Level 3

Applied Science

Transition Tasks

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Maths help

Science uses the language of mathematics to make sense of the world. It is important that you are able to use maths. The following exercises will help you to practise some of the maths you have covered during your GCSE studies to help with your BTEC course.

Activity 1: Standard form

1. **Write in standard form**

(a) **379.4**

(b) **0.0712**

2. **Convert these to ordinary numbers:**

(a) **The speed of light 3.00×10^{8} m s^{-1}**

(b) **The charge on an electron 1.60×10^{-19} C**

3. **Write one quarter of a million in standard form.**

4. **Write these constants in ascending order (ignoring units):**

permeability of free space; the Avogadro constant; proton rest mass; acceleration due to gravity; mass of the Sun.

5. **Work out the value of the following.**

Give your answer in standard form.

The mass of an electron/the mass of the Earth (use the data sheet).

6. **Solve $(2.4 \times 10^{7})x = 1.44 \times 10^{9}$**

Give your answer in standard form.

Activity 2: Decimal places, significant figures and rounding

1. **How many rockets would be needed to deliver 30 tonnes of material to a space station, if every rocket could hold 7 tonnes?**

2. **A power station has an output of 3.5 MW. The coal used had a potential output of 9.8 MW.**

Work out the efficiency of the power station.

Give your answer as a percentage to one decimal place.

3. **A radioactive source produces 17 804 beta particles in 1 hour.**

Calculate the mean number of beta particles produced in 1 minute.

Give your answer to one significant figure.

Activity 3: Fractions, ratios and percentages

1. **The ratio of turns of wire on a transformer is 350 : 7000 (input : output) What fraction of the turns are on the input side?**

2. **A bag of electrical components contains resistors, capacitors and diodes.**

   $\frac{2}{5}$ of the components are resistors.

   The ratio of capacitors to diodes in a bag is 1 : 5. There are 100 components in total.

   How many components are diodes?

3. **The number of coins in two piles are in the ratio 5 : 3. The coins in the first pile are all 50p coins. The coins in the second pile are all £1 coins.**

   Which pile has the most money?

4. **A rectangle measures 3.2 cm by 6.8 cm. It is cut into four equal sized smaller rectangles.**

   Work out the area of a small rectangle.

5. **Small cubes of edge length 1 cm are put into a box. The box is a cuboid of length 5 cm, width 4 cm and height 2 cm.**

   How many cubes are in the box if it is half full?

6. **In a circuit there are 600 resistors and 50 capacitors. 1.5% of the resistors are faulty. 2% of the capacitors are faulty.**

   How many faulty components are there altogether?

7. **How far would you have to drill in order to drill down 2% of the radius of the Earth?**

8. **Power station A was online 94% of the 7500 days it worked for.**

   Power station B was online $\frac{8}{9}$ of the 9720 days it worked for.

   Which power station was offline for longer?

Activity 4: Rearranging formulas

1. **Rearrange** $y = 2x + 3$ **to make** x **the subject.**

2. **Rearrange** $C = 2\pi r$ **to make** r **the subject.**

3. **Rearrange** $E = \frac{1}{2}mv^2$ **to make** v **the subject.**

4. **Rearrange** $s = ut + \frac{1}{2}at^2$ **to make** u **the subject.**

5. **Rearrange** $s = ut + \frac{1}{2}at^2$ **to make** a **the subject.**

6. **Rearrange** $\omega = \frac{v}{r}$ **to make** r **the subject.**

7. **Rearrange** $T = 2\pi\sqrt{\frac{v}{r}}$ **to make** r **the subject.**

8. **Rearrange** $v = \omega\sqrt{a^2 + x^2}$ **to make** x **the subject.**

Note: in science, subscripts are often used to label quantities. So in the following two examples, there are two masses, m_1 and m_2. The 1 and 2 are part of the quantity and should be kept with the m.

9. **Rearrange** $F = \frac{Gm_1m_2}{r^2}$ **to make** m_2 **the subject.**

10. **Rearrange** $F = \frac{Gm_1m_2}{r^2}$ **to make** r **the subject.**

Greek letters

Greek letters are used often in science. They can be used as symbols for numbers (such as π = 3.14…), as prefixes for units to make them smaller **(eg** μm **= 0.000 000 001** m**) or as symbols for particular quantities (such as** λ **which is used for wavelength).**

The Greek alphabet is shown below.

