

**2017 Year 11 Chemistry  
Gas Liquid Chromatography  
Validation Test**

**Name SOLUTIONS**

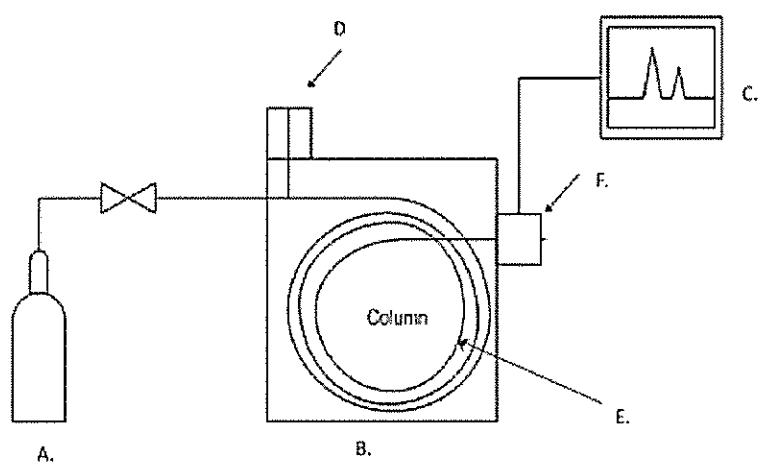
**35 minutes**

**/38 marks**

1. A mass spectrometer is often linked to a gas chromatogram. This is done so that the:
  - a) substances can be separated in the mass spectrometer and then passed through the GC for analysis.
  - b) exact mass of the mixture is determined by mass spectrometry before it is passed into the GC.
  - c) substances can be separated in the GC and then passed through the mass spectrometer.
  - d) gas used as the mobile phase in the GC is first purified by the mass spectrometer.
  
2. Which of the following statements about paper and gas chromatography is correct?
  - a) A long retention time in gas chromatography is indicative of a substance with a strong adsorption on to the stationary phase.
  - b) A high  $R_f$  value is indicative of a substance that adsorbs strongly onto the stationary phase.
  - c) A substance with a long retention time in gas chromatography is likely to have a high  $R_f$  value in paper chromatography.
  - d) The  $R_f$  and  $R_t$  values of a substance are determined solely by the interaction of the substance with the stationary phase.
  
3. The basis of the technique of chromatography for separating components of a mixture is:
  - a) the interaction of the components with both stationary and mobile phases.
  - b) the absorption of infrared radiation by the components.
  - c) the deflection of charged particles in a magnetic field.
  - d) the differing movement of particles of different mass in an electric field.
  
4. A new youth drink contains sugar, salt, alcohol and vitamin C. A gas chromatogram could be used to determine the
  - a) alcohol and sugar content only.
  - b) alcohol, sugar and vitamin C content only.
  - c) concentration of all ingredients in the drink.
  - d) alcohol content only.
  
5. Stationary phases often contain a non-polar polymer packing the column. What are the type of intermolecular forces we would expect the column would experience?
  - a) Dispersion forces only
  - b) Dispersion forces and induced dipole interactions
  - c) Induced dipole-dipoles and dipole-dipole interactions
  - d) Hydrogen bonding and dispersion forces

6. Write the associated letter or label the following diagram of a gas liquid chromatograph (3 marks)

1	a <input type="checkbox"/> b <input type="checkbox"/> c <input checked="" type="checkbox"/> d <input type="checkbox"/>
2	a <input checked="" type="checkbox"/> b <input type="checkbox"/> c <input type="checkbox"/> d <input type="checkbox"/>
3	a <input checked="" type="checkbox"/> b <input type="checkbox"/> c <input type="checkbox"/> d <input type="checkbox"/>
4	a <input type="checkbox"/> b <input type="checkbox"/> c <input type="checkbox"/> d <input checked="" type="checkbox"/>
5	a <input checked="" type="checkbox"/> b <input checked="" type="checkbox"/> c <input type="checkbox"/> d <input type="checkbox"/>



Letter	Label
A	Carrier gas
C	Chart Recorder
D	Injection Point
E	Chromatography
B	Oven
F	Detector

7. In gas–liquid chromatography:

a) What is the usual mobile phase?

(1 mark)

\_\_\_\_\_ -Inert gas

b) What is the stationary phase?

(1 mark)

\_\_\_\_\_ -Waxy polymer coating (high boiling point liquid adsorbed onto a solid)

c) Why is the column packed with very fine particles?

(1 mark)

\_\_\_\_\_ -Greater surface area

d) Why is the injection port heated?

