| *School* | *Candidate's Name (PLEASE PRINT)* |
|---|---|
| | |

WINCHESTER
COLLEGE

# Entrance Examination

# SCIENCE

**Wednesday 2 May 2018**

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 Limestone is made mainly of calcium carbonate, $CaCO_3$, a chalky white solid. Calcium carbonate is formed as a solid when solutions containing calcium ions and carbonate ions are mixed together. Calcium carbonate is also formed when calcium oxide reacts with carbon dioxide.

(a) In addition to the identities of the elements comprising calcium carbonate, give another piece of information that the chemical formula, $CaCO_3$, conveys.

(i) Ratio of elements or atoms / formula mass

..... [1]

(b) Explain what is meant by a *solution* in this context.

One substance (solute) [allow solid] (1) dissolved in another / a liquid / solvent (1)

..... [1]

(c) Name the process of forming a solid from a solution by mixing, as described above.

Precipitation [1]

(d) The formation of calcium carbonate from calcium oxide and carbon dioxide is an example of neutralisation. Identify the acid in this neutralisation reaction.

Carbon dioxide / $CO_2$ [1]

(e) Describe an experiment, including relevant observations, which would demonstrate that calcium carbonate reacts with hydrochloric acid to produce carbon dioxide.

Suitable reaction vessel (1)

Both reagents mixed (1)

Limewater (1)

Goes cloudy when gas passed through (1)

[The first three marks could be awarded for a labelled diagram]

.....

.....

..... [4]

A2 Hot, dry regions are susceptible to forest fires. Fire is a sign of chemical reactions taking place and releasing heat. On a small scale, fire can be useful in the home and in the laboratory.

(a) In addition to heat, give the two requirements necessary to maintain a fire.

Fuel / combustible material AND oxygen [NOT air] [1]

(b) Some fires may be extinguished using water. State which of the three requirements for fire is removed by the water.

Heat [1]

(c) Forest fires are typically contained by the use of fire breaks. These are strips of land cleared of trees and wood. Explain how fire breaks work.

Removes / creates gaps in fuel *owtte* (1)

.....

..... [1]

(d) Explain why high winds increase the severity of forest fires.

INCREASED / GREATER / MORE oxygen/air supply (1)

Ignore references to higher temperature. [1]

(e) Draw a labelled diagram of a Bunsen burner in use, adjusted for strong heating. Indicate the materials it uses and where they are supplied to the burner.

Burner shown (1)

Air hole open (1)

Gas inlet indicated (1)

Air indicated entering air hole (1)

[4]

(f) If a flammable liquid catches fire in the laboratory, a fire blanket is placed over its container until the fire goes out. Explain how the fire blanket puts out the fire.

Eliminates/barrier to oxygen/air (1)

..... [1]

A3 When fossil fuels containing sulfur are burnt, they release sulfur dioxide, $SO_2$, which causes acid rain. Sulfur dioxide is soluble in water. The table below shows how the pH of 1.0 $m^3$ of water depends on the mass of dissolved sulfur dioxide:

| Mass of $SO_2$ per $m^3$ of water / kg | 0.000 | 0.010 | 0.040 | 0.10 | 0.40 | 0.65 |
|---|---|---|---|---|---|---|
| pH of resulting solution | …….. | 2.8 | 2.5 | 2.3 | 2.0 | 1.9 |

(a) Fill in the missing pH value in the table. 7.0 (allow 7) [1]

(b) Plot the data on a suitable graph using the graph paper printed below. Axes correctly (check for "pH") labelled (1); units kg/$m^3$ (1); Data correct minus 1 per first/second error. Allow ecf from part (a)(2); Smooth line of best fit (1)

*See over for example graph*

[5]

# PHYSICS MARK SCHEME 2018

| *School* | *Candidate's Name (PLEASE PRINT)* |
|---|---|
| | |

## SECTION B - PHYSICS

B1 (a) The density of water can be calculated using a measuring cylinder, a mass balance and a supply of water. Explain what you would need to do with this equipment to obtain the measurements that you need.