A	α	alpha
B	β	beta
Γ	γ	gamma
Δ	δ	delta
E	ε	epsilon
Z	ζ	zeta
H	η	eta
Θ	θ	theta
I	ι	iota
K	κ	kappa
Λ	λ	lambda
M	μ	mu

N	ν	nu
Ξ	ξ	ksi
O	ο	omicron
Π	π	pi
P	ρ	rho
Σ	ς or σ	sigma
T	τ	tau
Y	υ	upsilon
Φ	φ	phi
X	χ	chi
Ψ	ψ	psi
Ω	ω	omega

Activity 5

List all of the uses of Greek letters that you have encountered in your GCSE Science and Maths studies.

SI units

Every measurement must have a size (eg 2.7) and a unit (eg metres or °C). Sometimes, there are different units available for the same type of measurement. For example, ounces, pounds, kilograms and tonnes are all used as units for mass.

To reduce confusion, and to help with conversion between different units, there is a standard system of units called the SI units which are used for most scientific purposes.

These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China.

The seven SI base units are:

Physical quantity	Usual quantity symbol	Unit	Abbreviation
mass	m	**kilogram**	kg
length	l **or** x	**metre**	m
time	t	**second**	s
electric current	I	**ampere**	A
temperature	T	**kelvin**	K
amount of substance	N	**mole**	mol
luminous intensity	**(not used at A-level / BTEC)**	**candela**	cd

All other units can be derived from the SI base units.

For example, area is measured in square metres (written as m^2) and speed is measured in metres per second (written as ms^{-1}).

It is not always appropriate to use a full unit. For example, measuring the width of a hair or the distance from Manchester to London in metres would cause the numbers to be difficult to work with.

Prefixes are used to multiply each of the units. You will be familiar with centi (meaning 1/100), kilo (1000) and milli (1/1000) from centimetres, kilometres and millimetres.

There is a wide range of prefixes. The majority of quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, a distance of 33 000 m would be quoted as 33 km.

The most common prefixes you will encounter are:

Prefix	Symbol	Multiplication factor		
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	μ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

Activity 6

Which SI unit and prefix would you use for the following quantities?

The time between heart beats

The length of a leaf

The distance that a migratory bird travelled each year

The width of a cheek cell

The mass of a rabbit

The mass of iron in the body

The volume of the trunk of a large tree

The temperature of the blue flame from a Bunsen burner

The current in a simple circuit using a 1.5 V battery and bulb

The width of an atom

Sometimes, there are units that are used that are not combinations of SI units and prefixes.

These are often multiples of units that are helpful to use. For example, one litre is 0.001 m^3, or one day is 86 400 seconds.

Activity 7

Re-write the following in SI units.

1 minute

1 hour

1 tonne

Activity 8

Re-write the following quantities:

1502 metres in kilometres

0.000 45 grams in micrograms

0.000 45 metres in millimetres

1055 kilometres in metres

180 megaseconds in seconds

2500 centimetres in millimetres

Important vocabulary for practical work

You will have come across most of the words used in practical work in your GCSE studies. It is important that you use the right definition for each word.

Activity 9

Join the boxes to link the word to its definition.

Accurate	**A statement suggesting what may happen in the future.**
Data	**An experiment that gives the same results when a different person carries it out, or a different set of equipment or technique is used.**
Precise	**A measurement that is close to the true value.**
Prediction	**An experiment that gives the same results when the same experimenter uses the same method and equipment.**
Range	**Physical, chemical or biological quantities or characteristics.**
Repeatable	**A variable that is kept constant during an experiment.**
Reproducible	**A variable that is measured as the outcome of an experiment.**
Resolution	**This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.**
Uncertainty	**The interval within the true value can be expected to lie.**
Variable	**The spread of data, showing the maximum and minimum values of the data.**
Control variable	**Measurements where repeated measurements show very little spread.**
Dependent variable	**Information, in any form, that has been collected.**

Biology Tasks

All life on Earth exists as cells. These have basic features in common.

Activity 10

Complete the table.

Structure	Function
Cell-surface membrane	
Chloroplast	
Cell vacuole	
Mitochondria	
Nucleus	
Cell wall	
Chromosomes	
Ribosomes	

Draw the structure of a plant cell and an animal cell.

On each cell, add labels showing each of the structures in the table, if they exist.

