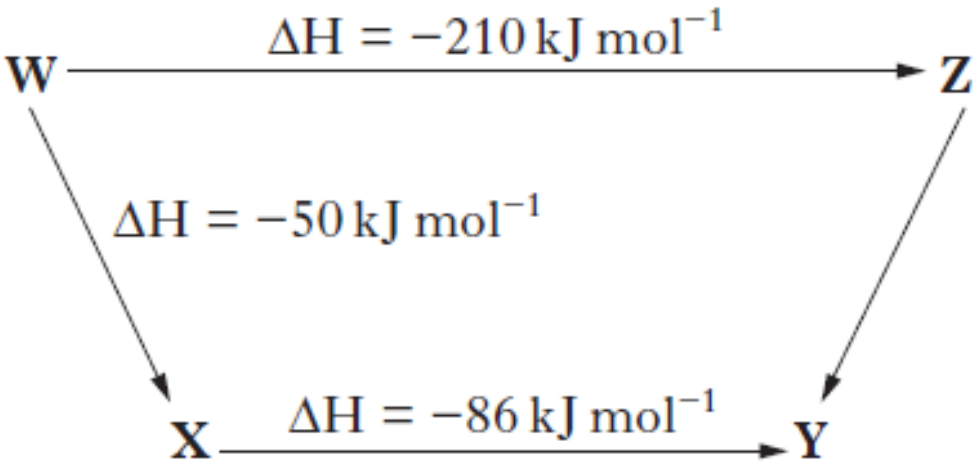
B. 0·10 mol of sodium will be left unreacted.

C. 0·15 mol of oxygen will be left unreacted.

D. 0·20 mol of sodium oxide will be formed.

(1)

6. Consider the reaction pathway shown below.



According to Hess's Law, the ΔH value, in kJ mol^{-1}, for reaction Z to Y is

A. +74

B. −74

C. +346

D. −346.

(1)

7. During a redox process in acid solution, chlorate ions, $ClO_3^-(aq)$, are converted into chlorine, $Cl_2(g)$.

$$ClO_3^-(aq) \rightarrow Cl_2(g)$$

The numbers of $H^+(aq)$ and $H_2O(\ell)$ required to balance the ion-electron equation for the formation of 1 mol of $Cl_2(g)$ are, respectively

A. 3 and 6

B. 6 and 3

C. 6 and 12

D. 12 and 6.

(1)

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8. $x\ P_2H_4 + y\ O_2 \rightarrow P_4O_{10} + z\ H_2O$

The equation is balanced when

A. x = 1, y = 5, z = 4

B. x = 4, y = 6, z = 2

C. x = 2, y = 7, z = 4

D. x = 2, y = 5, z = 2

(1)

9.

$TiCl_4$	+ 2Mg	→	$2MgCl_2$	+ Ti
mass of one mole = 189·9 g	mass of one mole = 24·3 g		mass of one mole = 95·3 g	mass of one mole = 47·9 g

The atom economy for the production of titanium in the above equation is equal to

A. $\frac{47{\cdot}9}{189{\cdot}9 + 24{\cdot}3} \times 100$

B. $\frac{95{\cdot}3 + 47{\cdot}9}{189{\cdot}9 + 24{\cdot}3} \times 100$

C. $\frac{47{\cdot}9}{189{\cdot}9 + (2 \times 24{\cdot}3)} \times 100$

D. $\frac{(2 \times 47{\cdot}9)}{189{\cdot}9 + 24{\cdot}3} \times 100$

(1)

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10. The mean bond enthalpy of a C – F bond is 484 kJ mol^{-1}.

In which of the processes is ΔH approximately equal to +1936 kJ mol^{-1}?

A. $CF_4(g) \rightarrow C(s) + 2F_2(g)$

B. $CF_4(g) \rightarrow C(g) + 4F(g)$

C. $CF_4(g) \rightarrow C(g) + 2F_2(g)$

D. $CF_4(g) \rightarrow C(s) + 4F(g)$

(1)

11. Methanol can be used as a fuel, in a variety of different ways.

An increasingly common use for methanol is as an additive in petrol.

Methanol has been tested as an additive in petrol at 118 g per litre of fuel.

Calculate the volume of carbon dioxide, in litres, that would be released by combustion of 118 g of methanol.

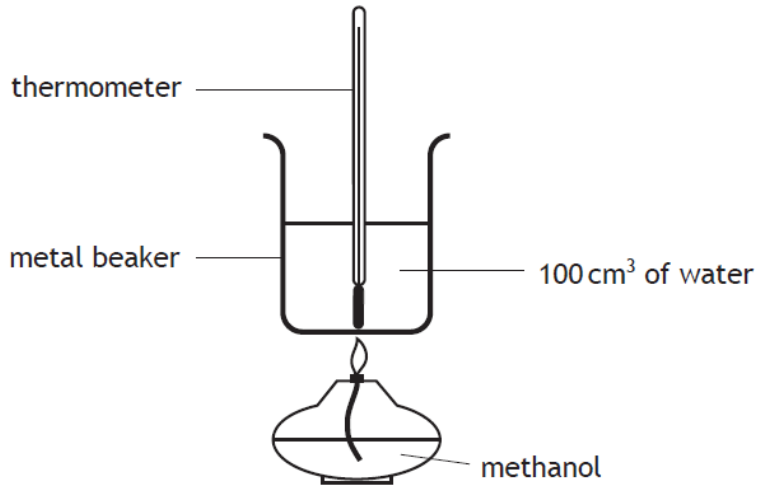
$$2CH_3OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(\ell)$$

(Take the molar volume of carbon dioxide to be 24 litres mol^{-1}).

(2)

12. Methanol can be used as a fuel, in a variety of different ways.

A student burned 1·07 g of methanol and recorded a temperature rise of 23 ºC.



Calculate the enthalpy of combustion, in kJ mol^{-1}, for methanol using the student's results.

(3)

13. The concentration of sodium hypochlorite in swimming pool water can be determined by redox titration.

Step 1

A 100·0 cm^3 sample from the swimming pool is first reacted with an excess of acidified potassium iodide solution forming iodine.

$$NaOCl(aq) + 2I^-(aq) + 2H^+(aq) \rightarrow I_2(aq) + NaCl(aq) + H_2O(\ell)$$

Step 2

The iodine formed in step 1 is titrated using a standard solution of sodium thiosulfate, concentration 0·00100 mol l^{-1}. A small volume of starch solution is added towards the endpoint.

$$I_2(aq) + 2Na_2S_2O_3(aq) \rightarrow 2NaI(aq) + Na_2S_4O_6(aq)$$

Calculate the concentration, in mol l^{-1}, of sodium hypochlorite in the swimming pool water if an average volume of 12·4 cm^3 of sodium thiosulfate was required.

(3)

14. A student used 2·5 g of ethanol and a slight excess of ethanoic acid to produce 2·9 g of ethyl ethanoate.

ethanol + ethanoic acid	⇌	ethyl ethanoate + water
mass of one mole = 46·0 g		mass of one mole = 88·0 g

One mole of ethanol reacts with one mole of ethanoic acid to produce one mole of ethyl ethanoate.

Calculate the percentage yield of ethyl ethanoate.

(2)

Total marks = 20