Semester One Examination 2019

Question/Answer Booklet

Chemistry Unit 1

Student Number: In figures ☐☐ ☐☐☐ ☐☐☐

In words _____

Student Name _____

Time allowed for this paper
Reading time before commencing work: ten minutes
Working time: three hours

Materials required/recommended for this paper
To be provided by the supervisor
This Question/Answer booklet
Multiple-choice answer sheet
Chemistry Data booklet

To be provided by the candidate
Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: non-programmable calculators approved for use in this examination

Important note to candidates
No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of examination
Section One Multiple-choice	25	25	50	50	25
Section Two Short answer	9	9	60	85	35
Section Three Extended answer	6	6	70	87	40
				Total	100

Instructions to candidates

1. The rules for the conduct of the Western Australian external examinations are detailed in the *Year 12 Information Handbook 2019*. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer booklet preferably using a blue/black pen. Do not use erasable or gel pens.

3. Answer the questions according to the following instructions.

   Section One: Answer all questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not use erasable or gel pens. If you make a mistake, place a cross through that square, then shade your new answer. Do not erase or use correction fluid/tape. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

   Sections Two and Three: Write your answers in this Question/Answer booklet.

4. When calculating numerical answers, show your working or reasoning clearly. Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning. Express numerical answers to the appropriate number of significant figures and include appropriate units where applicable.

5. You must be careful to confine your answers to the specific questions asked and to follow any instructions that are specific to a particular question.

6. Supplementary pages for planning/continuing your answers to questions are provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

7. The Chemistry Data booklet is not to be handed in with your Question/Answer booklet.

See next page

Section One: Multiple–choice **25% (50 Marks)**

This section has **25** questions. Answer **all** questions on the separate Multiple-choice answer sheet provided. For each question, shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. Do not erase or use correction fluid/tape. If you make a mistake, place a cross through that square, shade your new answer. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 50 minutes.

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1. The formula of cerium(III) sulfate is $Ce_2(SO_4)_3$. What is the correct formula of cerium(III) phosphate?

   (a) $CePO_4$
   (b) CeP
   (c) $Ce_2(PO_4)_3$
   (d) $Ce_3(PO_4)_2$

2. Which property best describes why the elements lithium, sodium and potassium are found in the same Group of the Periodic Table?

   (a) boiling point
   (b) reaction with water
   (c) number of outermost electrons
   (d) first ionisation energy

3. Element X has an electron configuration 2, 8, 8, 2 and combines with an element Y with an electron configuration 2, 8, 6 to form a compound. What is the likely formula of the compound?

   (a) X_2Y
   (b) XY
   (c) XY_2
   (d) X_3Y

4. A particular isotope of tin is designated $^{119}_{50}Sn$. The +2 cation of this isotope contains which of the following?

   (a) 48 protons, 69 neutrons and 50 electrons.
   (b) 69 protons, 119 neutrons and 48 electrons.
   (c) 50 protons, 119 neutrons and 54 electrons.
   (d) 50 protons, 69 neutrons and 48 electrons.

See next page

5. Which one of the following substances have both covalent and ionic bonding within them?

(a) NaF(s)
(b) $Mg_3(PO_4)_2(s)$
(c) HF (g)
(d) C(s) (graphite)

6. In the table below which line correctly identifies the researcher and their discovery?

	Bohr	Chadwick	Rutherford	Thompson
(a)	atom	nucleus	neutron	electron
(b)	atom	energy levels	electron	neutron
(c)	energy levels	neutron	nucleus	electron
(d)	neutron	electron	atom	nucleus

7. In an endothermic reaction, the

(a) reactants absorb heat and so the reaction container would feel cold.
(b) reactants absorb heat and so now have lower enthalpy.
(c) products will have lower enthalpy.
(d) heat of reaction is negative as the products have lower energy

8. A student tested a substance for electrical conductivity as a solid, when it was molten and when it was dissolved in water. The following results were obtained.

