School	*Candidate's Name (PLEASE PRINT)*

WINCHESTER
COLLEGE

Entrance Examination

SCIENCE

2020

Total time allowed: 1 hour 30 minutes

This paper is divided into **FOUR** sections.

Section A	Chemistry
Section B	Physics
Section C	Biology
Section D	General

Each section carries equal marks.
The mark for each question is given in brackets [ ].
All sections are composed of a number of short answer questions.

Candidates should attempt **ALL** the questions in these sections, answering in the spaces provided on the question paper. Calculators may be used.

Candidates will be penalized for giving answers to too many significant figures.

SECTION A – CHEMISTRY

A1 The periodic table places elements with similar properties in columns called groups. Copper, silver and gold are found in the same group.


Copper


Silver


Gold

Copper 29 Cu 64	
Silver 47 Ag 108	
Gold 79 Au 197	

(a) Give one property typical of metals shared by these three elements.

……. [1]

(b) Define *atom*.

……

……. [1]

(c) Give one reason why gold is often used to make electrical contacts.

……

……

……. [1]

(d) The *atomic masses* of the elements shown are 64, 108 and 197. These values give the relative masses of atoms of an element and are different for different elements.

When each atom of copper combines with one atom of oxygen to make copper(II) oxide, the mass of the solid increases by 25%.

Calculate the relative atomic mass of oxygen.

…….

…….

……. [2]

(e) In each box in the group of elements shown, the smaller of the two numbers is the element's *atomic number*. Before atomic structure was understood, this number was simply used to identify elements and list them in an order that grouped together similar elements.

Explain how the numbers given for copper, silver and gold show that some rows are longer than others in the periodic table.

…….

…….

……. [2]

A2 Fizzy drinks contain dissolved carbon dioxide. They go 'flat', meaning they stop fizzing if the carbon dioxide is allowed to escape into the air and drift away. Dissolving is a change that is easily reversed.

(a) The molecules in a gas are arranged differently from those in a liquid. Give one difference between their arrangements.

……

…… [1]

(b) State why the bubbles of carbon dioxide travel upwards through the surrounding water.

…… [1]

(c) Explain why fizzy drinks kept in glass bottles with their caps sealed do not go flat.

……

…… [2]

(d) A fizzy drink was tested with universal indicator, which went orange. Give the approximate pH of the drink and state whether it was acidic, alkaline or neutral.

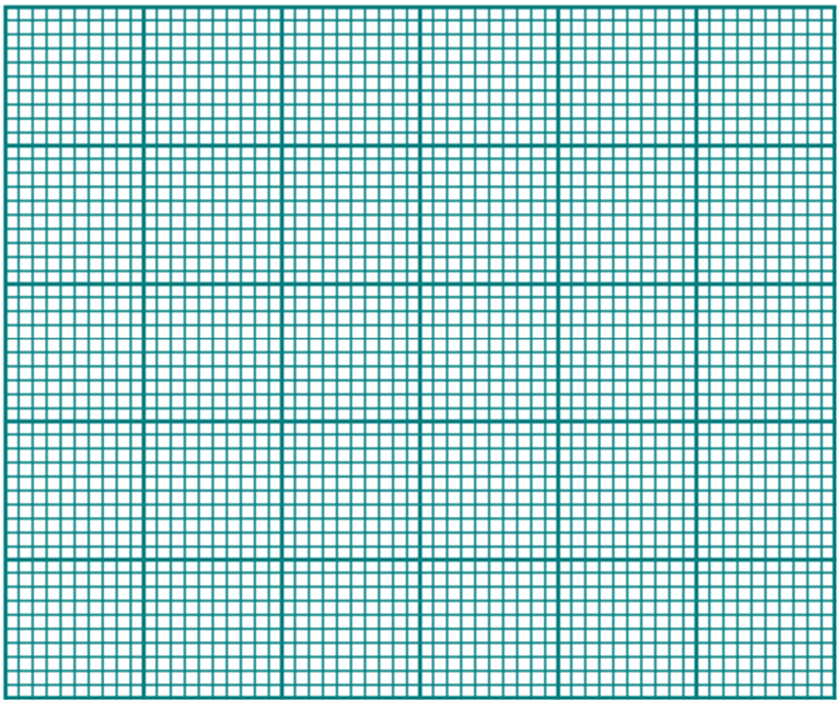
……

…… [2]

(e) The rate of release of carbon dioxide gas from lemonade was measured at two different temperatures (T) and the results are shown below:

Low T 17 °C	Time / s	20	60	100	150	240	300
	Volume / cm^3	9	17	22	28	38	43
High T 45 °C	Time / s	20	60	100	160	250	300
	Volume / cm^3	11	33	42	54	72	83

(i) Use the grid below to plot the data from the two experiments. Label each experiment clearly on your graph.



