Year 11 Transition to 6th Form BTEC Applied Science Projects

BTEC Applied Science is a mixture of all three science areas of Biology, Chemistry and Physics. The course comprises a mixture of coursework, practical work and exams. This project will give you an idea of the sort of topics you will be covering in this course. Please complete all tasks in as much detail as you can.
The first two tasks are Biology research tasks. Task 3 is a Physics research task. All three of these are new topics you have not met at GCSE. Tasks 4-9 are Chemistry tasks which mostly can be done on these sheets. These are mostly short tasks and some of them are recapping or stretching GCSE knowledge which is essential for the BTEC course.

You may find the following websites helpful:

Dummies.com – Education – Science

Britannica.com

Youtube – HealthCare – Nerve Transmission

Youtube - Bozeman Science – The Action Potential

Parkinsonsnewstoday.com

Parkinsons.org.uk

Scienceofparkinsons.com

Bbc Bitesize – Physics, Chemistry

Task 1

Using annotated drawings, explain the conduction of a nerve impulse along an axon, including changes in membrane permeability to sodium and potassium ions.

Task 2

Describe how imbalances in dopamine can cause Parkinson's Disease and how is L-Dopa used for the treatment of Parkinson's Disease.

Task 3

What are diffraction gratings in Physics and how they can be used to identify different gasses?

Task 4

Relative atomic mass (A_r)

The relative atomic mass of an element is the average mass of its atoms compared to 1/12th the mass of one atom of carbon-12.

The Periodic Table of Elements

Key: relative atomic mass / **atomic symbol** / name / atomic (proton) number

1 (1)	2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (8) (18)
							1.0 **H** hydrogen 1										4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											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											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	95.9 **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	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

* Lanthanide series	140 **Ce** cerium 58	141 **Pr** praseodymium 59	144 **Nd** neodymium 60	[147] **Pm** promethium 61	150 **Sm** samarium 62	152 **Eu** europium 63	157 **Gd** gadolinium 64	159 **Tb** terbium 65	163 **Dy** dysprosium 66	165 **Ho** holmium 67	167 **Er** erbium 68	169 **Tm** thulium 69	173 **Yb** ytterbium 70	175 **Lu** lutetium 71
* Actinide series	232 **Th** thorium 90	[231] **Pa** protactinium 91	238 **U** uranium 92	[237] **Np** neptunium 93	[242] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[245] **Bk** berkelium 97	[251] **Cf** californium 98	[254] **Es** einsteinium 99	[253] **Fm** fermium 100	[256] **Md** mendelevium 101	[254] **No** nobelium 102	[257] **Lr** lawrencium 103

Use the periodic table to give the A_r of the following elements.

Element	Relative atomic mass / g mol^{-1}
Sodium	
Magnesium	
Chlorine	
Argon	
Calcium	
Titanium	
Zinc	
Arsenic	
Tungsten	
Mercury	
Lead	

Task 5

Relative molecular mass (M_r)

The relative molecular mass is the average mass of one molecule of an element, or a compound compared to 1/12th the mass of one atom of carbon-12.

It is the sum of the relative atomic masses of the elements in a molecule.

Use the periodic table to calculate the M_r of the following molecules.

Molecule	Calculation	Relative molecular mass / g mol^{-1}
O_2		
NaOH		
HCl		
H_2O		
$MgCl_2$		
Na_2CO_3		
Fe_2O_3		
$C_{10}H_{22}$		
$CuSO_4$		
$Mg(OH)_2$		
$Fe(OH)_3$		
$Fe(NO_3)_3$		
$(NH_4)_2SO_4$		