State of substance	Electrical conductivity
Solid	Poor
Molten	Good
Aqueous	Good

The identity of the substance might be

(a) diamond.
(b) sodium.
(c) sulfur dioxide.
(d) sodium chloride.

See next page

9. Which one of the following statements is **true** about trends in the periodic table?

(a) Within Group 17, as the atomic number increases, the first ionisation energy decreases.
(b) Elements on the right-hand side of the table are less electronegative than elements on the left.
(c) Elements on the left–hand side of a period have a higher ionisation energy than elements on the right–hand.
(d) The number of valence electrons of the elements decreases when moving from left to right along the third row.

10. Which one of the following groups of elements are listed in increasing order of first ionisation energy?

(a) Li, Na, K.
(b) F, O, N.
(c) Ne, Ar, Kr.
(d) B, C, N.

11. Michael tested four white sodium salts that were in his laboratory. He found that they were all soluble in water. From this result it can be concluded that

(a) all white salts are soluble in water.
(b) all sodium salts are soluble in water.
(c) some sodium salts are insoluble in water.
(d) some sodium salts are soluble in water.

12. Which one of the following quantities is the same for 1 mole of ethane and 1 mole of carbon dioxide?

(a) the number of molecules
(b) the mass of gas at room temperature and pressure
(c) the number of atoms
(d) the molar mass

13. Which one of the following is an example of an endothermic process?

(a) the reaction of magnesium with sulfuric acid solution
(b) conversion of water to steam
(c) combustion of wood
(d) the reaction of sodium with water

See next page

14. Which one of the reactions below represents a precipitation reaction?

(a) $Mg(s) + 2\ HC\ell(aq) \rightarrow MgCl_2(aq) + H_2(g)$
(b) $AgNO_3(aq) + HC\ell(aq) \rightarrow AgC\ell(s) + HNO_3(aq)$
(c) $2\ Na(s) + 2\ H_2O(\ell) \rightarrow 2\ NaOH(aq) + H_2(g)$
(d) $S(g) + O_2(g) \rightarrow SO_2(g)$

15. Exothermic reactions always result in

(a) a greater mass of products compared to reactants.
(b) a decrease in the number of chemical bonds.
(c) a decrease in enthalpy.
(d) a decrease in the temperature of the surroundings.

16. The non-IUPAC name "1–bromo-2,2–dimethylethane" corresponds to the structure of substance **X**. What is the IUPAC name of substance **X**?

(a) 2–dimethyl–1–bromoethane
(b) 1–bromo–2–methylpropane
(c) 2–(bromomethyl)–propane
(d) 2–methyl–3–bromopropane

17. Which one of the following compounds will decolourise bromine water very rapidly in the absence of a catalyst?

(a) CH_3CH_3
(b) C_4H_{10}
(c) C_4H_8
(d) C_2H_6

18. Which one of the following statements best explains the stability of benzene?

(a) Cyclic hydrocarbons are more stable than straight chain hydrocarbons.
(b) Its ring structure contains three double bonds.
(c) It is an unsaturated hydrocarbon.
(d) Six delocalised electrons are present in the ring structure of benzene.

19. The process by which crude oil is separated into its components is called

(a) fractional distillation.
(b) catalytic cracking.
(c) combustion.
(d) simple distillation.

See next page

20. Mass spectrometers separate isotopes of different elements based on their

(a) mass only.
(b) electric charge only.
(c) mass and electric charge.
(d) emission of photons.

21. Which one of the following statements about Atomic Absorption Spectroscopy is **true**?

(a) It is based on the ability of electrons releasing energy while moving from higher energy level to lower energy level.
(b) It cannot provide qualitative or quantitative results.
(c) It can detect a large variety of all elements in very low concentrations.
(d) It can detect a range of metal ions but not non–metals.

