Question 1	B
Question 2	C
Question 3	C
Question 4	D
Question 5	A
Question 6	C
Question 7	D
Question 8	B
Question 9	A
Question 10	B

Part B ***Constructed-Response Questions***

Questions 11 to 20

Significant figures will be evaluated in questions 12, 14 and 16.

NOTE: • **The following examples of appropriate responses are guidelines and are not exhaustive. Teachers should use their professional judgement when correcting this exam. The Marking Scale below is provided as a recommended grading scale. This weighting is provided as a suggestion.**

Question 11

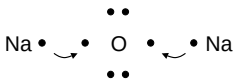
Examples of appropriate responses

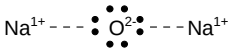
a)

Schematic Diagram

Note:
If students provide a Lewis Diagram (as seen below), you should give them full marks. Technically LD of atoms (not compounds) is part of the ST program so they may want to use them to provide the answer for this question.

Transfer of Electrons *Ions Produced and Bonds Formed*





Bohr-Rutherford diagrams should not be accepted since they are not meant to demonstrate bond formation.

Marking Scale[1]	
2 marks	Appropriate representation
1 mark	Partially appropriate representation with a major error (e.g. an incorrect number of electrons is transferred).
0 marks	Inappropriate representation and incorrect response.

b) The type of bond formed in Na_2O is **ionic.** I know this because **an ionic bond is formed when electrons are transferred (and not shared) between atoms**.

Marking Scale	
2 marks	Appropriate response.
1 mark	Partially appropriate response
0 marks	Inappropriate response.

[1] All Marking Scales adapted from *MELS, 555-410, Science and Technology, Marking Guide, June 2012*.

Question 12

Example of an appropriate procedure

Step 1 Determine the number of moles of $BaCl_2$ from the grams of $BaCl_2$.

$$\frac{7.8 \text{ g of } BaCl_2}{208.23 \text{ g/mol of } BaCl_2} = 0.0375 \text{ moles of } BaCl_2$$

Step 2 Determine the number of moles of HCl needed.

$$\frac{(0.0375 \text{ moles of } BaCl_2)(2 \text{ moles of HCl})}{1 \text{ mole of } BaCl_2} = 0.075 \text{ moles of HCl}$$

Step 3 Determine the concentration of HCl.

$$\frac{0.075 \text{ moles of HCl}}{0.1000 \text{ mL of solution}} = 0.75 \text{ M}$$

The molar concentration of HCl used in this reaction was **0.75 M or mol/L (7.5×10^{-1} mol/L)**.

Marking Scale	
4 marks	Appropriate procedure with a correct answer.
3 marks	Appropriate procedure with a minor error, such as an error in calculation or transcription, or an incorrect or missing unit of measure or incorrect significant figures (e.g. does not convert mL to L).
2 marks	Partially appropriate procedure with a major error, such as an incorrect application of a law, formula or rule (e.g. correctly calculates moles of HCl OR incorrect application of mole ratio).
1 mark	Partially appropriate procedure (e.g. calculates one variable).
0 marks	Inappropriate procedure, or did not show any work regardless of the answer.

Question 13

Examples of appropriate responses

a)

Isotopes of Molybdenum	Protons	Neutrons
$^{96}_{42}Mo$	42 protons	54 neutrons
$^{99}_{42}Mo$	42 protons	57 neutrons

Marking Scale	
2 marks	4 elements correct.
1 mark	2 or 3 elements correct.
0 marks	1 or no elements correct.

b) The type of nuclear transformation represented by the production of Mo-99 is **nuclear fission**.

Explanation:

Nuclear fission occurs when a nucleus of an atom breaks apart. This happens when a neutron hits an uranium nucleus, releasing smaller nuclei such as Mo-99, other nuclei and neutrons.

Marking Scale	
2 marks	Correct answer and appropriate explanation.
1 mark	Correct answer and partially appropriate explanation.
0 marks	Incorrect answer and explanation or no work shown.

Question 14

Example of an appropriate procedure

Step 1 Voltage is the same in a parallel circuit.