Task 5

Mass / M_r / moles

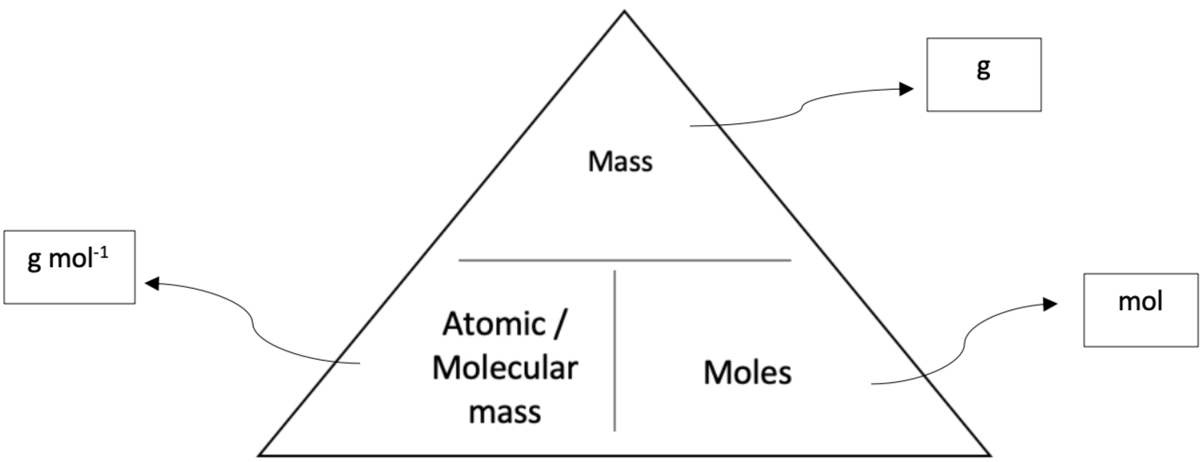
Moles is the amount of a substance. One mole of a substance contains 6.022 $\times10^{23}$ (Avogadro's constant) atoms or molecules. It is too big a number to use so instead we use moles.

23 g of sodium-23 contains 6.022 $\times10^{23}$ atoms.

24.3 g of magnesium-24.3 contains 6.022 $\times10^{23}$ atoms.

Use this equation and rearrange to answer the questions. Make sure you give the units

$$\text{Mass} = \text{M}_\text{r} \times \text{ moles}$$



Convert the following masses into mg, g or kg:

Mass		
mg	g	Kg
	1000	
	750	

2000	2	0.002
250000		
		0.4
		0.003

Calculating moles

1. Calculate the number of moles of 2 g of sodium hydroxide ($NaOH$)

2. Calculate the number of moles of 50 g of decane ($C_{10}H_{22}$)

3. Calculate the number of moles of 20 mg of sodium carbonate (Na_2CO_3)

4. Calculate the number of moles of 43 mg of oxygen (O_2)

5. Calculate the number of moles of 0.05 Kg of copper sulphate ($CuSO_4$)

6. Calculate the number of moles of 0.025 Kg of iron (II) oxide (Fe_2O_3)

Calculating mass

1. Calculate the mass of 0.5 moles of sodium carbonate (Na_2CO_3). Give your answer in g.

2. Calculate the mass of 0.25 moles of decane ($C_{10}H_{22}$). Give your answer in g.

3. Calculate the mass of 0.1 moles of magnesium chloride ($MgCl_2$). Give your answer in mg.

4. Calculate the mass of 0.125 moles of copper sulphate ($CuSO_4$). Give your answer in mg.

5. Calculate the mass of 1.25 moles of oxygen (O_2). Give your answer in kg.

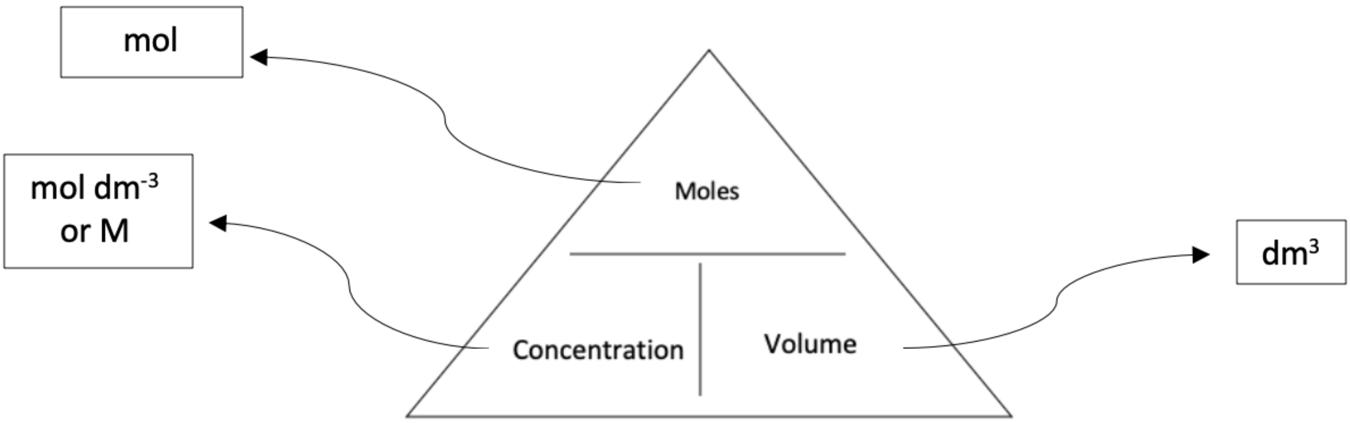
6. Calculate the mass of 0.75 moles of sodium hydroxide (NaOH). Give your answer in kg.