Measure mass of 'cylinder' empty (on balance) ✓

" " " " full ✓

Use cylinder to find volume of water ✓

(all 3 needed for two marks) [2]

(b) State the calculation you would now perform in order to obtain the density.

$$\text{density} = \frac{\text{mass (of water)}}{\text{volume}}$$

[1]

B2 (a) Write down an equation relating pressure, force and area.

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

[1]

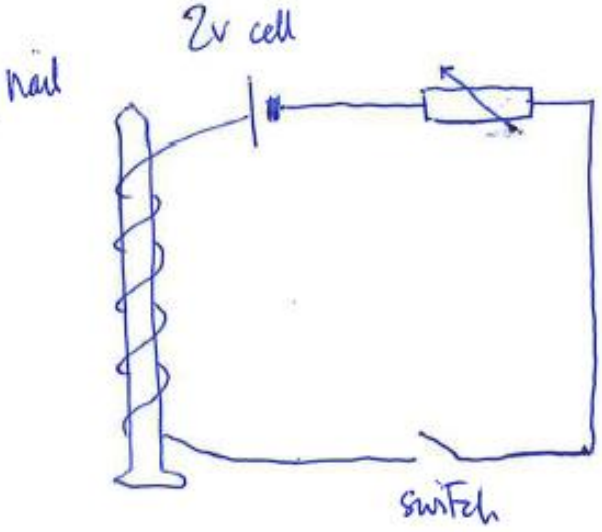
(b) Underline any of the following units which could be used for pressure:

[1]

N/cm² kg/m² N²/m N.m (only)

B3 A boy wishes to make an electromagnet. He has been to the workshops and collected a nail, some insulated wire, a switch, a variable resistor and a 2 volt cell.

(a) Draw a labelled diagram in the space below to show how he should assemble this apparatus to make an electromagnet. He should be able to switch the electromagnet off and on, and also vary its strength. You may use standard symbols where appropriate.




✓ Labelled diagram
✓ Turns round nail
✓ switch / resistor in working pos^n

[3]

(b) Suggest how, using the same apparatus, he could adjust his design to increase the maximum strength of the electromagnet.

More coils around nail

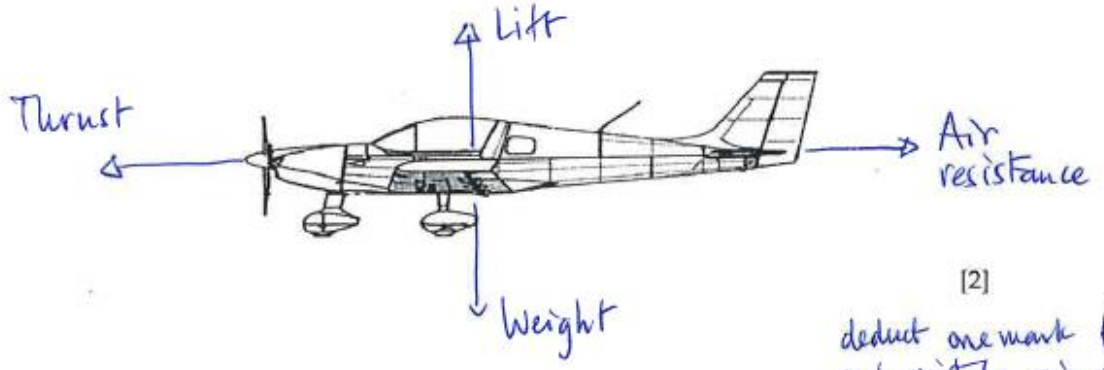
.....

.....

[1]

B4 An aeroplane is cruising at altitude at a steady 525 miles per hour in straight, horizontal flight. The four forces acting on the aeroplane are air resistance, lift, weight and thrust.