[6]

(ii) By referring to the graphs, describe the effect of temperature on the release of carbon dioxide from lemonade.

……

……

…… [2]

(iii) Suggest a relationship between temperature and the *solubility* of carbon dioxide in lemonade.

……

…… [1]

(iv) In an alternative experiment, a beaker of lemonade was left on an electronic balance and the mass recorded every minute for 10 minutes. Explain how the mass of carbon dioxide lost could be calculated from the measurements taken.

……

……

…… [2]

(f) Carbon dioxide turns directly from solid to gas at around −78 °C. Name this change of state.

……..……. [1]

End of Section A

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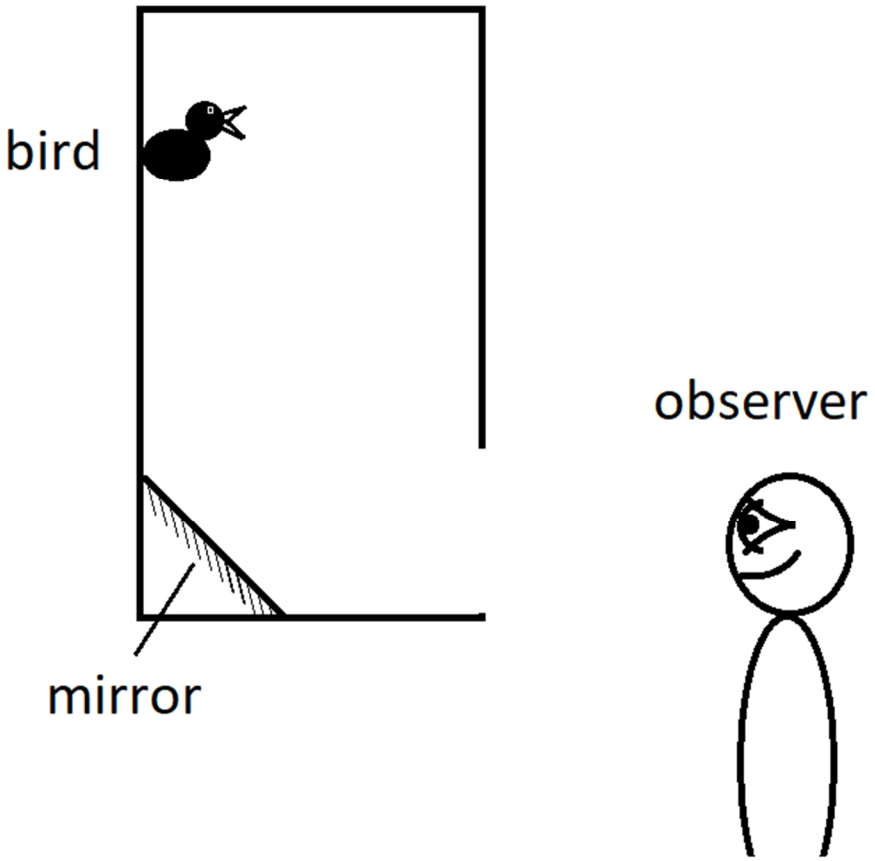
SECTION B - PHYSICS

B1 The bird in the picture is hidden in the bird box. Carefully draw light rays on the diagram to show how the observer can see it. The rays should have arrows on them indicating their direction of travel.



[3]

B2 A box containing a number of mints is resting on a flat table. The box weighs 0.30 N when empty. The mints have a density of 1.5 g/cm^3. The box has a rectangular base that is 6.0 cm long and 3.0 cm wide.

(a) Each mint has a mass of 5.0 grams. Calculate the volume of a mint.

.....

.....

..... [2]

(b) There are 15 mints in the box. Calculate the pressure the box exerts on the table top. Show all your working.

.....

.....

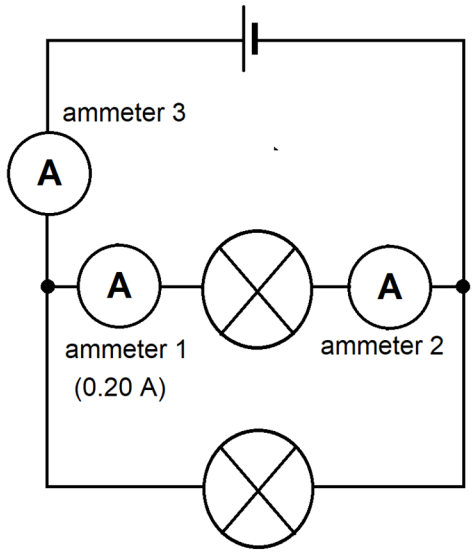
.....

