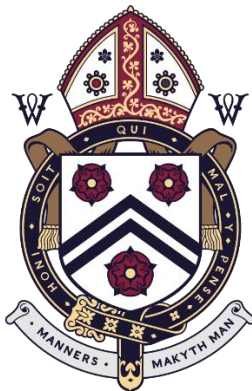


<i>School</i>	<i>Candidate's Name (PLEASE PRINT)</i>
---------------	--



WINCHESTER  
COLLEGE

## Entrance Examination

### SCIENCE 2021

Total time allowed: 1 hour 30 minutes

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

Section A    Biology  
Section B    Chemistry  
Section C    Physics

Each section carries 30 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.

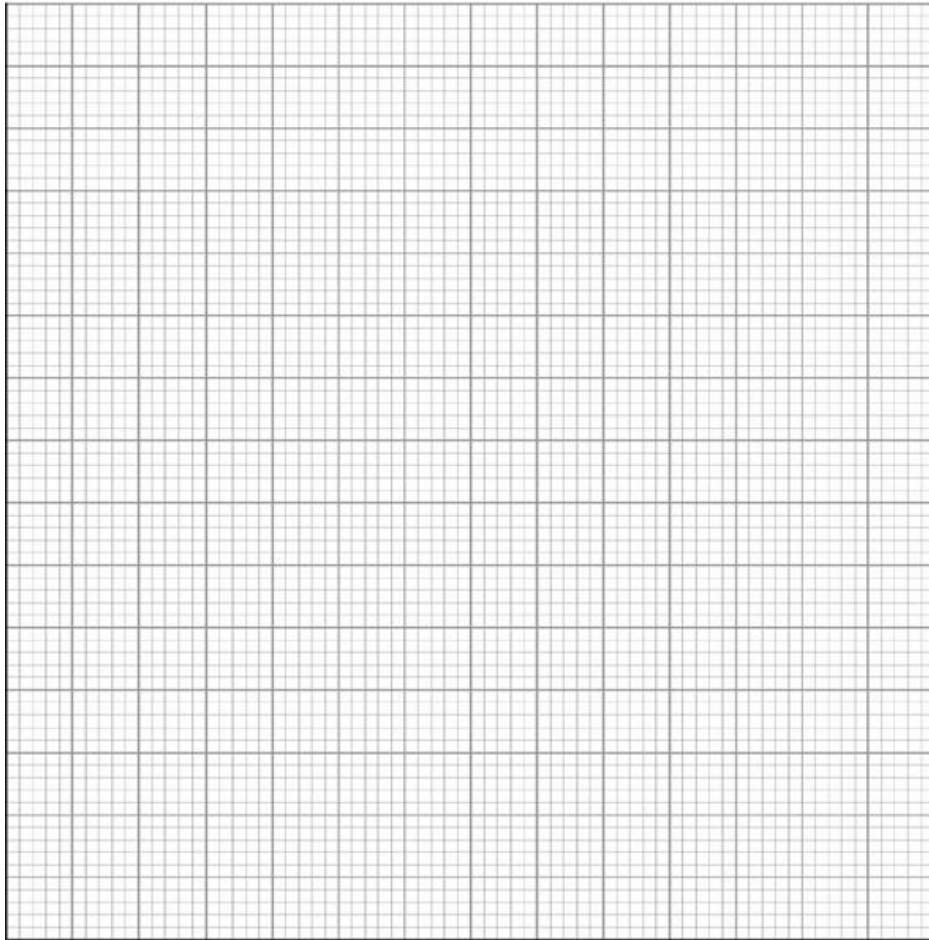
**Candidates will be penalized for giving answers to too many significant figures.**

## SECTION A – BIOLOGY

A1 Blodwyn and Myfanwy want to find out how their heart rate changes with exercise time. Blodwyn runs on a treadmill at a steady rate for 10 minutes and Myfanwy records Blodwyn's pulse rate every minute by feeling her wrist; she counts for 15 seconds then multiplies the number of pulses by 4 to make a minute. Her results are shown:

Time (min)	Heart rate (beats per minute)
0	72
1	98
2	113
3	121
4	132
5	135
6	134
7	132
8	133
9	130
10	131

- (a) Plot Blodwyn's data into a line graph on the grid below and join the points.



