Name: ……..…..

RADLEY

Academic Scholarship 2018

Chemistry

Time allowed – 30 Minutes

You may use a calculator

4 Questions [33 marks]

1.



Fig. 1

Bugatti, makers of the world's fastest production road cars, need to have excellent brakes to stop their cars from very high speeds. *Fig. 1* shows the world's first Titanium brake calliper manufactured by 3-D printing, and used by Bugatti on the Chiron supercar. Titanium is a very strong, but light, element. It has a density of 4.51g/cm^3.

a. Titanium is a metal. Name three properties of Titanium that are common to most metals.

……

……

……

[3]

b. Each brake calliper weighs 2.90kg. What is the volume in cm^3 of each calliper (1kg = 1000g)?

……

……

……

[2]

2.90kg corresponds to approximately 3.65×10^{25} atoms of Titanium. The process of 3-D printing takes 45 hours per calliper.

c. How many atoms are being printed per second?

……

……

[2]

Chemists use the Kelvin scale to measure temperature. This is very similar to the Celsius scale: Temperature in Kelvin = Temperature in Celsius + 273. Hence room temperature 25C = 298K.

Titanium has a melting point of 1941K.

d. Is Titanium a solid or liquid at 1678 C?

……

……

[1]

Titanium is higher than carbon in the reactivity series. Magnesium is used in the extraction of Titanium in the Kroll process. The equation below shows Magnesium reacting with Titanium Chloride to form Titanium and Magnesium Chloride.

$$\mathbf{TiCl_4 + 2Mg \rightarrow Ti + 2\ MgCl_2}$$

e. Which is higher in the reactivity series Titanium or Magnesium and why?

……

……

[2]

[Total: 10]

2.



Fig. 2

Vodka is a drink containing a high proportion of ethanol, *Fig. 2*. Ethanol is extracted by distillation from fermentation mixtures containing ethanol and water. Ethanol is a small molecule with formula C_2H_6O. *Fig. 3* shows a representation of the molecule

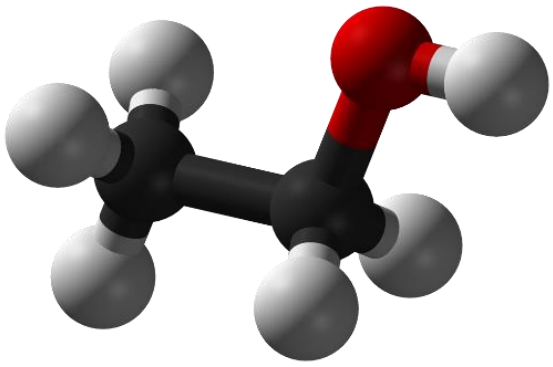


Fig. 3

a. Complete the following grid by putting ticks in the right boxes to show which atom is which.

	Red	Black	Grey
Carbon			
Hydrogen			
Oxygen			

[2]

b. Which physical property of ethanol must be different to that of water which means that distillation can be used to separate a mixture of ethanol and water?

……

[1]

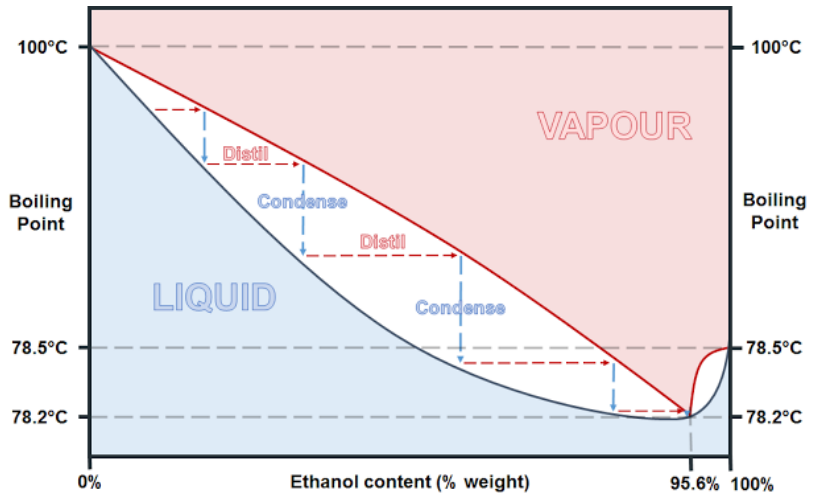


Fig.4

Fig. 4 is an unusual *graph* displaying the % composition of ethanol-water mixtures by weight in the liquid and vapour phases.

c. What is the boiling point of pure water?

……

[1]

d. What is the boiling point of pure ethanol?

……

[1]

e. What is the boiling point of the mixture where liquid and vapour compositions are the same?

……

[1]

f. This *graph* suggests that distillation of ethanol-water mixtures can only ever work to collect ethanol that has a certain maximum % content by weight. What is that maximum %?

