

Name

Current school



WELLINGTON
COLLEGE

13+ SCHOLARSHIP EXAMINATION 2022

SCIENCE

TIME ALLOWED: 45 minutes

TOTAL MARKS: 36 (marks for each question are shown in brackets)

- **Read the questions carefully and answer in the space provided**
- **Calculators may be used**
- **A copy of the periodic table is provided at the back of the paper**

In late 2017 it was suggested that the outer reaches of our solar system could be hiding a new planet.¹ In 2022, the Science Department at Wellington College decided to give it the name **Wellingtune** and use the 13+ Scholarship Exam as a chance to explore some of the science behind visiting a new planet.



Planet Ten renamed as Wellingtune¹

Reference: ¹<https://institutions.newscientist.com/article/mg23431314-400-weird-orbits-hint-planet-ten-might-lurk-at-solar-system-edge/> [accessed 10/01/22]

Q1 Wellingtune follows a circular orbit around the Sun and travels 25,000,000,000 miles during each orbit. Each orbit takes 282 Earth years.

(a) What is the velocity of the orbit? Give your answer in miles per (earth) year

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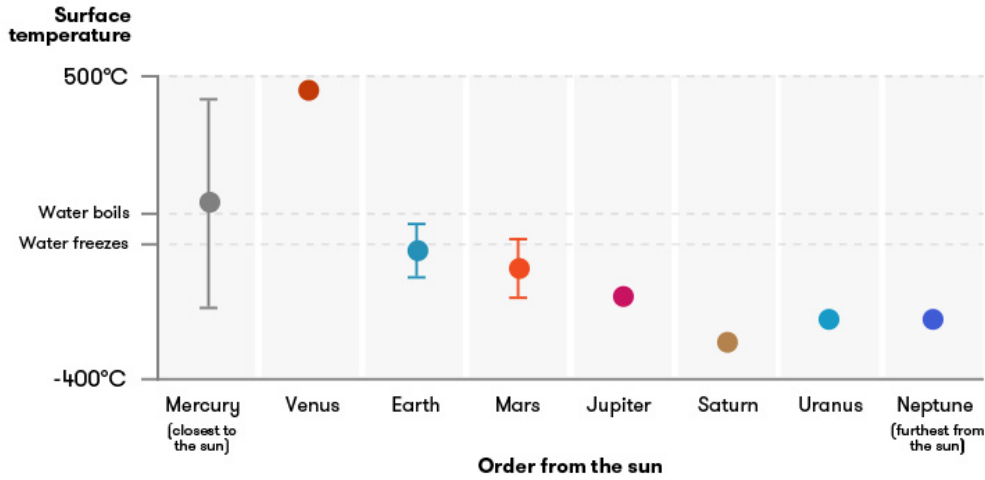
Answer..... miles/year [2]

(b) Convert your answer to m/s (meters per second). You may assume there are 365.25 days in each year and 1600 meters to the mile.

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Answer.....m/s [2]

Q2 The diagram below shows the surface temperature of the planets. The vertical bars illustrate the range of temperatures that may occur on each planet.



(a) State two key factors that affect the surface temperature of a planet.

1

2

[2]

(b) Wellington is even further from the sun than Neptune, estimate the surface temperature of Wellington. Explain your reasoning.

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[1]

Q3 It is decided to send a satellite to Wellington to learn more about the planet. The satellite will be attached to a rocket and launched into space.

(a) Rocket launch sites are always found on (or near) the equator. Why is this?

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[1]

(b) A 500 kg satellite will output 500,000,000 Joules of energy to reach Wellington. However, the fuel will contain more energy than this. Explain why.

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[2]

(c) Light travels at a finite speed, approximately 300,000,000 m/s. Nothing can travel faster than light. Why does this present a problem for controlling a satellite remotely as it nears Wellington?

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[2]

A robot was sent to Wellington to analyse the materials on the surface of the planet. Scientists discovered that ice forms a large part of the planet's surface.



Taken from: <https://wallpaperaccess.com/ice-planet>

Q4 Below the ice is a liquid. A sample of this liquid is collected and returned to Earth.

(a) Suggest an experiment which would allow the scientists to determine whether the liquid below the surface is pure water or a mixture.

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[2]

(b) The ice on Wellington is made up of deuterated water, D_2O . Deuterium is an element similar to hydrogen but has some different properties.

(i) How many elements are there in D_2O ?

(ii) How many atoms are there in D_2O ?