(1 mark)

\_\_\_\_\_ -Ensures sample is fully vapourized (accept boiled)

8. In HPLC the mobile phase is a liquid. Generally it is non-polar. The stationary phase is more polar. Explain how separation of components of a mixture is achieved in terms of intermolecular forces. (5 marks)

FOR [3]

Molecular  $R_f$  values depend on intermolecular force strength [1]

Molecules would more than likely to interact through electrostatic attractions through instantaneous dipoles/dispersion forces with the stationary phase [1]

Any polar molecule would form induced dipole-dipole interactions with the solvent and travel the column [1]

**OR vice-versa [2]**

+ the strength of these dipoles will allow **separation** to occur as the mobile phase carries it [1]

FOR [2]

**Polar material** (stationary phase) **will bind strongly to the more polar components** of the sample [1]

**Less polar molecules** will travel **with the solvent** (mobile phase) and become detected sooner [1]

9. Explain how to analyse a gas chromatogram for:

a) qualitative analysis (1 mark)

- Analyze the retention times for each component

b) quantitative analysis (1 mark)

- Measure and compare the peak area (height) of each component

10. Methanol is a volatile organic compound with a structural formula of  $\text{CH}_3\text{OH}$ . A student runs a sample of Methanol through a gas chromatogram at  $50^\circ\text{C}$ . The Methanol produces a peak after 4.2 minutes. The student then injects a mixture of unknown organic substances into the same column at the same temperature. This produces peaks after 3.1, 4.2 and 7.4 minutes. What can you conclude from this information.

(3 marks)

-The sample has three different compounds (1 m)

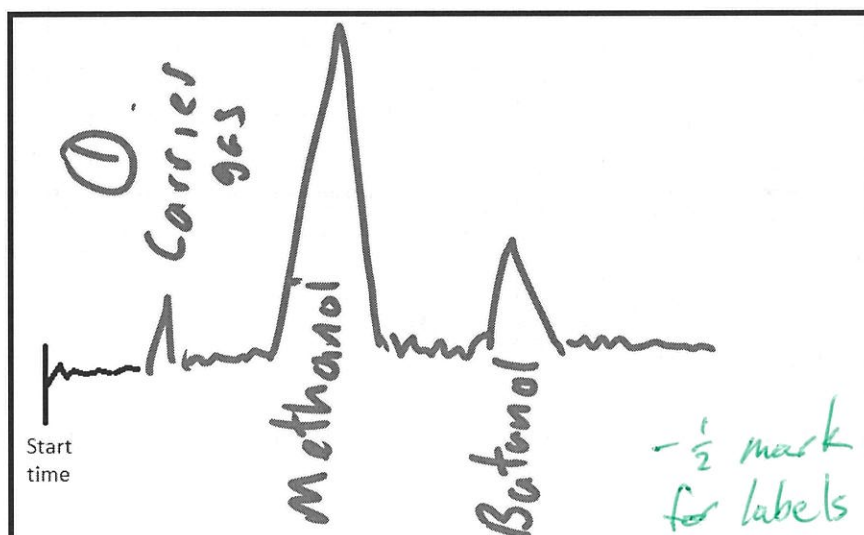
-One of the compounds is methanol - 4.2 min RT (1 m)

-One compound is less volatile - 7.4 min  $R_t$  (large amounts of IMF's) and the other is more volatile (smaller strength IMF's) - 3.1 min RT (1 m)

11. A mixture of methanol ( $\text{CH}_3\text{OH}$ ) and butanol ( $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ ) is approximately 90% methanol and 10% butanol. The mixture is passed through a gas liquid chromatogram. (using helium as the carrier gas)

Complete the chart below to show what you would expect to see on the chart recorder as each of the compounds comes off the column

(3 marks)