[5]

- (b) Blodwyn and Myfanwy's teacher then asked them to estimate what Blodwyn's heart rate would be at 2 minutes and 30 seconds.

Blodwyn said it would be 117 BPM.

Myfanwy said it would be somewhere between 113 and 121 BPM.

Explain why the teacher said Myfanwy's answer was better. Refer to the data in your answer.

.....

.....

.....

[3]

(c) Suggest one problem with the method that has been used and one improvement that can be made.

.....  
.....  
.....

[2]

(d) Suggest how Blodwyn could make the experimental data more reliable.

.....  
.....

[2]

(e) Explain why your heart rate goes up when you exercise.

.....  
.....

[2]

(f) Suggest why Blodwyn's graph levels off at 4-10 minutes.

.....  
.....  
.....

[2]

(g) Blodwyn is a normal teenage girl of average health and fitness. However, Myfanwy is a Welsh under-16 cross country champion and she trains in the gym for 4 hours every day. Suggest two ways that her graph would differ from Blodwyn's when it is her turn on the treadmill.

.....  
.....  
.....  
.....

[2]

A2 **Fig 2.1** shows the root of a germinating radish seed.



**Fig 2.1**

(a) How is the root adapted for absorbing water?

.....

.....

.....

.....

[3]

(b) Roots absorb water and dissolved mineral ions from the soil. Match up the substance with the function in the plant by drawing a line between them.

Water

Making chlorophyll

Nitrate ions

Raw material for making glucose

Magnesium ions

Producing proteins for growth

[3]

(c) Once water enters the root of an adult plant, explain in your own words what happens to it.

.....

.....

.....

.....

.....

.....

.....

[4]

(d) Apart from absorbing water, what else do plant roots do?

.....

.....

.....

[2]

**End of Section A**

<i>School</i>	<i>Candidate's Name (PLEASE PRINT)</i>
---------------	--

## SECTION B - CHEMISTRY

- B1 A student performed an investigation on the effect of heat on two solids. His findings are reproduced in the boxes below.

Numerical results

*I weighed a crucible, which had a mass of 18.67 g. I then added magnesium carbonate to the crucible until the total mass was 19.59 g. I heated it in a roaring flame for 3 minutes, after which the mass had gone down to 19.11 g. I heated it for another minute, reweighed it and found the mass was again 19.11 g. Then I took another crucible, which had a mass of 21.25 g and added copper hydroxide until the total mass was 24.23 g. I heated it strongly for 3 minutes after which its mass was 23.68 g. I heated it for another minute, reweighed it and found the mass was again 23.68 g.*

Other comments

*I heated the white magnesium carbonate again; after heating the residue was also white. To check the gas that comes off is carbon dioxide I bubbled it through lime water. The lime water went cloudy when the gas was bubbled through it. I heated the copper hydroxide again; the light blue solid turned to the black solid copper oxide. Some of the gas that comes off on heating condensed to a colourless liquid at the cooler end of the test tube. This liquid is water because it turned cobalt chloride paper pink.*

- (a) Draw a table to present the student's numerical results more clearly.

(b) Use the data recorded by the student to do the following calculations.

(i) What decrease in mass was recorded when the magnesium carbonate was heated?

..... [1]

(ii) What was the percentage decrease in mass of the magnesium carbonate on heating?

..... [1]

(iii) Which solid had the greatest percentage decrease in mass on heating? Justify your answer with a calculation. Show your working.

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

(c) The student heated the solids with a Bunsen burner.

(i) What is the source of energy that provides the heat of the Bunsen burner?

..... [1]

(ii) How is a roaring flame obtained from a Bunsen burner?

..... [1]

(iii) Suggest two safety hazards associated with a Bunsen burner.

1.....

2 ..... [2]



(d) What was the point of re-heating and re-weighing the solids?

.....  
.....

[1]

(e) Write down three statements that are observations and three statements that are conclusions from the student's *Other comments* box at the start of the question.

	Observations	Conclusions
1		
2		
3		

[3]

(f) Write the following word equations.

(i) For heating copper hydroxide.

.....

[1]

(ii) For heating magnesium carbonate.

.....

[1]

(g) Describe the arrangement and the motion of particles in the following cases.

(i) The constituent particles in magnesium carbonate as it begins to warm up.