(iii) Is D_2O a mixture or a compound?

[3]

(iv) Suggest how you could determine whether the deuterated water from Wellington's ice is lighter or denser than the water from ice on Earth.

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[2]

(c) A sample of the liquid below the ice is tested to check the pH.

(i) How could you determine the pH of the liquid?

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[1]

(ii) The scientists found the pH of the liquid to be 5. What can you deduce from this?

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[1]

Q5 The core of Wellington is made up of precious metals that are rare on Earth.

(a) One common property of metals is that they are sonorous. What do we mean by this?

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[1]

(b) Give an example of where we commonly use some of the rare-earth metals such as lanthanum and neodymium.

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[1]

(c) Aluminium has been found on Wellington as a pure metal. Explain why we do not find uncombined aluminium on Earth but instead as an ore.

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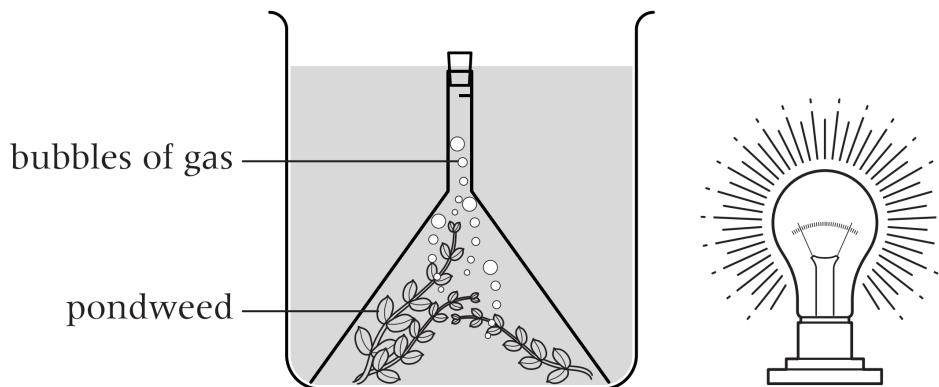
[1]

Q6 At the space station garden on Wellingtune, astronauts grow vegetables to add fresh food to their diet. Write and balance the symbol equation for photosynthesis.

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[2]

Q7 The astronauts are conducting experiments at the space station to determine how to increase the speed of photosynthesis. This experiment was set up to test the effect of different environmental conditions on the speed of photosynthesis.



(a) The light bulb is moved further away. Predict the effect on the number of bubbles produced.

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(b) Explain your reasoning.

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[2]

Q8 Due to the conditions on Wellington, it is unlikely that plants will grow naturally. Design a room where plants can be grown in the space station. Your answer should include how each feature of the room will maximise the growth of plants. You may present your answer as a labelled diagram.

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[4]

Q9 The absence of gravity in space makes living in a spacecraft physically undemanding. Without regular use and exercise, the muscles weaken. Design an investigation to find out how levels of protein in the diet effect muscle strength. Include experimental details in your answer.

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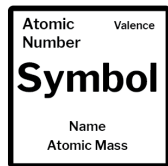
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[4]