$V_T = V_1 = V_2 = V_3 = 9.00$ V

Step 2 Find R_2 (4.50 mA = 0.0045 A)

$$R_2 = \frac{V_2}{I_2} \qquad R_2 = \frac{9.00 \text{ V}}{0.0045 \text{ A}} = 2000\ \Omega$$

Step 3 Find R_{eq}

$$\begin{aligned} R_{eq} &= \left(R_1^{-1} + R_2^{-1} + R_3^{-1}\right)^{-1} \\ &= \left(\left[15.0\ \text{k}\Omega\right]^{-1} + \left[2.00\ \text{k}\Omega\right]^{-1} + \left[1.00\ \text{k}\Omega\right]^{-1}\right)^{-1} \\ &= \left(\left[15\,000\ \Omega\right]^{-1} + \left[2000\ \Omega\right]^{-1} + \left[1000\ \Omega\right]^{-1}\right)^{-1} \\ &= \left(0.000067\ \Omega + 0.0005\ \Omega\ + 0.001\,\Omega\right)^{-1} \\ &= \left(0.00157\ \Omega\right)^{-1} \\ R_{eq} &= 638\ \Omega \end{aligned}$$

The equivalent resistance of the circuit is **638 Ω**.

Marking Scale	
4 marks	Appropriate procedure and correct answer.
3 marks	Appropriate procedure with a minor error, such as a calculation or transcription error, an incorrect or missing unit of measure OR an error in conversion or incorrect significant figures.
2 marks	Partially appropriate procedure with a major error, such as an incorrect application of a law, formula or rule (e.g. using R_{eq} for a series circuit).
1 mark	Partially appropriate procedure, regardless of the answer.
0 marks	Inappropriate procedure, or did not show any work regardless of the answer.

Question 15

Example of an appropriate procedure

$$F_e = \frac{kq_1q_2}{r^2}$$

$$r = \sqrt{\frac{kq_1q_2}{F_e}}$$

$$= \sqrt{\frac{\left(9 \times 10^9 \ \frac{\text{Nm}^2}{\text{C}^2}\right)\left(6.0 \times 10^{-5}\text{C}\right)\left(2.0 \times 10^{-4}\text{C}\right)}{\left(4.6 \times 10^3\text{N}\right)}}$$

$$= 0.153 \text{ m}$$

The distance between the charged particles is **0.153 m**.

Note: *Significant figures are **not** evaluated in this question.*

Marking Scale	
4 marks	Appropriate procedure and correct answer.
3 marks	Appropriate procedure with a minor error, such as a calculation or transcription error, an incorrect or missing unit of measure.
2 marks	Partially appropriate procedure with a major error, such as an incorrect application of a law, formula or rule (e.g. does not take the square root of the radius).
1 mark	Partially appropriate procedure.
0 marks	Inappropriate procedure, or did not show any work regardless of the answer.

Question 16

Example of an appropriate procedure

Step 1 $E_m = \frac{1}{2} mv^2 + mgh$

$= \frac{1}{2}$ (45 kg) (4.0 m/s)^2 + (45 kg) (9.8 N/kg) (0.56 m)

= 360 J + 247 J

= 607 J

Step 2 At max height, velocity = 0 therefore $E_m = mgh$

$$607 \text{ J} = mgh$$

$$607 \text{ J} = (45 \text{ kg})(9.8 \text{ N/kg})$$

$$h = \frac{607 \text{ J}}{(45 \text{ kg})(9.8 \text{ N/kg})}$$

$$h = 1.4 \text{ m}$$

The maximum height above the initial position that Joseph will reach is **1.4 m**.

Marking Scale	
4 marks	Appropriate procedure and correct answer.
3 marks	Appropriate procedure with a minor error, such as a calculation or transcription error, an incorrect or missing unit of measure or incorrect significant figures.
2 marks	Partially appropriate procedure with a major error, such as an incorrect application of a law, formula or rule (e.g. calculates mechanical energy only).
1 mark	Partially appropriate procedure (e.g. only calculates E_k or E_p).
0 marks	Inappropriate procedure, or did not show any work regardless of the answer.

