**University of Worcester Science Equivalency Test – information for candidates.**

A. The Science Equivalency Test is comprised of a series of GCSE level questions which are used to sample candidates' recall, knowledge and understanding of the Biology, Chemistry and Physics topics listed in Section B below. The test also assesses candidates' knowledge, understanding and application of 'working scientifically' (the development of scientific thinking; experimental skills and strategies; analysis and evaluation; scientific vocabulary, quantities, units, symbols and nomenclature).
Approximately 25% of the marks are linked to questions which have some mathematical content e.g. doing calculations and representing values; choosing how to represent data; drawing charts and graphs; working with proportionality and ratio; dealing with variability; looking for relationships: line graphs; looking for relationships: batches and scatter graphs. (further information available from http://www.ase.org.uk/resources/maths-in-science/)
Candidates have two hours to complete the test. Section 3 below contains some sample questions, plus links to more examples which are available online.

B. Science content which may be assessed by the test:

Biology

- Prokaryotic and eukaryotic cells
- Cell metabolism
- Transport in cells
- Transport systems in multicellular organisms
- Human circulatory system
- Transport systems in plants
- Health and disease
- Communicable diseases
- Treating, curing and preventing disease
- Nervous coordination and control in humans
- Hormonal coordination and control in humans
- Homeostasis in humans
- Importance of photosynthesis
- Levels of organisation within an ecosystem
- Biodiversity
- Reproduction
- The genome and gene expression
- Inheritance
- Variation and evolution
- Selective breeding and gene technology

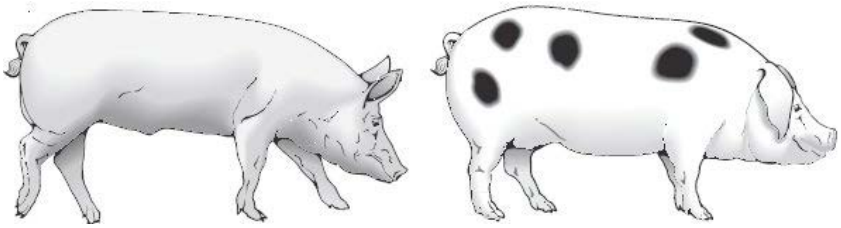
Chemistry

- A simple model of the atom, relative atomic mass, electronic charge and isotopes
- The modern Periodic Table
- Properties of transition metals
- Structure, bonding and the properties of matter
- Different kinds of chemical bonds: ionic, covalent and metallic bonding
- Structure and bonding of carbon
- Bulk and surface properties of matter including nanoparticles
- Chemical symbols, formulae and equations
- Chemical changes
- Identification of common gases
- Chemistry of acids
- A reactivity series of metals as the tendency of a metal to form its positive ion
- Electrolysis of various molten ionic liquids and aqueous ionic solutions
- Redox reactions (reduction and oxidation)
- Exothermic and endothermic reactions, including reaction profiles
- Carbon compounds both as fuels and feedstock
- Chemical cells and fuel cells
- Factors that influence the rate of reaction, including catalysts
- Reversible reactions and the concept of dynamic equilibrium
- Homologous series, including alkanes, alkenes, alcohols and carboxylic acids
- Simple reactions of alkanes, alkenes and alcohols
- Synthetic and naturally occurring polymers, including DNA
- Assessing purity and separating mixtures
- Conservation of mass and the quantitative interpretation of balanced equations
- Use of amount of substance in relation to masses of pure substances
- Use the mole in relation to volumes of gases
- Principles for determining the concentrations of solutions
- Identification of ions by chemical and spectroscopic means
- Life cycle assessment and recycling
- Fractional distillation of crude oil and cracking
- Different methods of extracting and purifying metals with reference to a reactivity series with oxygen and the position of carbon within it
- Using materials
- The balance between equilibrium position and rate in industrial processes
- Agricultural productivity and the use of nitrogen, phosphorus and potassium-based fertilisers
- The comparison of yield and atom economy of chemical reactions
- The composition and evolution of the Earth’s atmosphere since its formation
- Earth and atmospheric science
- Carbon dioxide and methane as greenhouse gases
- Common atmospheric pollutants and their sources
- The Earth’s water resources and obtaining potable water

