TONBRIDGE SCHOOL

Test for Entrance into Year 12 in September 2015

Chemistry

Time allowed : 45 minutes

Total Marks : 30

Answer **ANY THREE** questions. All questions are out of 10. Choose questions that you feel you will score most highly on. We recommend that you spend the first 5 minutes of the exam reading through all the questions to help you select the right questions.

*Answer any **THREE** questions*

As a resolution, this year the head of chemistry has decided to get fit. The following questions relate to his struggles.

1 The isotonic drinks that he has been recommended to rehydrate himself contain a mixture of sodium chloride and calcium chloride, as well as various sugars and flavourings. A student analysed 500 cm^3 of one of the drinks and found that it contained 1.21g of sodium chloride.

(a) Draw a labelled diagram to represent the structure of a calcium atom [2]
(b) Draw a diagram to show the ionic bonding present in sodium chloride [3]
(c) Describe a simple experiment, including the expected result, that could show sodium chloride contains ions [3]
(d) Calculate the concentration of sodium chloride in the drink in moles per dm^3 [2]

2 When out running, sugar in his blood and cells is being respired to produce a variety of products. When able to respire aerobically the process can be summarised as:

$$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O \qquad \Delta H = -2803\ kJmol^{-1}$$

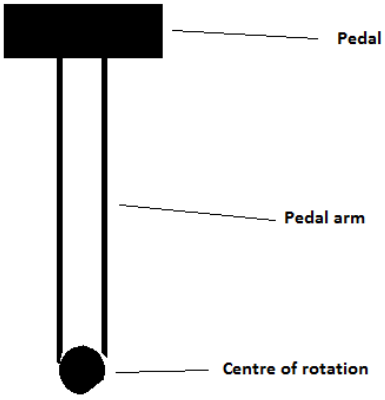
However, as a run progresses more and more anaerobic respiration occurs, producing lactic acid (2-hydroxypropanoic acid), $C_3H_6O_3$, in his muscles, which can lead to cramp and tiredness.

(a) Write a balanced symbol equation for the anaerobic respiration of glucose to form lactic acid [2]
(b) Suggest the displayed formula of lactic acid [1]
(c) Calculate the heat energy released by respiring 8g of glucose [3]
(d) Draw a labelled enthalpy level diagram for the respiration of glucose [3]
(e) Suggest an observable physical effect of the heat released in respiration [1]

3 As well as running, he has been swimming to reduce strain on his knee joints. The school pool is sterilised by a mixture of low concentrations of chlorine and ultraviolet radiation of water that is pumped out of the pool, treated and then returned. When chlorine is dissolved in water it reversibly reacts to make hydrochloric acid, HCl and hypochlorous acid, HClO.
The pool is 15m wide, 25m long, 1.2m deep at the shallow end and 3.5m deep at the deep end. The pipe carrying water to the radiation unit can carry 500cm^3 per second. The density of water is 1 gcm^{-3}. 1 mole is 6.02×10^{23}.

(a) Suggest a balanced equation for the reaction of chlorine with water [2]
(b) Calculate the volume of the swimming pool in cm3 [3]
(c) Hence calculate the mass of the water (if you have been unable to answer part b, assume the volume to be 1100000000 cm^3 – this is not the correct answer) [1]
(d) Hence calculate the number of water molecules in the swimming pool [2]
(e) Assuming each cm^3 is only irradiated once, calculate how long it would take to pass all the water through the UV system. Give your answer in suitable units [2]

4 The new cycling machine at the school gym is made of a mixture of steel and plastic, in particular, poly(propene). The length of the steel pedal arm on the bike is 20cm. The poly(propene) pedal is 1.5cm thick and attached directly to the top of the pedal arm.



(a) Describe the structure of a metal (you may use a labelled diagram) [2]
(b) Describe, in simple terms, the difference between iron and steel [2]
(c) Draw the structure of propene and poly(propene) [3]
(d) Calculate the distance travelled by **top** of the pedal, if the head of chemistry cycles for 12 minutes at 1.4 revolutions per second [3]

5 Following his efforts the head of chemistry is sent for a full check up by the headmaster. He has tests to measure his lung volume, heart rate and blood pressure. In addition, a blood sample is taken and analysed. In the analysis of his blood, it was found that the iron in his haemoglobin contained three isotopes in the following ratio:

^{53}Fe – 2.4%
^{54}Fe – 11.3%
^{56}Fe – 86.3%

(a) Suggest which gas makes up the largest proportion of the air breathed out by the head of chemistry [1]
(b) Explain why oxygen has a low boiling point [2]
(c) Explain what is meant by the term isotopes [2]
(d) Calculate the releative atomic mass of this sample of iron. Give your answer to three significant figures [3]
(e) Will the chemical properties of the different iron atoms differ?
Explain your answer [2]

END OF PAPER

THE PERIODIC TABLE

Period	Group 1	2										3	4	5	6	7	0
1	1 H Hydrogen 1																4 He Helium 2
2	7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
3	23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
4	39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
5	86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
6	133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
7	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key

Relative atomic mass
Symbol
Name
Atomic number