Task 6

Moles/ Concentration/ Volume

Use this equation and rearrange to answer the questions.

$$\text{Moles} = \text{Concentration} \times \text{Volume}$$



Convert the following volumes into cm^3 or dm^3

Volume	
cm^3	dm^3
75	
400	
660	
1230	

	0.005
	0.15
	0.7
	1.567

Calculating moles

1. A sodium hydroxide solution has a volume of 0.25 dm^3 and a concentration of 2 mol dm^{-3}. Calculate the moles of sodium hydroxide.

2. A sodium hydroxide solution has a volume of 500 cm^3 and a concentration of 0.5 mol dm^{-3}. Calculate the moles of sodium hydroxide.

3. A hydrochloric acid solution has a volume of 300 cm^3 and a concentration of 1 mol dm^{-3}. Calculate the moles of hydrochloric acid.

4. A sodium carbonate solution has a volume of 450 cm^3 and a concentration of 0.125 mol dm^3. Calculate the moles of sodium carbonate.

5. A nitric acid solution has a volume of 100 cm^3 and a concentration of 0.75 mol dm^3. Calculate the moles of nitric acid.

Calculating concentration

1. A solution of hydrochloric acid contains 0.2 moles in 2 dm^3. Calculate the concentration of the solution in mol dm^{-3}.

2. A solution of hydrochloric acid contains 0.5 moles in 500 cm^3. Calculate the concentration of the solution in mol dm^{-3}.

3. A solution of sodium hydroxide contains 1 mole in 250 cm^3. Calculate the concentration of the solution in mol dm^{-3}.

4. A solution of nitric acid contains 0.6 moles in 1200 cm^3. Calculate the concentration of the solution in mol dm^{-3}.

5. A solution of sulfuric acid contains 0.125 moles in 200 cm^3. Calculate the concentration of the solution in mol dm^{-3}.

Calculating volume

1. A solution of sulfuric acid has a concentration of 2 mol dm^{-3}. Calculate the volume of solution needed so that it contains 0.05 mol. Give your answer in $dm^{3.}$

2. A solution of hydrochloric acid has a concentration of 0.5 mol dm^{-3}. Calculate the volume of solution needed so that it contains 0.25 mol. Give your answer in $cm^{3.}$

3. A solution of nitric acid has a concentration of 1 mol dm^{-3}. Calculate the volume of solution needed so that it contains 0.25 mol. Give your answer in $cm^{3.}$

4. A solution of sodium hydroxide has a concentration of 2 mol dm^{-3}. Calculate the volume of solution needed so that it contains 0.125 mol. Give your answer in $cm^{3.}$

5. A solution of hydrochloric acid has a concentration of 0.25 mol dm^{-3}. Calculate the volume of solution needed so that it contains 0.5 mol. Give your answer in $cm^{3.}$

Task 7

Using two equations simultaneously

1. A sodium hydroxide (NaOH) solution has a volume of 0.1 dm^3 and a concentration of 0.5 mol dm^{-3}. Calculate the mass of sodium hydroxide needed in g.

2. A sodium hydroxide (NaOH) solution has a volume of 400 cm^3 and a concentration of 0.25 mol dm^{-3}. Calculate the mass of sodium hydroxide needed in g.