(a) On the diagram below, indicate with arrows each of these four forces acting on the plane:




[2]

deduct one mark for each mistake, min. zero.

(b) State which forces must balance each other, and explain how you know this.

Lift balances weight ; thrust balances air resistance (both for 1 mark)
acceleration is zero ∴ forces must balance in each direction (owtte) [2]

B5 (a) Sound is a type of wave. State how the sound wave associated with a loud sound differs from that of a quiet sound of the same pitch.

greater amplitude [1]

b) Billy Wykeham is watching a storm. He sees a lightning flash – there is a gap of several seconds before he hears the thunder. "This is evidence," says Billy, "that light travels very fast. In fact, it shows that light travels almost instantly from the flash to my eye." Explain carefully how far you agree with Billy.

This is evidence that sound travels slower than light. ✓

It is not evidence that light travels faster ✓ [2]

c) Light in fact travels at 300,000 km/s and takes roughly 8 minutes to travel from the Sun to the Earth. Use this information to calculate how far the Sun is from the Earth. Be sure to show your working.

distance = speed x time

= 300 000 km/s x 8 x 60 s

= 144 000 000 km [2]

B6 This question is about energy changing from one form into another. For example, a solar panel converts **light energy** from the Sun into **electrical energy** as electrical current is produced, with some being wasted as **heat energy** as the panel heats up.

Describe in as much detail as you can the energy changes involved when a firework rocket travels up into the air and then explodes in a colourful display.

Chemical energy in rocket fuel → kinetic energy of propellant & body.
KE of body → PE of body at great height.
Chemical energy in firework → KE of hot fragments + light & heat energy (seen in the display) (any 4)

[4]

B7 Estimate the volume of your thumb, by first considering the dimensions of it. Show your working. State the units of your answer.

✓ Estimate dimensions of thumb (reasonably)
✓ Calculate volume = area x length
✓ State units of answer

[3]

**End of Section B**

| *School* | *Candidate's Name (PLEASE PRINT)* |
|---|---|
| | |

## SECTION C – BIOLOGY

C1 *Saccharomyces cerevisiae,* a species of yeast, is a single-celled organism in the Fungi kingdom. Structurally, the cells are similar to animal cells, but also have a cell wall.

(a) Draw a diagram of *Saccharomyces cerevisiae* and label as many features as you can.

Clear outline;
Cell wall shown;
Nucleus drawn and labeled;
Other feature. expected in eukaryote, shown and labelled

* Do not give mark for nucleus if it is shown inside a vacuole

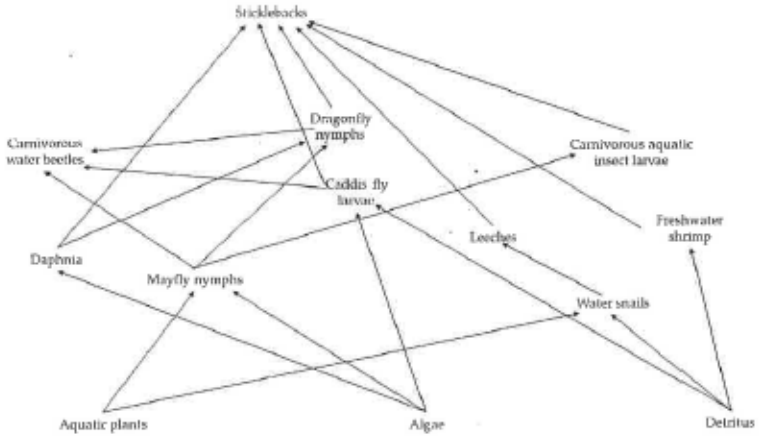
[4]

(b) Name two features that are present in a plant cell, but which are not present in *Saccharomyces cerevisiae*.

Large vacuole;.....

Chloroplast;..... [2]

C2 The River Itchen runs through Winchester and supports a wide variety of life. Below is a food web showing how the various organisms depend on each other.