.....

.....

..... [4]

B3 In the circuit shown, the light bulbs are all identical. Ammeter 1 reads 0.20 A. Indicate (by circling the correct answer) whether the readings on the other two ammeters are more than, less than or equal to 0.20 A. In each case, explain your answer in the space provided.



(a) The reading on ammeter 2 is more than / less than / equal to 0.20 A

Reason:

.....

.....

..... [2]

(b) The reading on ammeter 3 is more than / less than / equal to 0.20 A

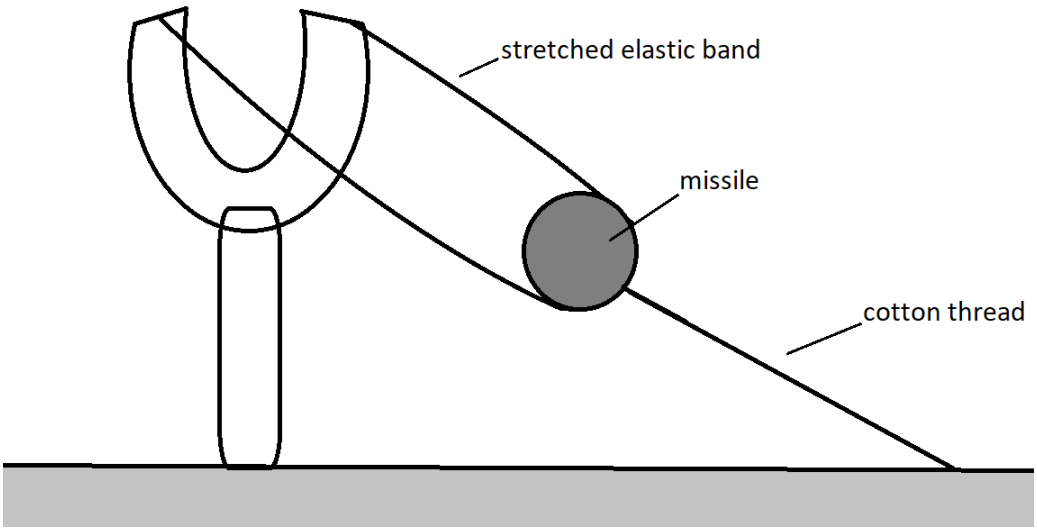
Reason:

.....

.....

..... [2]

B4 A stretched catapult is held taut, with a missile ready to launch at an angle, as shown. The thread is then cut.



(a) In terms of forces, explain why the missile is stationary until the thread is cut but then accelerates rapidly.

.....

.....

..... [2]

(b) Take your starting point as the moment when the thread is cut and your end point as the moment when the missile reaches its maximum height. Identify the *main* stores of energy that have increased and decreased between these two moments (i.e. what forms has the energy been converted *from* and what forms has it been converted *to*?).

In each case explain *how we know* that this store of energy has increased or decreased.

(i) The main energy store that has decreased is:

……..……..……

We know the energy in this store has decreased because:

……..……..……

……...…… [2]

ii) One of the main energy stores that has increased is:

……..…….

We know the energy in this store has increased because:

……..…….

……..……. [2]

iii) The other main energy store that has increased is:

……..…….

We know the energy in this store has increased because:

……..….

……..…. [2]

B5 Explain why in the northern hemisphere the days in June are longer than those in December, whereas at the Equator days and nights are always roughly equal in length. You will probably find it helpful to draw a diagram.

……..…….

……..…….

……..…….

……..……. [4]

End of Section B

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SECTION C – BIOLOGY

C1 Cholera is a gut infection caused by the bacterium *Vibrio cholerae*.

(a) Suggest one action that can reduce the risk of infection from the disease caused by *Vibrio cholerae*.

……...

……... [1]

(b) Cholera is an infection that can result in severe diarrhoea and loss of water (dehydration). State one use of water in the body.

……...

……... [1]

Another micro-organism called *Saccharomyces cerevisiae* can respire anaerobically. It is commonly known as Baker's (or Brewer's) Yeast.

(c) Suggest why a baker, or brewer, uses *Saccharomyces cerevisiae*. Explain your reasoning.

……...

……...

……...