Physics

- Energy changes in a system, and in the ways energy is stored before and after such changes
- Conservation, dissipation and national and global energy sources
- Forces and their interactions
- Work done as force x distance, energy transfer
- Pressure and pressure differences in fluids
- Moments, levers and gears
- Waves in air, fluids and solids
- Waves at material interfaces: applications in exploring structures
- Frequency range of the spectrum
- Interactions of electromagnetic radiation with matter and their applications
- Lenses
- Colour and frequency; differential effects in transmission, absorption and diffuse reflection
- Black body radiation (qualitative only)
- Current, potential difference and resistance
- Series and parallel circuits
- Domestic uses of electricity and safety
- Energy transfers
- Static electricity – forces and electric fields
- Permanent and induced magnetism, magnetic forces and fields
- Magnetic effects of currents and the motor effect
- Magnetic effects of currents and the motor effect
- Induced potential, transformers and the national grid
- Microphones and speakers; oscillating currents in detection and generation of radiation
- Changes of state and the particle model
- Particle model and pressure
- Nuclear atom and isotopes
- Absorption and emission of ionizing radiations and of electrons and nuclear particles
- Hazards and uses of radioactive emissions and of background radiation
- Nuclear fission and fusion
- Solar system; stability of orbital motions; satellites
- Red-shift as sources move away; the ‘big bang’ and universal expansion

C. Sample questions and answers

| Question |
| --- |
| The drawings below show pigs from two different breeds.<br>  <br>(i) From the drawings above, give **two** ways in which the pigs are different.<br>1. .....1 mark<br>2. .....1 mark<br>(ii) What are these differences called? Tick the correct box.<br>adaptations ☐ classification ☐<br>fertilisation ☐ variations ☐<br>1 mark |
| Mark Scheme |
| (i) any **two** answers from<br>one has spots (*accept 'the spots' **or** 'it has different markings')*<br>one has upright **or** floppy **or** pointy ears (*accept 'the ears')*<br>one has a straight **or** curvy or bent snout (*accept '(longer) nose **or** snout **or** face' accept 'shape of head')*<br>different shaped body (*accept 'fatter' **or** 'thinner'* BUT *'different shaped' or 'bigger' are insufficient)*<br>one is darker **or** lighter (*accept 'they are different colours'* BUT *'skin' is insufficient)*<br>*accept 'length of legs'*<br>(ii) • variations ✓ (*if more than one box is ticked, award no mark)* |

Question

**Figure 1** shows a woman filling her bathroom sink with hot water.

**Figure 1**


(a) The mirror changes from being dry to being covered with small drops of water.

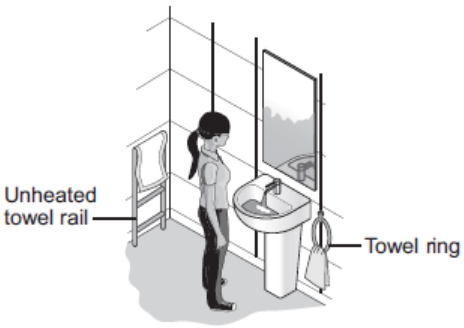
Name the process causing this change on the mirror.

..... **(1 mark)**

(b) The woman dries herself with a towel. She hangs the wet towel in the bathroom to dry.

**Figure 2** shows two places she could hang the towel.

**Figure 2**




The towel will dry faster if it is hung from the unheated towel rail instead of the towel ring.

Explain why.

.....

.....

.....

**(2 marks)**

Mark Scheme

.(a) condensation

1 mark

(b) larger (exposed) surface area 1 mark

(so) water can evaporate faster
**or**
(so) more water (molecules) can escape (*allow more water can evaporate)* 1 mark

Question

The figure opposite shows a power station.

Fossil fuels are burnt at some power stations.