Periodic Table of the Elements

										13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	18 VIIIA 8A			
1 -1, +1	2 IIA 2A												5 +3	6 +4, +3, +2, +1 -4, -3 -2, -1	7 +5, +3, -3	8 -2	9 -1	10 0
H Hydrogen 1.008	Li Lithium 6.941	Be Beryllium 9.012											B Boron 10.811	C Carbon 12.011	N Nitrogen 14.007	O Oxygen 15.999	F Fluorine 18.998	Ne Neon 20.180
11 +1	12 +2	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8 VIII 8	9 VIII 8	10 VIII 8	11 IB 1B	12 IIB 2B	13 +3	14 +4, -4	15 +5, +3, -3	16 +6, +4, +2, -2	17 +5, +3, +1 -1	18 0	
Na Sodium 22.990	Mg Magnesium 24.305											Al Aluminum 26.982	Si Silicon 28.086	P Phosphorus 30.974	S Sulfur 32.066	Cl Chlorine 35.453	Ar Argon 39.948	
19 +1	20 +2	21 +3	22 +4	23 +5	24 +6, +3	25 +7, +4, +2	26 +6, +3, +2	27 +3, +2	28 +2	29 +2	30 +2	31 +3	32 +4, +2, -4	33 +5, +3, -3	34 +6, +4, +2, -2	35 +5, +3, +1 -1	36 +2, 0	
K Potassium 39.098	Ca Calcium 40.078	Sc Scandium 44.956	Ti Titanium 47.88	V Vanadium 50.942	Cr Chromium 51.996	Mn Manganese 54.938	Fe Iron 55.845	Co Cobalt 58.933	Ni Nickel 58.693	Cu Copper 63.546	Zn Zinc 65.38	Ga Gallium 69.723	Ge Germanium 72.631	As Arsenic 74.922	Se Selenium 78.971	Br Bromine 79.904	Kr Krypton 84.798	
37 +1	38 +2	39 +3	40 +4	41 +5	42 +6, +4	43 +7, +4	44 +4, +3	45 +3	46 +4, +2	47 +1	48 +2	49 +3	50 +4, +2, -4	51 +5, +3, -3	52 +6, +4, +2, -2	53 +7, +5, +3, +1 -1	54 +6, +4, +2, 0	
Rb Rubidium 85.468	Sr Strontium 87.62	Y Yttrium 88.906	Zr Zirconium 91.224	Nb Niobium 92.906	Mo Molybdenum 95.95	Tc Technetium 98.907	Ru Ruthenium 101.07	Rh Rhodium 102.906	Pd Palladium 106.42	Ag Silver 107.868	Cd Cadmium 112.414	In Indium 114.818	Sn Tin 118.711	Sb Antimony 121.760	Te Tellurium 127.6	I Iodine 126.904	Xe Xenon 131.294	
55 +1	56 +2	57-71	72 +4	73 +5	74 +6, +4	75 +4	76 +4	77 +4, +3	78 +4, +2	79 +3	80 +2, +1	81 +3, +1	82 +4, +2	83 +3	84 +4, +2, -2	85 +1, -1	86 +2, 0	
Cs Cesium 132.905	Ba Barium 137.328		Hf Hafnium 178.49	Ta Tantalum 180.948	W Tungsten 183.85	Re Rhenium 186.207	Os Osmium 190.23	Ir Iridium 192.22	Pt Platinum 195.08	Au Gold 196.967	Hg Mercury 200.59	Tl Thallium 204.383	Pb Lead 207.2	Bi Bismuth 208.980	Po Polonium (208.982)	At Astatine 209.987	Rn Radon 222.018	
87 +1	88 +2	89-103	104 +4	105 +5	106 +6	107 +7	108 +8	109 unknown	110 unknown	111 unknown	112 +2	113 unknown	114 unknown	115 unknown	116 unknown	117 unknown	118 unknown	
Fr Francium 223.020	Ra Radium 226.025		Rf Rutherfordium [261]	Db Dubnium [262]	Sg Seaborgium [266]	Bh Bohrium [264]	Hs Hassium [269]	Mt Meitnerium [278]	Ds Darmstadtium [281]	Rg Roentgenium [280]	Cn Copernicium [285]	Nh Nihonium [286]	Fl Flerovium [289]	Mc Moscovium [289]	Lv Livermorium [293]	Ts Tennessine [294]	Og Oganesson [294]	



Lanthanide Series	57 +3	58 +4, +3	59 +3	60 +3	61 +3	62 +3	63 +3, +2	64 +3	65 +3	66 +3	67 +3	68 +3	69 +3	70 +3	71 +3
	La Lanthanum 138.905	Ce Cerium 140.116	Pr Praseodymium 140.908	Nd Neodymium 144.243	Pm Promethium 144.913	Sm Samarium 150.36	Eu Europium 151.964	Gd Gadolinium 157.25	Tb Terbium 158.925	Dy Dysprosium 162.500	Ho Holmium 164.930	Er Erbium 167.259	Tm Thulium 168.934	Yb Ytterbium 173.055	Lu Lutetium 174.967
Actinide Series	89 +3	90 +4	91 +5	92 +6	93 +5	94 +4	95 +3	96 +3	97 +3	98 +3	99 +3	100 +3	101 +3	102 +2	103 +3
	Ac Actinium 227.028	Th Thorium 232.038	Pa Protactinium 231.036	U Uranium 238.029	Np Neptunium 237.048	Pu Plutonium 244.064	Am Americium 243.061	Cm Curium 247.070	Bk Berkelium 247.070	Cf Californium 251.080	Es Einsteinium [254]	Fm Fermium 257.095	Md Mendelevium 258.1	No Nobelium 259.101	Lr Lawrencium [262]