……... [2]

Vibro cholerae and *Saccharomyces cerevisiae* are both single-celled organisms. However, one is a bacterium and the other a fungus.

(d) State two differences between these two kingdoms.

……...

……...

……... [2]

C2 The ball python, *Python regius*, is a species native to West and Central Africa, where it lives in grasslands and scrublands. Its name refers to its tendency to curl into a ball when frightened.

Figure C2.1 A ball python, *Python regius*

(a) A ball python is a reptile. State one visible feature of a reptile that distinguishes it from all other animals.

..... [1]

(b) (i) State two features of a ball python that might show variation between individuals of the same population.

Feature 1……....

Feature 2……..….. [2]

(ii) Explain how the features given in (b) (i) could provide a survival advantage to a ball python.

……..

……..

……..

…….. [2]

C3 This question is about photosynthesis and the effect of light intensity.

The intensity of light falling on an object is inversely proportional to the square of the distance between the light source and the object.

i.e. Light intensity $\propto 1/d^2$

(a) (i) State what happens to the light intensity when the distance between a light source and an object increases.

……

…… [1]

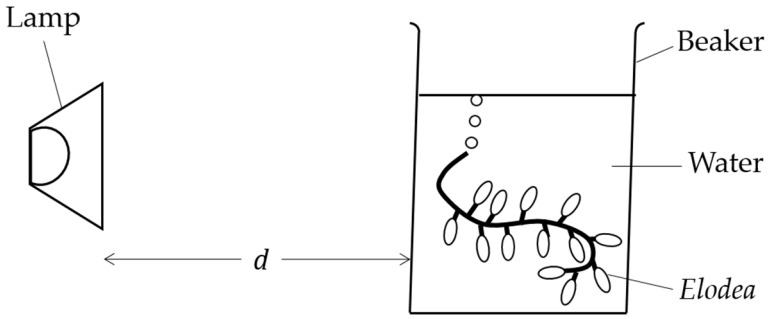

Figure C3.1 Apparatus used to measure the rate of gas production by pondweed

(ii) State the name of the gas in the bubbles…… [1]

A pupil is asked to use the apparatus shown in Figure C3.1 to investigate the effect of light intensity on the rate of photosynthesis in the pondweed *Elodea*. Use your answer to C3 (a) (i) and Figure C3.1 to think about the simple experiment the pupil would perform.

(b) State the independent and dependent variables in the experiment.

Independent: ……. [1]

Dependent: ……...……. [1]

(c) Explain why it is important to perform a control when conducting an experiment.

……...

……... [1]

(d) State one control that the pupil could perform.

……...

……... [1]

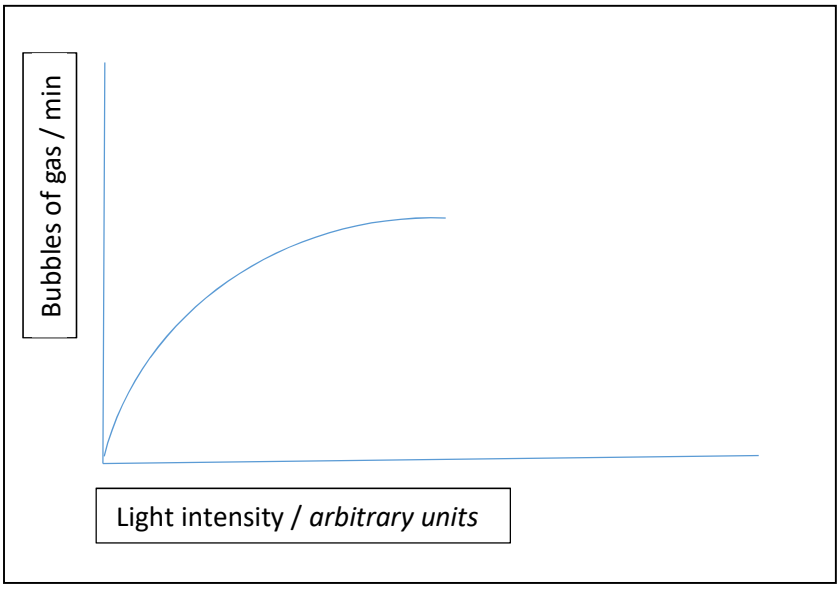

Figure C3.2 A sketch graph showing the effect of light intensity on the number of bubbles produced per minute by *Elodea*

(e) Figure C3.2 shows a sketch graph of the data obtained from the experiment. Describe the trend in the pupil's results and explain the data using your understanding of photosynthesis.

……...

……...

……...

……...

……...