(a) tick the correct answer to complete the sentence.

Fossil fuels release energy by

**Combustion** ☐ **Decomposition** ☐ **Distillation** ☐

(b) Burning fuels can also release substances which cause an environmental effect.

Draw **one** line from each substance to an environmental effect caused by the substance.

| Substance | Environmental effect |
|---|---|
| Carbon dioxide | Acid rain |
| Oxides of nitrogen | Bioleaching |
| Solid particles | Global dimming |
| | Global warming |

Mark Scheme

**(**a) combustion ( 1 mark)

(b)

| Substance | Environmental effect |
|---|---|
| Carbon dioxide | Global dimming |
| Oxides of nitrogen | Acid rain |
| Solid particles | Global warming |
| | Bioleaching |

(3 marks)

*extra lines from substance negates mark*

Question

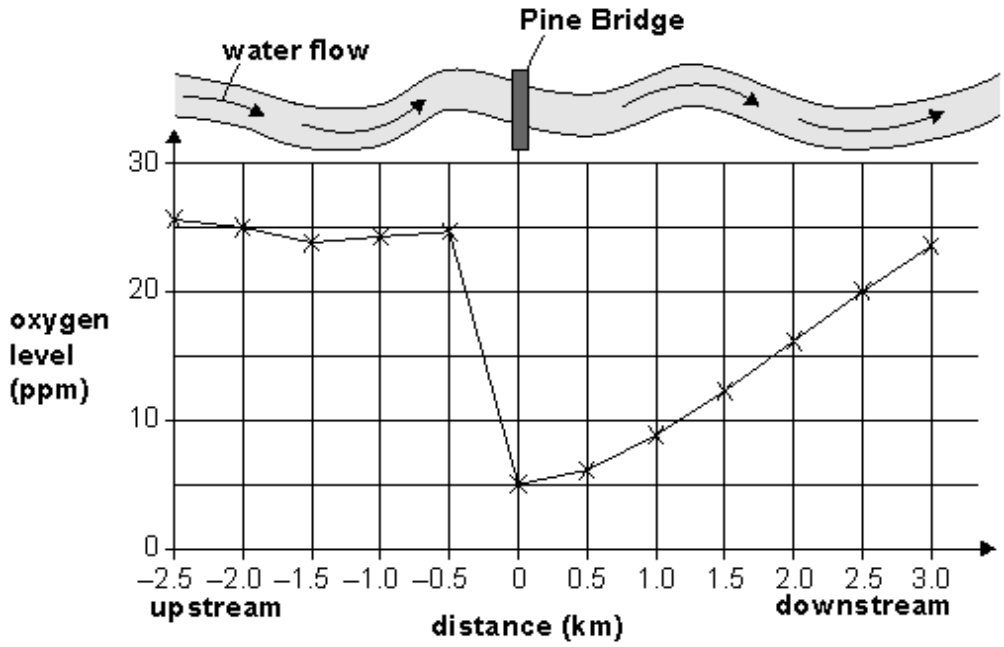
**The information below comes from a newspaper report.**

## River Pollution

**Scientists from the Environment Agency were called to investigate a river.**

Local fishermen reported that they had not caught trout in the river at Pine Bridge for many months. There were more algae growing in the river and it had a bad smell.

Scientists measured the oxygen levels in the water upstream and downstream from Pine Bridge. The results are shown below.




(a) (i) What was the oxygen level in the river at Pine Bridge?

..... ppm (1 mark)

(ii) Describe what happens to the oxygen level in the river as you travel **downstream** from Pine Bridge.

..... (1 mark)

(b) Trout only live in water with oxygen levels higher than 20 ppm.
How far **downstream** from Pine Bridge would you be likely to find trout?
Write the unit.