22. Which of the following equations represent addition reactions?

I $CH_3–CH=CH_2 + Br_2 \rightarrow CH_3–CHBr–CH_2Br$
II $CH_2=CH_2 + H_2O \rightarrow CH_3–CH_2–OH$
III $CH_3OH + HBr \rightarrow CH_3Br + H_2O$
IV $CH_3–CH_2–CH_2–OH + HC\ell \rightarrow CH_3–CH_2–CH_2C\ell + H_2O$
V $CH_3–CH_2–CH_2–CH_2–OH \rightarrow CH_3–CH_2–CH_2=CH_2 + H_2O$

(a) I and II.
(b) I and III.
(c) III and IV.
(d) V only.

23. Which one of the following substances will exhibit cis/trans isomerism?

(a) $CH_3C(CH_3)CBr_2$
(b) $CH_3CBrC(CH_3)Br$
(c) $CH_2CHCHCHBr_2$
(d) $CH_3CH_2CHCBr_2$

24. Imagine you completed an investigation, submitted your findings and were then told by your teacher that your investigation was not valid. To solve this problem, you should

(a) redesign your experimental method.
(b) repeat the experiment many times and average the results.
(c) buy new, high accuracy equipment so you can obtain more precise results.
(d) have just one scientist collect all the data to make the results more reliable.

25. A flame test can be used to distinguish between

(a) potassium chloride and potassium nitrate.
(b) silver chloride and calcium chloride.
(c) methane and chloromethane.
(d) two metals.

End of Section One

See next page

Section Two: Short answer **35% (85 Marks)**

This section has **nine** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for the use of planning/continuing your answer to a question have been provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 60 minutes.

Question 26 **(6 marks)**

Complete the table below.

Formula	Name
	Sodium Chromate
	Dinitrogen tetroxide
	Iron (III) dihydrogenphosphate
$NaMnO_4$	
$(NH_4)_2SO_4$	
CBr_4	

See next page

Question 27 **(10 marks)**

Group 1 elements are also known as alkali metals and Group 2 elements are known as alkaline earth metals.

(a) Describe with the, **aid of a diagram**, the bonding present in sodium metal. (3 marks)

(b) Metals are noted for their thermal conductivity and generally high melting point. Explain these physical properties of metals by referring to the metallic bonding model. (4 marks)

Thermal Conductivity:

High Melting Point:

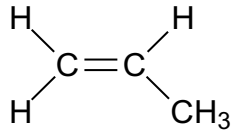
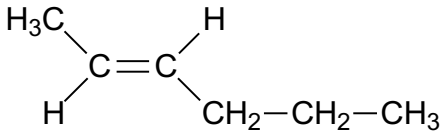
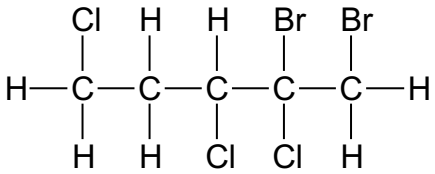
When sodium metal reacts with chlorine gas, it produces a white solid.

(c) The white solid does not conduct electricity. However, if it is heated until it melts, the liquid will conduct electricity. Explain this behaviour. (3 marks)

See next page

Question 28 **(16 marks)**

(a) Complete the table below. (8 marks)

Structural Formula	IUPAC Name
	
	2,3–dimethylpent–2–ene
	
	

(b) Select one molecule from the table in part (a) that can exist as a *cis* isomer and draw its *cis* structure below. (2 marks)

See next page

(c) Samples of benzene and hept–1–ene appear similar in that they are colourless, clear liquids. Their chemical reactions, however are quite different. Draw the full structural formula of the organic product when bromine water reacts with each of these substances and name the product. (6 marks)

Hept–1–ene / Br_2 Product	**Benzene / Br_2 product**
Name:	**Name:**

Question 29 **(9 Marks)**

The combustion of hydrogen gas can be represented as follows:

$$2\ H_2(g)\ +\ O_2(g)\ \rightarrow\ 2\ H_2O(g)\ +\ \text{heat}$$

(i) The activation energy of the reaction is 250 kJ mol^{-1}.
(ii) The enthalpy change for the reaction is 100 kJ mol^{-1}.
(iii) Finely divided iron filings are used in the reaction as a catalyst.