……... [3]

(f) Suggest one improvement to the apparatus shown in Figure C3.1 and explain how this change improves the experiment.

……...

……...

……... [2]

Adding sodium hydrogen carbonate ($NaHCO_3$) to the water increases the quantity of dissolved carbon dioxide (CO_2) in solution.

(g) Draw a line on the graph above (Figure C3.2) to show what you predict would happen to the rate of bubble production if a pupil added sodium hydrogen carbonate and repeated the experiment. Explain the new trend you have drawn.

…….....

……..……

……..……

……..……

……..……

……..…… [3]

End of Section C

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Please turn over for Section D

SECTION D – GENERAL

Read the following passages and answer the questions that follow

Life at the extremes

An extremophile is an organism that thrives in environmental conditions considered challenging for a carbon-based life form with water as a solvent. Extremophiles tend to be micro-organisms. Bacteria were found in the Mariana Trench, the deepest place in Earth's oceans, reaching 11 km deep. Some micro-organisms have been found thriving inside rocks up to 580 m below the sea floor under 2,600 m of ocean off the coast of the northwestern United States. Enormous pressures are experienced at these depths. The atmosphere exerts a pressure at sea level of 1 atmosphere (atm): this is the definition of the unit. For each 10 m of depth under water the water exerts another atmosphere of pressure. The rocks that make up the Earth's crust under the oceans have a density of 2.9 times that of water, and so exert 2.9 times as much pressure as water would at a given depth.

Bacteria can live in deep-sea hydrothermal vents in temperatures up to 120 °C. At the other extreme bacteria have been found thriving in ice at –20 °C. Life, however, has not been observed at the lowest temperatures on Earth; –89 °C has been recorded in Antarctica. As temperature increases so does the energy associated with the movement of the atoms and molecules in the substance being heated. The lowest possible temperature is –273 °C, also known as absolute zero. In the Kelvin scale of absolute temperature the unit of temperature difference is the same as it is in the Celsius scale; the start of the scale, zero Kelvin, or 0 K, is at –273 °C. Therefore the freezing point of water, 0 °C, is at 273 K.

Most living organisms function in the pH range of 6.5 to 8.5. However, bacteria have been identified thriving in pH as low as 1 and as high as 11. In our stomachs, conditions are surprisingly acidic – far more so than the blood, which is around pH 7.4.

Other bacteria, known as halophiles, thrive in extremely salty environments with salt concentrations up to 30%. While salt is essential in our diet, too much salt can cause serious health problems.

Tardigrades are tiny animals, about 0.5 mm long when fully grown. They are among the most resilient animals known. It was discovered in 2008 that they could survive 10 days in outer space.

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D1 What are micro-organisms?

.....

..... [1]

D2 How can bacteria have a beneficial effect on the human body?

.....

..... [1]

D3 Suggest why micro-organisms are more capable of living in extreme conditions than higher organisms.

.....

.....

..... [2]

D4 Calculate the pressure in atmospheres from sea water at the bottom of the Mariana Trench (line 4).

.....

..... [1]

D5 Calculate the total pressure in atmospheres under the ocean rocks (line 5).

.....

.....

..... [2]

D6 The water in the hydrothermal vent (line 12) is at 120 °C yet is in the liquid state. Suggest why water does not boil at 100 °C in these hydrothermal vents.

.....

..... [1]

D7 Suggest and explain the effect on the rate of chemical reactions of increasing the temperature.

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.....

..... [2]

D8 Suggest how temperatures that are too cold prevent organisms from staying alive.

.....

.....

..... [2]

D9 Convert the lowest temperature ever recorded on Earth from degrees Celsius into Kelvin.

.....

..... [1]

D10 Assume energy increases in proportion to absolute temperature. How much more energy at 57 °C is there compared to 27 °C? Give your answer as a percentage.

.....

..... [2]

D11 State where highly acidic, neutral and highly alkaline pHs are found on the pH scale. Give numerical values.

Highly acidic …….. Neutral …….. Highly alkaline …….. [3]

D12 Name (a) an element, and (b) a base expected to react with an acid.

(a) element ..... (b) base ..... [2]

D13 Suggest how acidic conditions in the stomach could be helpful to an organism.

.....

..... [1]

D14 State a type of chemical reaction that produces a salt.

..... [1]

D15 Suggest two foods that are high in salt.

1 ..... 2 ..... [1]

D16 Suggest what it is about outer space that makes the tardigrades' survival there so remarkable.

.....

.....

..... [2]

End of Section D

Have you written your School and Name in the boxes provided at the top of Sections A, B, C and D?