..... (1 mark)

The scientists collected samples of the river animals found at different places.

| animals collected | distance from Pine Bridge (km) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **–2.0** | **–1.5** | **–1.0** | **–0.5** | **0** | **0.5** | **1.0** | **1.5** | **2.0** |
| stonefly nymphs | ✓ | ✓ | ✓ | ✓ | | | | | |
| mayfly nymphs | ✓ | ✓ | ✓ | ✓ | | | | | |
| freshwater shrimps | ✓ | ✓ | ✓ | ✓ | | | | | ✓ |
| caddis fly larvae | ✓ | ✓ | ✓ | ✓ | | | | | |
| rat-tailed maggots | | | | | ✓ | ✓ | | | |
| sludge worms | | | | | ✓ | ✓ | ✓ | | |
| water lice | | | | | | | ✓ | ✓ | ✓ |
| bloodworms | | | | | | | ✓ | | |

(c) Trout only live in water with oxygen levels higher than 20 ppm.
Give the name of one **other** animal that **only** lives in oxygen levels above 20 ppm.
Use the table and the information above to help you.

..... (1 mark)

(d) Use the information from the table and the graph.
Name **two** animals that are **only** found when the oxygen level is below 10 ppm.

1. ..... 2. .....

(2 marks)

(e) In the river, trout are predators. Near Pine Bridge, the number of trout decreased.

Suggest **one** reason why pollution may cause the trout population to decrease.

.....

.....

(1 mark)

Answer

(a) (i) • 5 *ppm*

(ii) • it increased

*accept 'it went up'*

*OR 'it goes from 5 (ppm) at Pine Bridge to 20 (ppm) at 2.5 km'*

**BUT** *'It went from 5 (ppm) to 24 (ppm)' is insufficient*

(b) any **one** from

- further than 2.5 km (*accept 'at 2.5 km')*
- beyond 2.5 km (*accept a single distance from 2.5 km to 3 km (inclusive)*

***the unit is required for the mark***

(c) any **one** from

- stonefly nymphs (*accept 'nymphs')*
- mayfly nymphs (*accept 'stonefly' ; accept 'mayfly')*
- caddis fly larvae (*accept 'caddis fly' ; accept 'larvae')*
  *'fly' is insufficient*

  ***do not*** *accept 'freshwater shrimps' ; 'trout' is insufficient*

(d) any **two** from

- rat-tailed maggots (*accept 'rat-tailed'* ***or*** *'maggots')*
  *'rat'* ***or*** *'sludge'* ***or*** *'blood' are insufficient*
- sludge worms
- bloodworms

*if the type of worm is not specified, accept 'worms' for one mark (e.g. 'bloodworm'* ***and*** *'worm'); award two marks for 'rat-tailed maggots'* ***and*** *'worm'. Responses may be given in any order*

(e) any **one** from

- less food available for the trout (*accept 'they die of starvation')*

*do **not** accept 'no food is available for the trout' **or** 'all their food is killed'*

- the food chain may be affected

- the trout may have left the area to find food
  *do **not** accept 'humans **or** predators have caught the trout'*
  *do **not** accept 'all the trout are killed'*
  *'the water is polluted' is insufficient*

- the oxygen level is too low (to allow the trout to breathe)

  *accept 'it reduces the oxygen level' **or** 'the oxygen level is lower'*
  *do **not** accept 'there is no oxygen'*
  *accept 'not enough oxygen'*
  *'the oxygen level is low' is insufficient*

- they are more likely to catch disease

  *accept 'the trout may be poisoned **or** killed'*
  *'the trout have died' is insufficient as the cause may not be directly attributable to the pollution*

Additional sample GCSE level questions and specimen answers are available from the exam board websites:

AQA
http://www.aqa.org.uk/subjects/science/gcse/combined-science-synergy-8465/assessment-resources
http://www.aqa.org.uk/subjects/science/gcse/biology-4401/past-papers-and-mark-schemes
http://www.aqa.org.uk/subjects/science/gcse/chemistry-4402/past-papers-and-mark-schemes
http://www.aqa.org.uk/subjects/science/gcse/physics-4403/past-papers-and-mark-schemes

OCR
http://www.ocr.org.uk/qualifications/by-type/gcse-related/science/

EDEXCEL
http://qualifications.pearson.com/en/subjects/science.html#Science