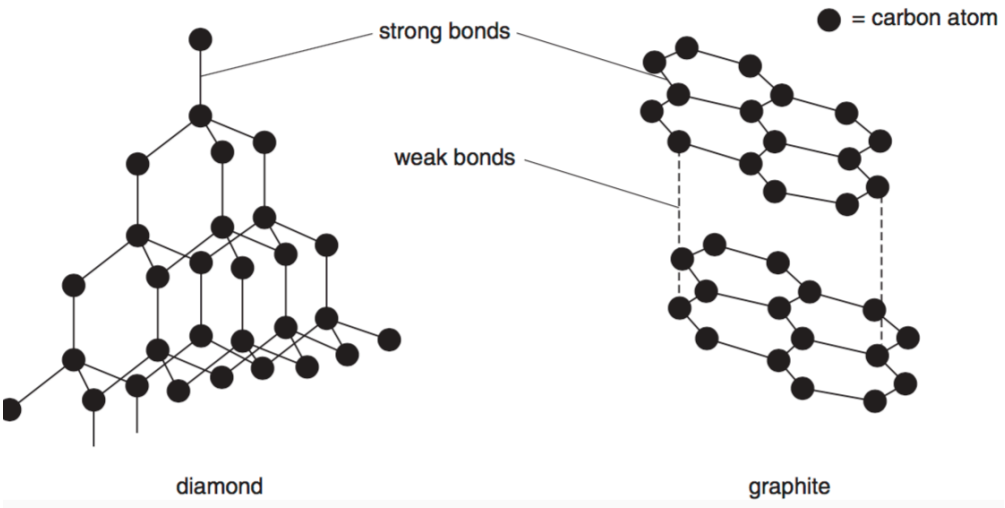
(a) On the axes below sketch an appropriate and clearly labelled energy profile diagram for the above reaction. Include the reactants, products, activation energy and the enthalpy change. (5 marks)

(b) State and explain the effect the finely divided iron filings have on the reaction. (4 marks)

See next page

Question 30 **(11 Marks)**

The structures of diamond and graphite are drawn below.



(a) State the name of the "strong bonds" shown on the diagram in the space below. (1 mark)

(b) Diamond is noted for its hardness and graphite is used as a lubricant because of its soft slippery properties.

(i) Explain why there is such a difference in this physical property of these carbon structures. (3 marks)

(ii) Explain why there is a significant difference in the electrical conductivity of diamond and graphite. (2 marks)

See next page

Question 30 (continued)

(c) Carbon is also found in nanomaterials. Describe how the structure of a carbon nano-particle is different in three ways from either structure in part (a). (3 marks)

(d) List **two** possible health issues that might be related to the use of nano-particles. (2 marks)

See next page

Question 31 **(13 marks)**

The table below shows some of the ores of iron that are mined in Western Australia.

Ore	Formula
Haematite	Fe_2O_3
Magnetite	$FeO.Fe_2O_3$
Siderite	$FeCO_3$

(a) By calculation, determine and state which ore has the greatest percentage by mass of iron. (4 marks)

(b) Iron is malleable. Define malleability and explain this property by referring to its structure and bonding. (4 marks)

See next page

Question 31 (continued)

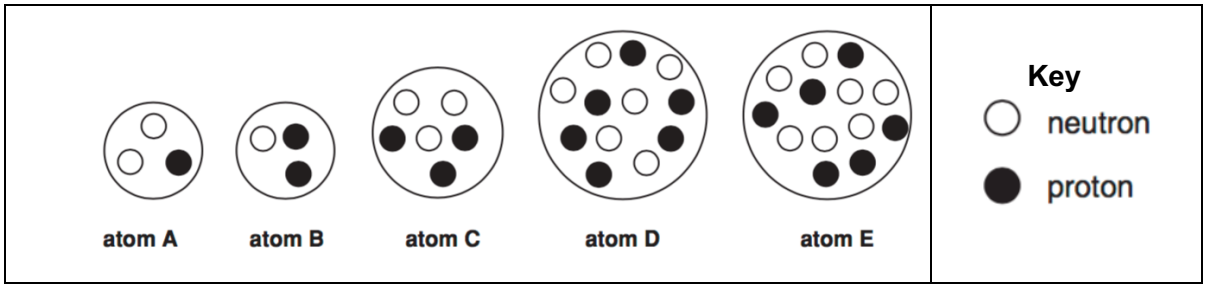
(c) Certain physical properties of iron can be changed by the addition of carbon when the iron is molten. This new substance is called an alloy. Construct a suitable diagram and explain why a property of iron changes when it becomes an alloy. (3 marks)