……

[1]

g. Look back again at *Fig. 4*. This *graph* appears on the website of a Vodka producer. Although the *graph* displays some clear information there is one *major* fault with the Y-axis, what is it?

……

[1]

[Total: 8]

3.



Fig.5

Stink bombs are glass ampules containing a chemical compound. Unconfined the compound can liberate the very smelly gas hydrogen sulphide. When an ampule is broken in the corner of a classroom it is not long before the smell can be detected everywhere.

Transfusion Transport Gas Effusion Molecule Diffusion Salt

Suffusion Competition Natural Selection Ionizing Mixing

a. Ring the word above that best describes the process taking place after the ampule is broken.

[1]

When a stink bomb is broken the mass of hydrogen sulphide that is lost to the atmosphere is approximately 0.05g. After a short time the smell can be detected everywhere.

b. Estimate what mass of hydrogen sulphide is present, on average, in g per cm^3 in a normal sized classroom. Show all working.

……

……

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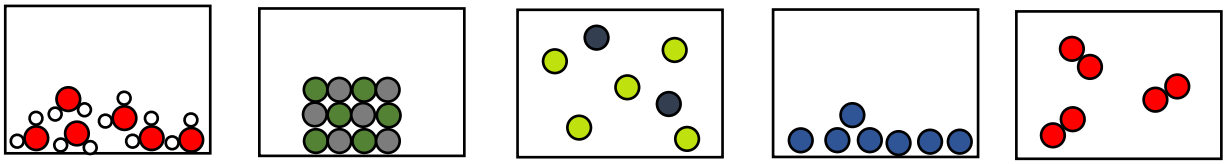
[3]

c. What does this tell you about how sensitive the human nose is to hydrogen sulphide?

……

[1]

d. Underneath each of the boxes below write the most appropriate word from the choices ***mixture***, ***element*** or ***compound***.



…… …… …… …… ……

[3]

e. On a cold day will it take a longer or a shorter time to smell the stink bomb from across the classroom? Explain why.

……

……

……

[3]

f. Hydrogen sulphide is a very poisonous gas. Why is it still comparatively safe to sell stink bombs to children?

……

……

[1]

[Total: 12]

4.

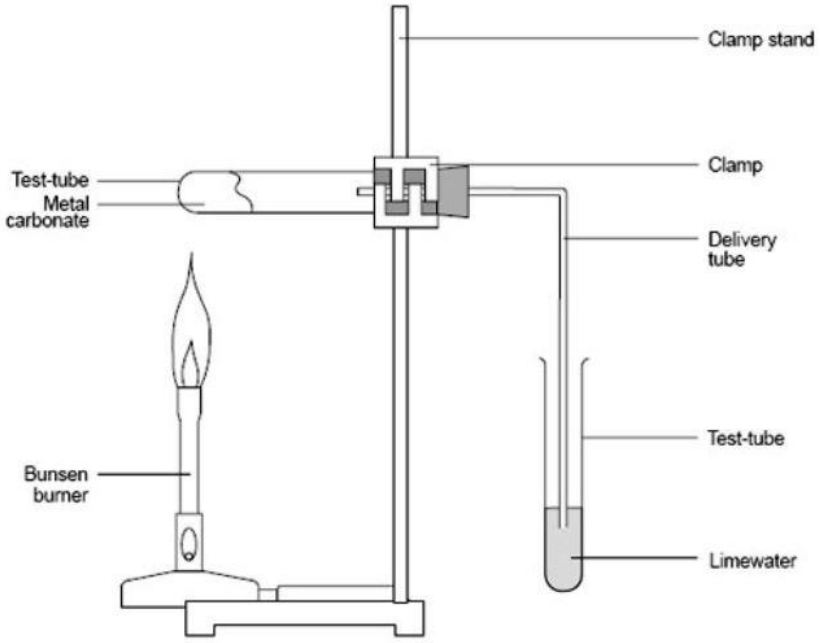


Fig. 6

Fig. 6 above is a diagrammatic representation of an experiment to test the decomposition products of heated metal carbonates. One of the fundamental rules of Chemistry is that during any process mass is not created nor is it destroyed.

When heated Magnesium Carbonate will decompose to form Magnesium Oxide and a gas according to the following equation:

$$\mathbf{MgCO_3 \rightarrow MgO + CO_2}$$

a. Name the gas produced.

……

[1]

b. If 8.4g of Magnesium Carbonate is decomposed, forming 4.0g of Magnesium Oxide, what mass of gas must have been produced?

……

[1]

c. In *Fig. 6* the gas produced is bubbled through a liquid solution. What will happen to the appearance of this liquid solution when the gas is bubbled through it?

……

[1]

[Total: 3]

End of Paper