Chemistry Tasks

Activity 11

On the periodic table on the following page:

- **Draw a line showing the metals and non-metals.**
- **Colour the transition metals blue.**
- **Colour the halogens yellow.**
- **Colour the alkali metals red.**
- **Colour the noble gases green.**
- **Draw a blue arrow showing the direction of periods.**
- **Draw a red arrow showing the direction of groups.**
- **Draw a blue ring around the symbols for all gases.**
- **Draw a red ring around the symbols for all liquids.**

Activity 12

Use the periodic table to find the following:

1. **The atomic number of: osmium, sodium, lead, chlorine.**
2. **The relative atomic mass of: helium, barium, europium, oxygen.**
3. **The number of protons in: mercury, iodine, calcium.**
4. **The symbol for: gold, lead, copper, iron.**
5. **The name of: Sr, Na, Ag, Hg.**
6. **THInK can be written using a combination of the symbols for Thorium, Indium and Potassium (ThInK). Which combinations of element symbols could be used to make the following words?**

AMERICA, FUN, PIRATE, LIFESPAN, FRACTION, EROSION, DYNAMO

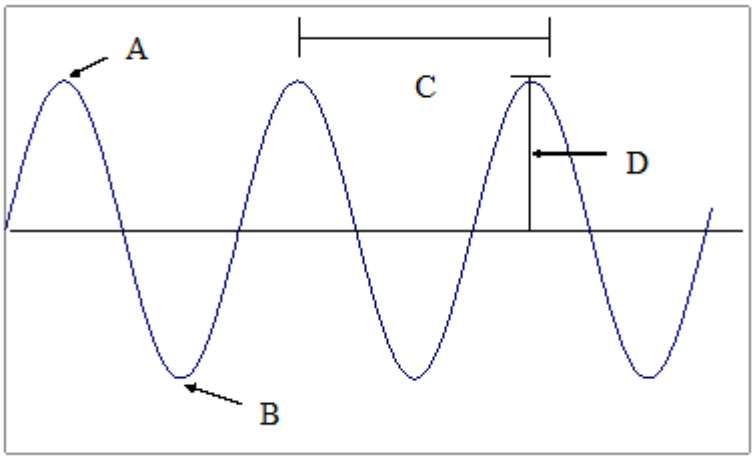
1	2												3	4	5	6	7	0
								1.0 H hydrogen 1										(18) 4.0 He helium 2
(1)	(2)		Key										(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass symbol name atomic (proton) number										10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)		27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	96.0 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La * lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac † actinium 89	[267] Rf rutherfordium 104	[268] Db dubnium 105	[271] Sg seaborgium 106	[272] Bh bohrium 107	[270] Hs hassium 108	[276] Mt meitnerium 109	[281] Ds darmstadtium 110	[280] Rg roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

* 58 – 71 Lanthanides	140.1 Ce cerium 58	140.9 Pr praseodymium 59	144.2 Nd neodymium 60	[145] Pm promethium 61	150.4 Sm samarium 62	152.0 Eu europium 63	157.3 Gd gadolinium 64	158.9 Tb terbium 65	162.5 Dy dysprosium 66	164.9 Ho holmium 67	167.3 Er erbium 68	168.9 Tm thulium 69	173.1 Yb ytterbium 70	175.0 Lu lutetium 71
† 90 – 103 Actinides	232.0 Th thorium 90	231.0 Pa protactinium 91	238.0 U uranium 92	[237] Np neptunium 93	[244] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[247] Bk berkelium 97	[251] Cf californium 98	[252] Es einsteinium 99	[257] Fm fermium 100	[258] Md mendelevium 101	[259] No nobelium 102	[262] Lr lawrencium 103

Physics Tasks

Activity 13

1. Label the following diagram:



$$v = f\lambda$$

v = velocity
f = frequency
λ = wavelength

2. Explain the difference between a transverse and a longitudinal wave and give examples of each. (4)

3. Water waves move a distance of 15 metres in 3 seconds. Calculate the wave speed. (2)

4. During a thunderstorm, a pupil notices that the sound of thunder came 15 seconds after they had seen the flash of lightning. The average speed of sound in air is 340 m/s. Calculate how far away from the storm the pupil is. (2)

5. A lighthouse sends out a flash of light and a burst of sound at the same time. The average speed of sound in air is 340 m/s. Calculate after how long the light is seen will an observer on the bridge of a ship 1.5 km away hear the sound. (2)

6. The wavelength of the radio waves transmitted by the Wyvis AM radio transmitter is 200 m. Calculate the frequency allocated to the Wyvis AM radio station in kHz. Assume the velocity of the wave is 3 x 10^8 m/s. (2)

7. The frequency of the radio waves transmitted by BBC Radio 1 is 99.2 MHz and the wavelength of the radio waves is 3 m. Calculate the speed at which the radio waves travel. (2)

8. Moray Firth Radio broadcasts on a frequency of 97.4 MHz. Calculate the wavelength of the radio waves transmitted. Assume that speed of the wave is 3 x 10^8 m/s. (2)

9. State, in order of increasing wavelength, the members of the electromagnetic spectrum. (7)