(d) Explain why alloys are described as homogeneous mixtures. (2 marks)

See next page

Question 32 **(13 marks)**

The diagram below shows the nuclei of five different atoms.



(a) Which atom has an atomic number of 3? (1 mark)

(b) Which atom has a mass number of 12? (1 mark)

(c) A mass spectrometer can be used to determine the proportion of each isotope present in a sample of an element.

(i) Define the term “isotope”. (2 marks)

(ii) Name the **four** steps used in mass spectrometry to detect an isotope. (4 marks)

One: _____

Two: _____

Three: _____

Four: _____

See next page

Question 32 (continued)

(iii) Lithium has two naturally occurring isotopes: (2 marks)

Li – 6: natural abundance 7%

Li – 7: natural abundance 93%

Calculate the relative atomic mass of lithium.

(d) Sodium atoms and potassium atoms have different radii. Compare their atomic radius and explain the difference in size. (3 marks)

See next page

Question 33 **(3 marks)**

(a) "Carbon dioxide is a molecular compound and it is a non–conductor of electricity". Explain the above statement. (3 marks)

Question 34 **(4 marks)**

(a) Using an appropriate example from your practical work this year, explain the difference between the independent variable and the dependent variable in an investigation. (4 marks)

End of Section Two

Section Three: Extended answer **40% (87 Marks)**

This section contains **six** questions. You must answer **all** questions. Write your answers in the spaces provided.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression. Lists or dot points are unlikely to gain full marks.

Final answers to calculations should be expressed to the appropriate number of significant figures.

Supplementary pages for the use of planning/continuing your answer to a question have been provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

Suggested working time: 70 minutes.

Question 35 **(18 marks)**

The table below lists the boiling points of some alkanes and their state at room temperature (25 ^{o}C).

Name	Formula	Boiling point (^{o}C)	State
Ethane	C_2H_6	–89	
Propane	C_3H_8	–42	Gas
Methyl propane		–11.7	Gas
Butane		–1	Gas
Pentane	C_5H_{12}	36	Liquid
Hexane	C_6H_{14}	69	

(a) Complete the table above. (4 marks)

See next page

(b) State and explain the trend in boiling points of butane, pentane and hexane, by referring to the intermolecular forces present. (5 marks)

(c) Butene is an unsaturated hydrocarbon. How does an unsaturated hydrocarbon differ structurally from a saturated hydrocarbon? (2 marks)

(d) Describe a chemical test to distinguish between oct–1–ene and octane. Include any conditions, balanced chemical equations and observations for any reactions taking place. (7 marks)

See next page

Question 36 **(14 marks)**

Design a process where, if you were given a mixture of iron filings, salt and charcoal, you could separate each component.

(a) Prepare a list of essential equipment you will need to request to complete this exercise. (5 marks)

(b) Describe how you would separate the different substances from the mixture. Identify the separation techniques you would choose and show two details of how each one specifically separates an item from the mixture. (9 marks)

Technique One:

Technique Two:

Technique Three:

See next page

Question 37 **(12 marks)**

Sophie carried out experiments on some substances to learn more about them. The table below summarises her results.