(a) (i) State and explain at at least one factor that could affect the number of dragonfly nymphs in this ecosystem.

Factor:

Decrease in (named) food source (from diagram);

Increase in named predator

Any other valid reason; [2]

* MAX one mark if no explanation given.

(ii) Suggest and explain what may happen if caddis fly larvae were wiped out by a disease.

More algae / detritus;

Because fewer things to eat them;

More water snails / shrimp / Daphnia / Mayfly nymph;

Because less competition for food; [3]

Fewer dragonfly nymphs / Mayfly nymphs / Leeches / other;
Because sticklebacks / water beetles rely on them more for food.
AVP; with valid explanation;

(b) The organisms at the bottom of the food web photosynthesise, providing raw materials for the ecosystem.

Complete the following symbol equation for photosynthesis, and state two requirements needed for the process.

1 mark correct symbols
2 marks if balanced
MAX 3 marks

6 $CO_2$ + 6 $H_2O$ → $C_6H_{12}O_6$ + 6 $O_2$

Requirement 1 ...sunlight (allow light)...

Requirement 2 ...chlorophyll / chloroplasts... [3]

(c) Some students designed an experiment to test how the rate of photosynthesis is affected by light intensity. Their method is described below:

1. Obtain a cutting of the pondweed *Elodea* and place it in a boiling tube, with enough water to cover the plant.
2. Check for bubbles of gas coming from the cut end of the stem.
3. Place a lamp 30 cm away from the boiling tube and switch it on. This should be the only source of light.
4. Count the number of bubbles of gas coming from the stem in one minute.
5. Record this result.
6. Repeat steps 3 – 5 above four more times, with the same cutting, moving the lamp 5 cm closer each time.

(i) State the independent and dependent variables for this experiment.

Independent: Distance of lamp / light intensity.

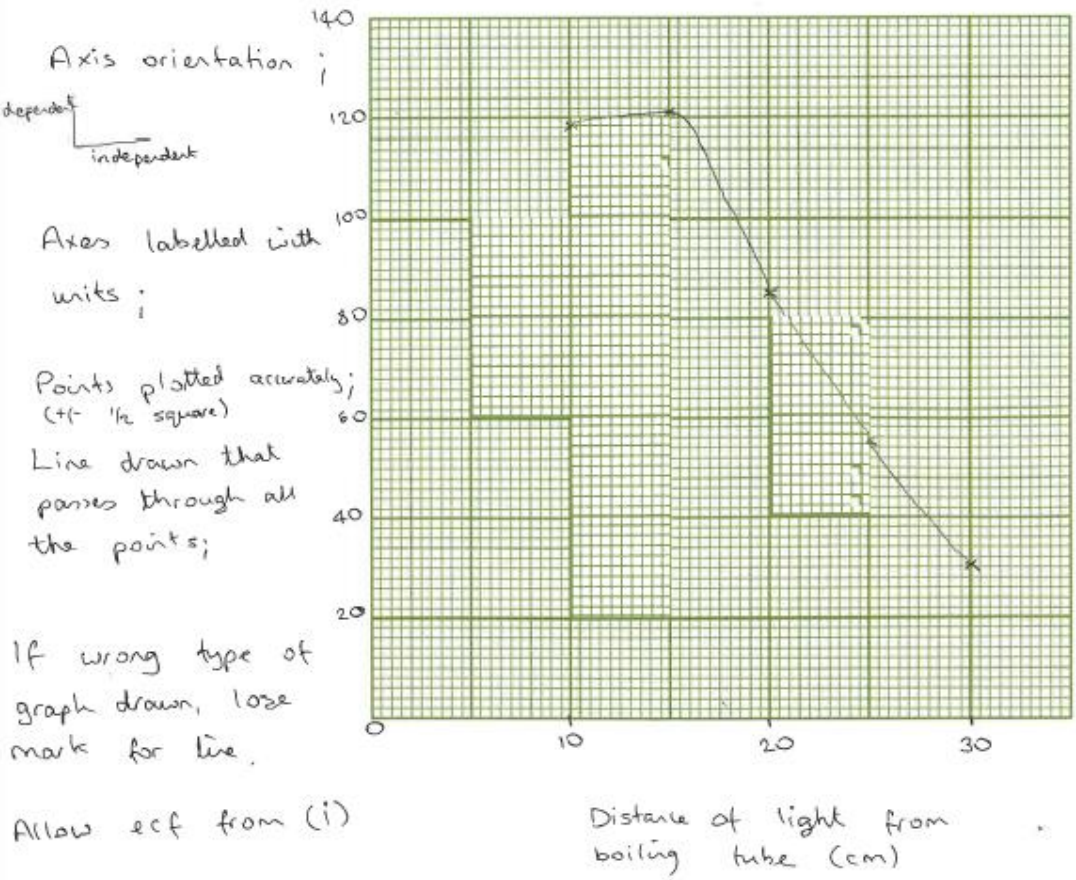
Dependent: Number of gas bubbles / ~~volume of~~ [1]
Rate of photosynthesis