.....

.....

[2]

- (ii) The molecules of carbon dioxide formed from the decomposition of magnesium carbonate.

.....  
.....

[2]

B2 Below are the names of some techniques for separating chemicals.

**filtration      chromatography      distillation      evaporation**

Decide which technique is most appropriate for the following.

- (a) Obtaining potassium nitrate crystals from potassium nitrate solution.

.....

[1]

- (b) Recovering chalk from a suspension of chalk in water.

.....

[1]

- (c) Separating blue ink from black ink.

.....

[1]

B3 Identify the following processes as either physical or chemical changes.

- (a) A positive oxygen test using a glowing splint.

.....  
.....

[1]

(b) A positive test for water from its boiling and freezing points.

.....  
.....

[1]

B4 Use the following observations to determine the relative reactivities of copper, nickel and carbon. Explain your reasoning.

- On warming nickel metal in copper sulfate solution, the metal dissolved, producing a pink-brown precipitate, leaving the solution less blue.
- On heating nickel oxide with carbon, some silvery solid was recovered.

Most reactive:

Least reactive:

Explanation:

.....  
.....  
.....

[3]

**End of Section B**

<i>School</i>	<i>Candidate's Name (PLEASE PRINT)</i>
---------------	--

**SECTION C – PHYSICS**

- C1 (a) The Apollo astronauts left several arrays of reflectors on the Moon's surface. It is possible to detect the reflection of laser light sent from the Earth from these arrays. The reflection is detected 2.5 seconds after the beam is sent.

Given that light travels at  $3.0 \times 10^8$  m/s, calculate the distance between the Earth and the Moon.

.....

.....

.....

..... [3]

- (b) Radar can be used in a similar way to calculate the distance between Earth and other planets of the Solar System. In June 1962 Soviet scientists measured the distance between Earth and Mercury to be about 85 million kilometres. In May 1963 American scientists at the Jet Propulsion Laboratory measured it to be 97 million kilometres. Explain this difference.

.....

..... [1]

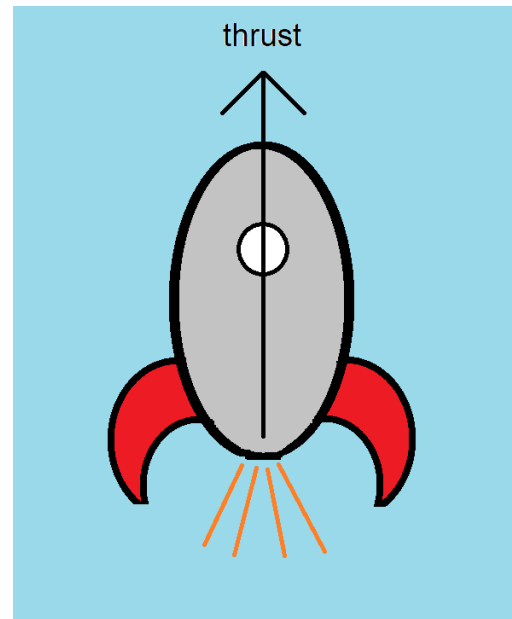
- (c) Suggest why the radar method is unsuitable for measuring the distances to stars.

.....

..... [1]

C2

A rocket engine is burning fuel and exerting a thrust upwards as shown on the diagram. The rocket is moving upwards at constant speed.



[3]

- (a) On the diagram, mark two other forces acting on the rocket. Label these forces and show their direction.

- (b) Explain whether the upward force on the rocket will be greater than, less than or equal to the downward forces and how you know this.

.....  
.....  
.....  
.....

[2]

- (c) Explain whether the energy in the following stores is increasing, decreasing or remaining constant and how you know this.

- (i) Chemical store (i.e. chemical energy).

.....  
.....  
.....  
.....

[2]

(ii) Gravitational store (i.e. gravitational potential energy).

.....  
.....  
.....  
.....

[2]

(iii) Kinetic store (i.e. kinetic energy).

.....  
.....  
.....  
.....

[2]

(d) State the main *other* store of energy which is increasing (i.e. what is the main other form of energy produced?)

.....

[1]

C3 A cuboid of copper sits on a table. The block is 2.5 cm wide and 4.5 cm long. It has a mass of 150 g. Copper has a density of 8.96 g/cm<sup>3</sup>.

