1 The rate of a photochemical reaction is affected by light.

(a) The decomposition of silver bromide is the basis of film photography. This is a redox reaction.

$$\underset{\text{cream}}{2AgBr} \rightarrow \underset{\text{black}}{2Ag} + Br_2$$

step 1 $2Br^- \rightarrow Br_2 + 2e^-$

step 2 $Ag^+ + e^- \rightarrow Ag$

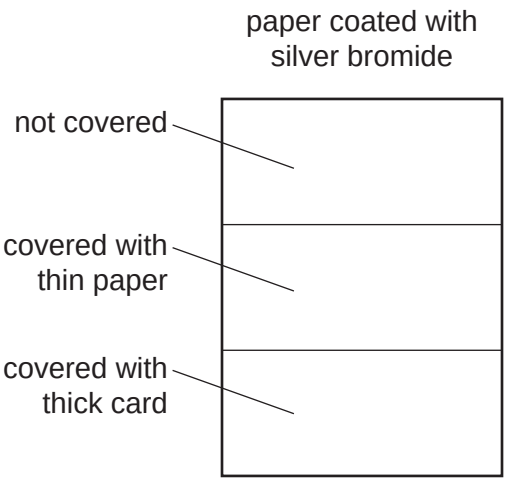
(i) Which step is reduction? Explain your answer.

..... [1]

(ii) Which ion is the oxidising agent? Explain your answer.

..... [1]

(b) A piece of white paper was coated with silver bromide and exposed to the light. Sections of the paper were covered as shown in the diagram.



Predict the appearance of the different sections of the paper after exposure to the light and the removal of the card. Explain your predictions.

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.....

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.....

.....

..... [4]

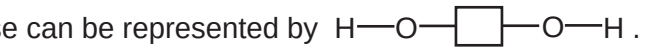
(c) Photosynthesis is another example of a photochemical reaction. Green plants can make simple carbohydrates, such as glucose. These can polymerise to make more complex carbohydrates, such as starch.

(i) Write a word equation for photosynthesis.

..... [2]

(ii) Name the substance which is responsible for the colour in green plants and is essential for photosynthesis.

..... [1]

(iii) The structural formula of glucose can be represented by  .

Draw part of the structural formula of starch which contains two glucose units.

[2]

(iv) Living organisms need carbohydrates for respiration.

What is meant by *respiration*?

..... [1]

[Total: 12]

2 For each of the following, give the name of an element from Period 3 (sodium to argon), which matches the description.

(a) an element which is gaseous at room temperature and pressure

..... [1]

(b) an element that is added to water to kill bacteria

..... [1]

(c) an element that forms a basic oxide of the type XO

..... [1]

(d) an element used as an inert atmosphere in lamps

..... [1]

(e) an element that forms an amphoteric oxide

..... [1]

(f) an element that reacts vigorously with cold water to produce hydrogen

..... [1]

[Total: 6]

3 A student is told to produce the maximum amount of copper from a mixture of copper and copper(II) carbonate.

The student adds the mixture to an excess of dilute sulfuric acid in a beaker and stirs the mixture with a glass rod. The copper(II) carbonate reacts with the sulfuric acid, forming a solution of copper(II) sulfate but the copper does not react with the sulfuric acid.

The student then

- removes the unreacted copper from the mixture,
- converts the solution of copper(II) sulfate into copper by a series of reactions.

(a) Describe **two** things that the student would observe when the mixture is added to the dilute sulfuric acid.

.....

..... [2]

(b) Describe how the student can produce pure dry copper from the mixture of copper and copper(II) sulfate solution.

.....

.....

.....

..... [3]

(c) The student then adds sodium hydroxide solution to the copper(II) sulfate solution to produce copper(II) hydroxide.

(i) Describe what the student would observe.

..... [1]

(ii) Write an **ionic** equation for this reaction.

..... [1]

(d) After separating the copper(II) hydroxide from the mixture, the copper(II) hydroxide is heated strongly. The copper(II) hydroxide decomposes into copper(II) oxide and steam.

(i) Write an equation for the decomposition of copper(II) hydroxide. Include state symbols.

..... [2]

(ii) Name a non-metallic element that can be used to convert copper(II) oxide into copper.

..... [1]

4 The following reactivity series shows both familiar and unfamiliar elements in order of decreasing reactivity. Each element is represented by a redox equation.

$$Rb \rightleftharpoons Rb^{+} + e^{-}$$
$$Mg \rightleftharpoons Mg^{2+} + 2e^{-}$$
$$Mn \rightleftharpoons Mn^{2+} + 2e^{-}$$
$$Zn \rightleftharpoons Zn^{2+} + 2e^{-}$$
$$H_2 \rightleftharpoons 2H^{+} + 2e^{-}$$
$$Cu \rightleftharpoons Cu^{2+} + 2e^{-}$$
$$Hg \rightleftharpoons Hg^{2+} + 2e^{-}$$

Two of the uses of the series are to predict the thermal stability of compounds of the metals and to explain their redox reactions.

(a) Most metal hydroxides decompose when heated.

(i) Complete the equation for the thermal decomposition of copper(II) hydroxide.

$Cu(OH)_2 \rightarrow$ ..... + ... [1]

(ii) Choose a metal from the above series whose hydroxide does not decompose when heated.

..... [1]

(b) Define in terms of electron transfer the term *oxidation*.

..... [1]

(ii) Explain why the positive ions in the above equations are oxidising agents.

.....

..... [1]

(c) Which metals in the series above do not react with dilute acids to form hydrogen?

..... [1]

(ii) Describe an experiment which would confirm the prediction made in **(c)(i)**.

.....

..... [1]

(d) Which metal in the series above can form a negative ion which gives a pink / purple solution in water?

..... [1]

(ii) Describe what you would observe when zinc, a reducing agent, is added to this pink / purple solution.

..... [1]

5 The elements in Period 3 and some of their common oxidation states are shown below.

Element	Na	Mg	A*l*	Si	P	S	*l*	Ar
Oxidation State	+1	+2	+3	+4	–3	–2	–1	0

(a) **(i)** Why do the oxidation states increase from sodium to silicon?

.....[1]

(ii) After Group(IV) the oxidation states are negative and decrease across the period. Explain why.

.....

.....[2]

(b) The following compounds contain two elements. Predict their formulae.

aluminium sulphide .....

silicon phosphide ..... [2]

(c) Choose a different element from Period 3 that matches each description.

(i) It has a similar structure to diamond.

.....[1]

(ii) It reacts violently with cold water to form a solution pH = 14.

.....[1]

(iii) It has a gaseous oxide of the type XO_2, which is acidic.

.....[1]

(d) The only oxidation state of argon is zero. Why it is used to fill light bulbs?

.....

.....[1]

(e) Draw a diagram that shows the arrangement of the valency electrons in the ionic compound sodium phosphide.

Use o to represent an electron from sodium.
Use x to represent an electron from phosphorus. [3]

(f) Sodium reacts with sulphur to form sodium sulphide.

$$2Na + S \rightarrow Na_2S$$

An 11.5 g sample of sodium is reacted with 10 g of sulphur. All of the sodium reacted but there was an excess of sulphur.
Calculate the mass of sulphur left unreacted.

(i) Number of moles of sodium atoms reacted = ...
[2 moles of Na react with 1 mole of S]

(ii) Number of moles of sulphur atoms that reacted = ...

(iii) Mass of sulphur reacted = ...g

(iv) Mass of sulphur left unreacted = ...g [4]