

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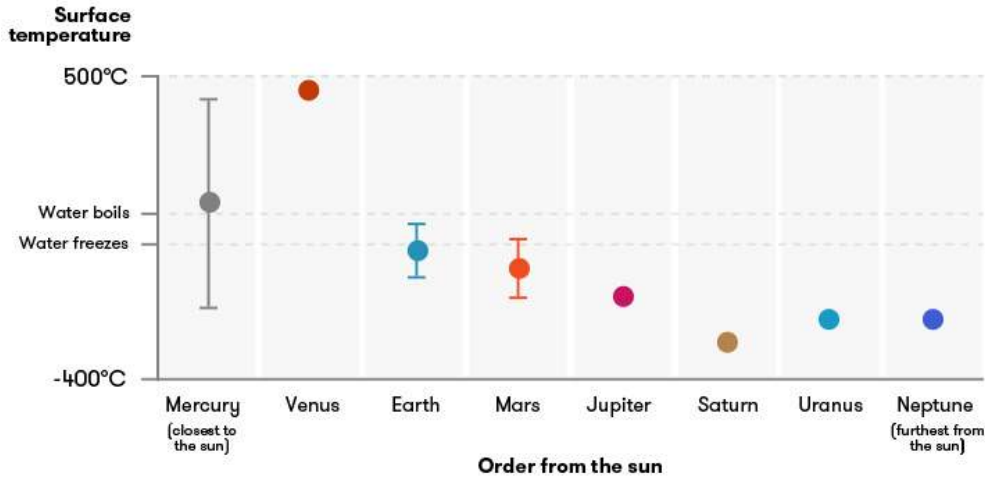
Answer..... miles/year [2]

(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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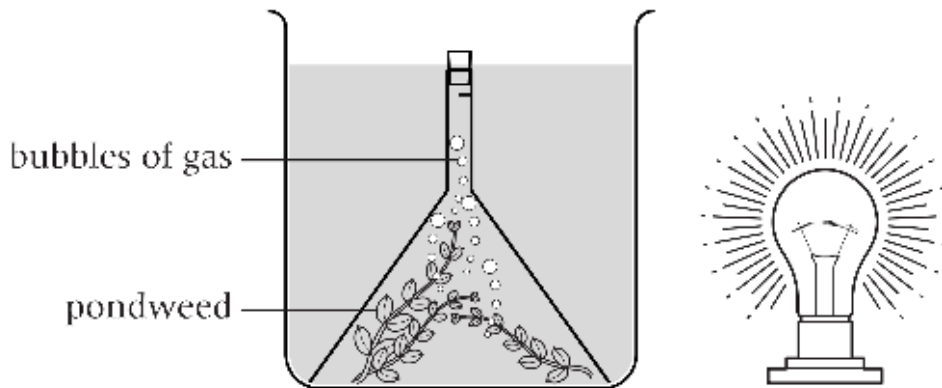
[1]

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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[4]

Periodic Table of the Elements

										1A IA 1A											18 VIIIA 8A														
1 1 H Hydrogen 1.008																	2 IIA 2A	3 3 Li Lithium 6.941	4 4 Be Beryllium 9.012											5 IIIA 3A	6 IVA 4A	7 VA 5A	8 VIA 6A	9 VIIA 7A	10 10 Ne Neon 20.180
																		13 13 Al Aluminum 26.982	14 14 Si Silicon 28.086	15 15 P Phosphorus 30.974	16 16 S Sulfur 32.065	17 17 Cl Chlorine 35.453	18 18 Ar Argon 39.948												
19 19 K Potassium 39.098	20 20 Ca Calcium 40.078	21 3B Sc Scandium 44.956	22 4B Ti Titanium 47.88	23 5B V Vanadium 50.942	24 6B Cr Chromium 51.996	25 7B Mn Manganese 54.938	26 8 Fe Iron 55.845	27 9 Co Cobalt 58.933	28 10 Ni Nickel 58.693	29 11 Cu Copper 63.546	30 12 Zn Zinc 65.38	31 13 Ga Gallium 69.723	32 14 Ge Germanium 72.631	33 15 As Arsenic 74.922	34 16 Se Selenium 78.971	35 17 Br Bromine 79.904	36 18 Kr Krypton 83.798																		
37 37 Rb Rubidium 85.468	38 38 Sr Strontium 87.62	39 3B Y Yttrium 88.906	40 4B Zr Zirconium 91.224	41 5B Nb Niobium 92.906	42 6B Mo Molybdenum 95.94	43 7B Tc Technetium 98.906	44 8 Ru Ruthenium 101.07	45 9 Rh Rhodium 101.07	46 10 Pd Palladium 106.36	47 11 Ag Silver 107.868	48 12 Cd Cadmium 112.414	49 13 In Indium 114.818	50 14 Sn Tin 118.710	51 15 Sb Antimony 121.757	52 16 Te Tellurium 127.6	53 17 I Iodine 126.905	54 18 Xe Xenon 131.29																		
55 55 Cs Cesium 132.905	56 56 Ba Barium 137.327	57-71 3B Lanthanide Series	72 4B Hf Hafnium 178.49	73 5B Ta Tantalum 180.948	74 6B W Tungsten 183.85	75 7B Re Rhenium 186.207	76 8 Os Osmium 190.23	77 9 Ir Iridium 192.22	78 10 Pt Platinum 195.08	79 11 Au Gold 196.967	80 12 Hg Mercury 200.59	81 13 Tl Thallium 204.387	82 14 Pb Lead 207.2	83 15 Bi Bismuth 208.980	84 16 Po Polonium 209	85 17 At Astatine 209	86 18 Rn Radon 222.018																		
87 87 Fr Francium 223	88 88 Ra Radium 226	89-103 3B Actinide Series	104 4B Rf Rutherfordium 261	105 5B Db Dubnium 262	106 6B Sg Seaborgium 266	107 7B Bh Bohrium 264	108 8 Hs Hassium 265	109 9 Mt Meitnerium 268	110 10 Ds Darmstadtium 269	111 11 Rg Roentgenium 269	112 12 Cn Copernicium 285	113 13 Nh Nihonium 284	114 14 Fl Flerovium 289	115 15 Mc Moscovium 288	116 16 Lv Livermorium 293	117 17 Ts Tennessine 294	118 18 Og Oganesson 294																		



Lanthanide Series	57 57 La Lanthanum 138.905	58 58 Ce Cerium 140.12	59 59 Pr Praseodymium 140.908	60 60 Nd Neodymium 144.242	61 61 Pm Promethium 144.913	62 62 Sm Samarium 150.36	63 63 Eu Europium 151.964	64 64 Gd Gadolinium 157.25	65 65 Tb Terbium 158.925	66 66 Dy Dysprosium 162.500	67 67 Ho Holmium 164.930	68 68 Er Erbium 167.259	69 69 Tm Thulium 168.934	70 70 Yb Ytterbium 173.054	71 71 Lu Lutetium 174.967
Actinide Series	89 89 Ac Actinium 227.028	90 90 Th Thorium 232.038	91 91 Pa Protactinium 231.036	92 92 U Uranium 238.029	93 93 Np Neptunium 237.048	94 94 Pu Plutonium 244.064	95 95 Am Americium 243.061	96 96 Cm Curium 247.070	97 97 Bk Berkelium 247.070	98 98 Cf Californium 251.080	99 99 Es Einsteinium 252.083	100 100 Fm Fermium 257.085	101 101 Md Mendelevium 258.10	102 102 No Nobelium 259.10	103 103 Lr Lawrencium 260.10