3. 2 g of sodium chloride (NaCl) is dissolved in 0.25 dm^3 of water. Calculate the concentration of the solution in mol dm^{-3}.

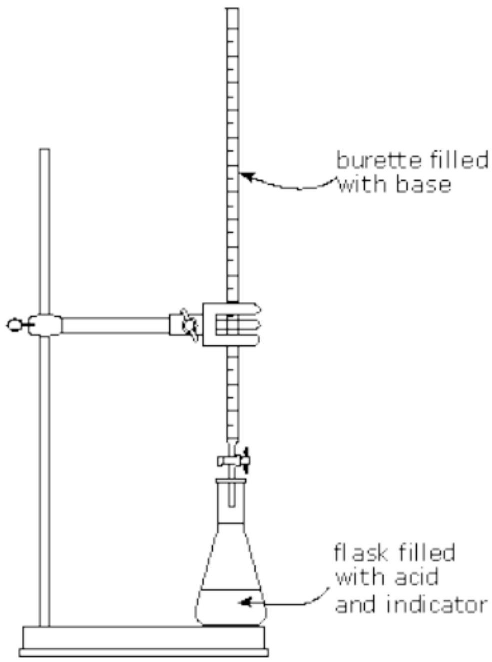
4. 10.6 g of sodium carbonate (Na_2CO_3) is dissolved in 0.1 dm^3 of water. Calculate the concentration of the solution in mol dm^{-3}.

5. A solution of copper sulphate ($CuSO_4$) has a concentration of 0.5 mol dm^{-3}. 12 g of copper sulphate was needed to make it. Calculate the volume of water needed in dm^3.

6. A solution of sodium carbonate (Na_2CO_3) has a concentration of 2 mol dm^{-3}. 5 g of sodium carbonate was needed to make it. Calculate the volume of water needed in cm^3.

Task 8

Acid-alkali titrations



Titration is a required practical that students have to do as part of the BTEC course. The experiment and the write-up make up Task A of Unit 2 in Year 12. Your task is to research titrations using the questions below to help.

Research questions

1. What is titration?

2. What are titrations used for?

3. What equipment do you need?

4. How would you calibrate a balance, burette and pipette?

5. What mass of sodium carbonate (Na_2CO_3) would be needed to make a solution with a concentration is 0.2 mol dm^3 in 250 cm^3?

6. How would you prepare the sodium carbonate standard solution?

7. What is the method for the titration of 0.2 mol dm^{-3} sodium carbonate and an unknown concentration of hydrochloric acid?

8. How would you calculate the concentration of HCl?

9. How do you know when the experiment has reached endpoint?

Task 9

Titration calculations

$$\text{Moles} = \text{Concentration} \times \text{Volume}$$

$$\text{Concentration} = \frac{\text{Moles}}{\text{Volume}}$$

1. 25 cm^3 of 0.1 M NaOH is needed to titrate 12.5 cm^3 of a solution of hydrochloric acid. Calculate the concentration of the acid.

   $NaOH\ (aq) + HCl\ (aq) \longrightarrow NaCl\ (aq) + H_2O\ (l)$

2. 23.15 cm^3 of 0.125 M NaOH is needed to titrate 25 cm^3 of a solution of hydrochloric acid. Calculate the concentration of the acid.

   $NaOH\ (aq) + HCl\ (aq) \longrightarrow NaCl\ (aq) + H_2O\ (l)$

3. 25 cm^3 of 0.2 M NaOH is needed to titrate 25 cm^3 of a solution of sulphuric acid (H_2SO_4). Calculate the concentration of the acid.

$$2NaOH\ (aq) + H_2SO_4\ (aq) \longrightarrow Na_2SO_4\ (aq) + 2H_2O\ (l)$$

4. 10 cm^3 of a solution of hydrochloric acid (HCl) was titrated with a 0.5 M solution of sodium carbonate. 30 cm^3 of the carbonate was required for neutralisation. Calculate the concentration of hydrochloric acid.

$$Na_2CO_3\ (aq) + 2HCl\ (aq) \longrightarrow 2NaCl\ (aq) + H_2O\ (l) + CO_2\ (g)$$