①

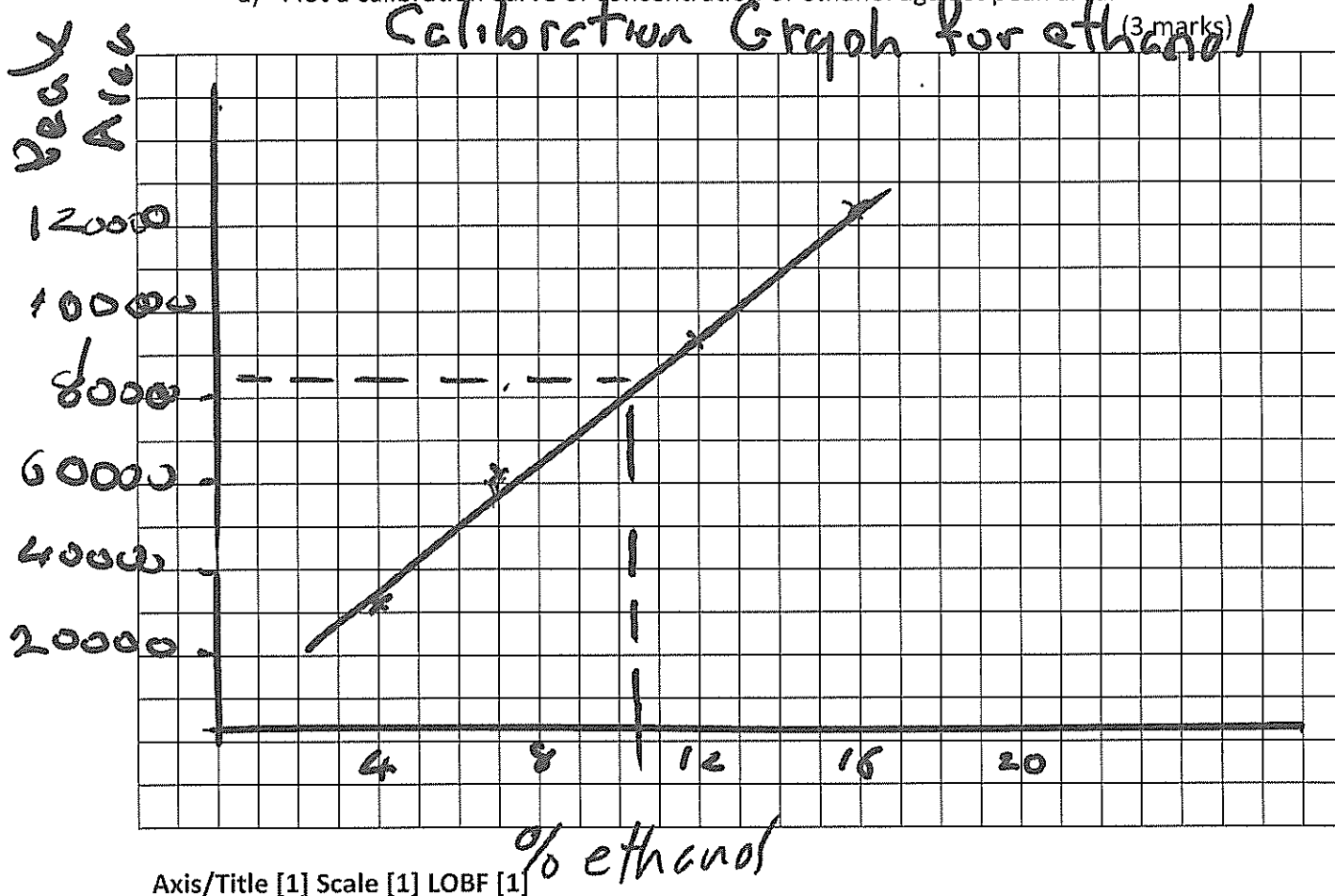
①

12. Australian wines are routinely tested for ethanol content. A quick and reliable method is by gas-liquid chromatography. The peak areas produced by a sample of wine and a number of standard solutions of ethanol are shown below.

Peak areas from GLC analysis of a wine sample and standards.

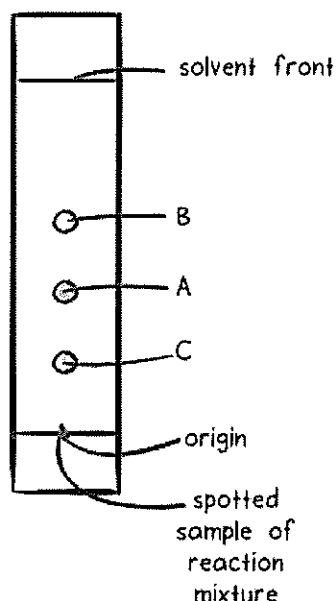
	% ethanol	Relative ethanol peak area
Standard 1	4.00	31 200
Standard 2	8.00	62 900
Standard 3	12.0	94 200
Standard 4	16.0	125 700
Wine	?	82 400

- a) Plot a calibration curve of concentration of ethanol against peak area.



- a) Determine the percentage of ethanol in the wine sample. (1 marks)  
10.5% ethanol (accept 10.25% to 10.75%)
- b) Why is it necessary to measure the peak areas produced by a number of standards? (2 marks)
- To ensure is accurate over a range of concentration (1 m)
- Instrument must have a linear response (straight line) (1 m)

13.



A TLC plate set with finely divided, covalent network, silica powder ( $\text{SiO}_2$ ) was used to separate the components in a plant extract by chromatography. The silica acts as the stationary phase and water was used as the mobile phase. A spot of the plant extract was placed at the origin of the silica and, once it had been adsorbed, water was adsorbed until it reached near the top (solvent front). The components separated as three coloured bands, as shown in the diagram to the right.

- a) i) In which of the three bands, A, B or C, were the components most strongly adsorbed to the stationary phase?           C           (1 mark)
- ii) Band B starts to show signs of separating into two different bands just before we stop the solvent travelling any further. Give one possible modification that could be made to this experiment to more effectively separate band B into its separate components. (1 mark)

Different mobile phase / increase length of the chromatogram

- b) Calculate the  $R_f$  value of component C. (2 marks)

$$1/4.8 = 0.208 \quad [0.195-0.22]$$

- c) Which one of the three bands, A, B or C, contains the component that would have the smallest retention time if this separation was conducted using a high-performance liquid chromatography with silica as the stationary phase? Explain your answer. (2 marks)

B would be the smallest  $R_f$  value [1]

in the same stationary phase so same intermolecular forces provided the solvent was the same. [1]