* Both needed for 1 mark

The table below shows the results they obtained:

| Distance of the light from the boiling tube (cm) | Number of bubbles produced in one minute |
|---|---|
| 30 | 30 |
| 25 | 55 |
| 20 | 85 |
| 15 | 121 |
| 10 | 118 |

(ii) Plot a graph using these results.




Axis orientation ;

Axes labelled with units ;

Points plotted accurately ; (+/- ½ square)

Line drawn that passes through all the points ;

If wrong type of graph drawn, lose mark for line.

Allow ecf from (i)

[4]

(iii) Describe the trend in the students' results and explain the data using your understanding of photosynthesis.

As light moves further away, number of bubbles decreases (or converse);

* Allow plausible explanation for plateau

Comparative use of data to illustrate;

Not much difference between 10 and 15 cm;

Because: light needed for photosynthesis;

to provide energy for reaction; [4]

At 10cm another factor is limiting; owtte

(d) Suggest two ways in which the experiment could be improved.

Repeat readings; take a mean;

Control one named variable;

Method for getting accurate light intensity; [2]

Measure volume of gas, not number of bubbles;

More readings between zero and 10 cm;

**End of Section C**

2018 Entrance Science Paper

Section D General

Mark Scheme

1. Thrust = (5 000 000 lb / 2.2 lb $kg^{-1}$) × 9.8 N $kg^{-1}$ = 2.2 × $10^7$ N (1)
2. (a) Changing mass increases net force as weight is reduced (1)
   And increases acceleration as weight decreases as well as net force increasing (1)
   (b) Thinner atmosphere means less air resistance (1)
   And increases acceleration as there is a larger net force (1)
3. Oxygen liquefied to avoid very high gas pressures OR much more oxygen in the tank (1)
4. No atmosphere in space (1)
5. Carbon dioxide (1)
   Water (1)
6. NASA (1)
7. Sputnik 1 was a satellite (1)
   USSR / Russia was responsible for it (1)
8. First man on the Moon (1)
9. Most abundant: nitrogen (1)
   2nd most abundant: oxygen (1)
10. Carbon monoxide (1)
11. Hydrogen is found in compounds, eg water, instead as it is quite reactive OR it is so light that it escapes from the atmosphere (1)
12. Diffusion (1)
13. DNA (1)
14. Harmful: causing disease (1)
    Harmful: causing food to go mouldy (1)
    Benficial: breakdown of waste / dead organisms OR making bread / wine (1)
15. Glucose → ethanol + carbon dioxide (1)
16. Blubber OR white fur (camouflage and warmth) OR black skin (to absorb light) OR greasy coat (to shed water) OR small surface area to volume ratio (to retain heat) (2)

[Total: 25]