Substance	Conducts electricity	Melting point
X	In the solid state and liquid states	High
Y	In the liquid state only	High
Z	In the solid state	Very high

(a) Using the results in the table above, classify substances X, Y and Z as either covalent network (CN), metallic (M), or ionic (I). Explain your reasoning. (12 marks)

Substance	Classification (GCN, M, I)	Justification – Three reasons for your choice
X		1 _____ _____ 2 _____ _____ 3 _____ _____
Y		1 _____ _____ 2 _____ _____ 3 _____ _____
Z		1 _____ _____ 2 _____ _____ 3 _____ _____

See next page

Question 38 **(8 marks)**

Calcium carbonate is used in some toothpastes. To determine the mass of calcium carbonate in one gram of toothpaste, a 10.40 g sample of the toothpaste was reacted with hydrochloric acid solution.

When calcium carbonate reacts with hydrochloric acid solution the products are calcium chloride, water and carbon dioxide.

(a) If the molecular equation describing this reaction is

$$CaCO_3 + 2HC\ell \rightarrow CaC\ell_2 + CO_2 + H_2O$$

Write a balanced ionic equation for the reaction taking place, include state symbols. (2 marks)

(b) If 3.570 g of carbon dioxide is produced, calculate the mass of calcium carbonate present in the 10.40 g sample. (4 marks)

(c) Calculate the mass of calcium carbonate in one gram the toothpaste. (1 mark)

(d) By referring to the given equation in part (a) state what assumption has been made about the reaction of the acid with the toothpaste. (1 mark)

See next page

Question 39 **(21 marks)**

The following table shows the first ionisation energy for some elements in Group I.

Group 1	First Ionisation energy in kJ mol^{-1}
Lithium	526
Sodium	504
Potassium	
Rubidium	410

(a) Write an equation to demonstrate the second ionisation energy of sodium. (1 mark)

(b) Complete the table by estimating the ionisation energy of potassium. (1 mark)

(c) State and explain the trend in ionisation energy shown in the table. (4 marks)

(d) Why is the second ionisation energy of an atom larger than the first ionisation energy? (3 marks)

See next page

Question 39 (continued)

Below is a table showing the atomic radius and melting point for the second Period elements.

Element	Atomic Radius (pm) (1 picometre = 10^{-12}m)	Melting point (°C)
Lithium	145	182
Beryllium	105	1280
Boron	85	2350
Carbon	70	3727
Nitrogen	65	–215
Oxygen	60	–219
Fluorine	50	–222
Neon	38	–251

(e) (i) State and explain the trend in atomic radius across the second Period. (3 marks)

See next page

(ii) Plot a suitable graph of atomic number against melting point for the second Period elements. (6 marks)

A spare grid is provided at the end of this Question/Answer booklet. If you need to use it, cross out this attempt and clearly indicate that you have redrawn it on the spare page

See next page

Question 39 (continued)

(iii) State and explain the difference in melting points of lithium, nitrogen and neon.
(3 marks)

See next page

Question 40 **(14 Marks)**

Commercial production of nitric acid is by the Ostwald process, named after German chemist Wilhelm Ostwald. In this process, anhydrous ammonia reacts with oxygen gas to form nitric oxide (NO) and water, in the presence of a platinum catalyst at a high temperature of about 500 K and a pressure of 9 atm.

(a) Write a balanced chemical equation for the reaction above, include state symbols. (4 marks)

Subsequently the NO is reacted with more oxygen and water

Equation Two : $4\ NO(g) + 3\ O_2(g) + 2\ H_2O(\ell) \rightarrow 4\ HNO_3(aq)$

Overall, starting with ammonia, the Ostwald Process can be represented as

Equation Three : $NH_3(g) + 2\ O_2(g) \rightarrow HNO_3(aq) + H_2O(\ell)$

(b) A reactor contains 2.180 kg of ammonia gas. If the ammonia is fully consumed in the reaction, **using Equation Three**, calculate:

(i) the number of moles of ammonia that reacted. (3 marks)

(ii) the number of particles of ammonia that reacted. (2 marks)

See next page

Question 40 (continued)

(iii) The mass of oxygen gas consumed. (2 marks)

(iv) The mass of nitric acid produced. (3 marks)

End of Questions

Supplementary page

Question number: _____

Supplementary page

Question number: _____

Supplementary page

Question number: _____

Supplementary page

Question number: _____

Spare grid