(a) Using the equation density = mass / volume, calculate the height of the block. Show your working.

.....  
.....  
.....  
.....

[3]

- (b) The block's weight is about 1.5 N. Calculate the pressure it exerts on the table top in N/cm<sup>2</sup>.

.....

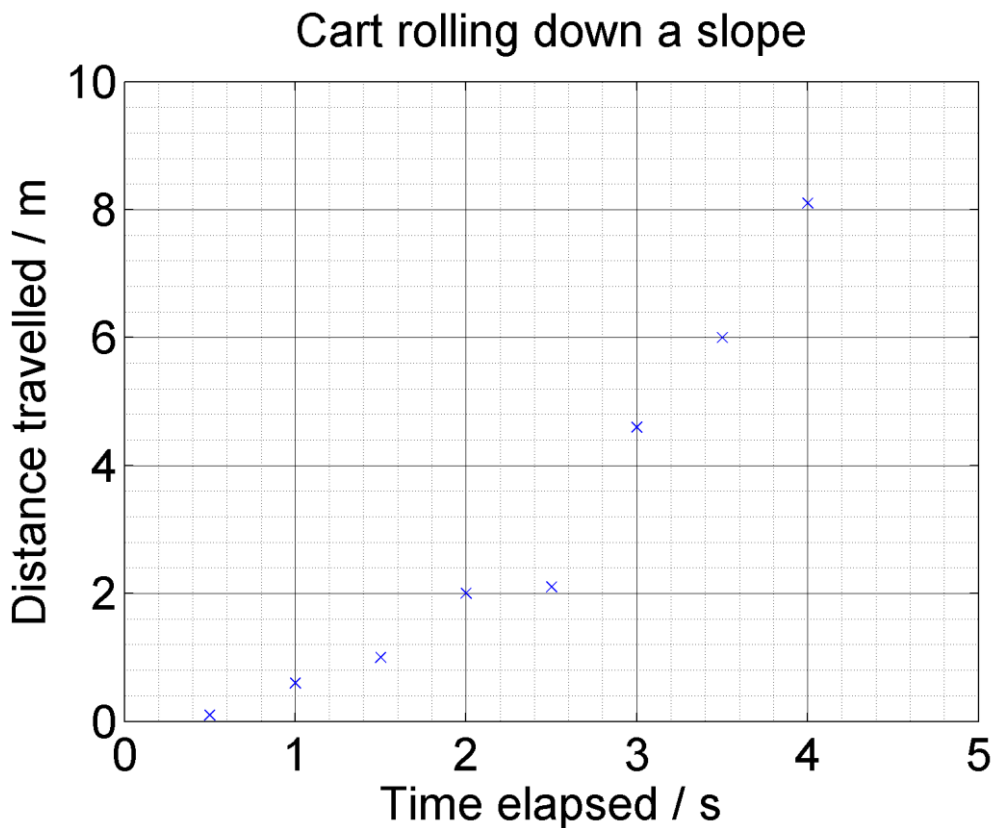
.....

.....Answer: ..... N/cm<sup>2</sup> [2]

C4 A cart is released from rest and rolls down a slope. A tape measure has been laid out along the slope to measure the distance it has moved. The cart's journey is filmed and the resulting video is used to obtain readings of time elapsed versus distance travelled. The video is not very high quality so the distance can only be measured to the nearest 10 cm and may be up to 20 cm away from the true value.

Time elapsed / s	Distance travelled / m
0.5	0.1
1.0	0.6
1.5	1.0
2.0	2.0
2.5	2.1
3.0	4.6
3.5	6.0
4.0	8.1

The results are shown in the table to the right and graph below:



(a) Add a suitable curve of best fit to the graph. [2]

(b) Identify any points that do not appear to follow the trend. Explain whether the uncertainty in the distance measurements is enough to account for this.

.....  
.....  
.....  
.....

[2]

(c) Showing your working, use your best-fit curve to estimate how far the cart has travelled after 2.7 seconds.

.....  
.....  
.....  
.....

[2]

(d) Explain what the results tell you about the speed of the cart and how they do so.

.....  
.....  
.....  
.....

[2]

**End of Section C**  
**End of this paper**