

## PERIODICITY AHL (HL only)

Please ensure that you have also completed the Core (SL & HL) questions

1. The chromium complex ion  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$  is blue in colour.

(a) State how water behaves as a *ligand* in this complex ion.

[1]

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(b) In terms of acid-base theory, what type of reaction is the formation of  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$  from  $\text{Cr}^{3+}$  and water? Explain your answer.

[2]

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(c) Sketch a diagram to show the energy levels of the 3d-orbitals of chromium in  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ . Complete the diagram by adding the d-electrons of chromium using arrows to represent electrons.

[3]



(d) Predict the type of magnetism that  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$  might exhibit. Explain your answer.

[2]

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(e) Explain how the blue colour arises in this octahedral complex ion, you may refer to your diagram in (c).

[4]

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(f) Using **section 15 and 17** of the data booklet, predict what would happen to the colour of  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$  if some of the water ligands were replaced by hydroxide ligands ( $\text{OH}^-$ ) using concentrated sodium hydroxide solution. Explain your answer.

[2]

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(g) Explain why Zinc compounds are colourless or white.

[2]

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2. 1,2-ethanediamine (en) is a bidentate ligand shown in **section 16** of the data booklet.

(a) Sketch the structure of  $[\text{Ni}(\text{en})_3]^{2+}$  showing the shape of the complex ion.

[2]

(b) State the coordination number of the central nickel ion in  $[\text{Ni}(\text{en})_3]^{2+}$ .

[1]

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(c)  $[\text{Ni}(\text{en})_3]^{2+}$  is purple in colour. If drops of concentrated sodium hydroxide solution,  $\text{NaOH}(\text{aq})$ , are added the colour changes to blue.

Using **sections 15 and 17** of the data booklet suggest whether 1,2-ethanediamine (en) is a stronger or weaker ligand than  $\text{OH}^-$ . Explain your answer.

[1]

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(d) Nickel is used as a catalyst in a number of reactions. State one reason why transition metals make good catalysts.

[1]

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Total marks 21 (32 minutes)