Question 17

Example of an appropriate procedure and response

Punnett Square

G → golden allele for kernel colour, g → blue allele for kernel colour

Parent Genotypes	G	g
g	Gg	gg
g	Gg	gg

Answer

Parent	Genotype	Phenotype
Parent 1	Gg	Golden
Parent 2	gg	Blue

Marking Scale	
4 marks	Appropriate procedure and correct answer. The genotypes and phenotypes are correct and the supporting work is shown.
3 marks	Appropriate procedure with a minor error (e.g. transcription error).
2 marks	Partially appropriate procedure with a major error (e.g. correct application of Punnett Square BUT does not lead to a correct answer).
1 mark	Partially appropriate procedure.
0 marks	Inappropriate procedure, or did not show any work regardless of the answer.

Question 18

Examples of appropriate responses

Aspects and explanations
Aspects which help reduce their ecological footprint:

- Having their own garden and producing their own vegetables means they are using part of their property for the purpose of growing food rather than just owning land. This reduces the amount of "wasted space".
- Buying local produce at the market reduces their EF because fewer resources and less energy are required to transport the food to the market and home.
- Buying organic vegetables reduces their EF because no pesticides are used which require manufacturing, transport, etc. causing more space to be used by people not consuming organic foods.
- Samuel takes short, quick showers to reduce the amount of water used and therefore reduces his EF.
- Recycling and composting reduces the amount of space required to dispose of wastes. Therefore their EF is decreased.

Marking Scale	
2 marks	Appropriate response. States and fully explains an aspect that reduces the EF.
1 mark	Partially appropriate response. States aspect and provides an incomplete explanation.
0 marks	No appropriate explanations.

Aspects and explanations
Aspects they can change to reduce their ecological footprint:

- Live in a smaller house with a smaller back yard. The less living space they use, the smaller their EF.
- Get rid of their swimming pool and use a public pool. A private pool requires lots of water. By reducing the amount of water they consume, they are reducing their EF.
- Germain could use a bicycle or public transportation instead of his van to get groceries, especially when he goes to the corner market. Using fuel for a large van when he is driving by himself is wasteful. Fuel is a type of energy which takes a lot of space and resources to produce. It contributes to a high EF.
- Use the dishwasher less often since it uses a lot of water. Dishes washed by hand in a sink full of water require less water and therefore reduces the EF of the household.
- Reduce the number of meals they order out or eat at a restaurant. Ordering out involves a lot of packaging. Restaurants also require a lot of space and resources. Having to drive to a restaurant or having food delivered uses fuel and resources which contribute to the family's EF.

Marking Scale	
2 marks	Appropriate response. States and fully explains a change that reduces the EF.
1 mark	Partially appropriate response. States change and provides an incomplete explanation.
0 marks	No appropriate explanations

Note: *Explanation must refer directly to the definition of ecological footprint, such as the use of land and water (e.g. "Not driving a van causes less pollution" is not an acceptable explanation). Accept any other appropriate response.*

Question 19

Examples of appropriate responses

a) Farm **#1** does NOT contribute to the process of eutrophication.

Explanation: The fertilizer KCl does not contain phosphorous, which is found in the fertilizer used by farm #2. Phosphorous used on the farmland will leach into the nearby lake.

Marking Scale	
2 marks	Appropriate responses. Identifies farm number correctly, and explanation is correct.
1 mark	Partially appropriate response. Identifies farm number correctly BUT explanation is incomplete (e.g. identifies that the fertilizer is the cause but does not explicitly refer to phosphorous).
0 marks	Inappropriate response.

b) The side of the lake that will become shallower more quickly after several years of fertilizer usage will be next to farm **#2**.

Explanation: The phosphorous found in the fertilizer used on this farm will leach into the lake and contribute to eutrophication. This process will encourage algae to bloom excessively. The overpopulated algae will die and sink to the bottom of the lake. Sediment will build up over time and cause the lake to become shallower.

Marking Scale	
2 marks	Appropriate responses. Identifies farm number correctly, and explanation is appropriate.
1 mark	Partially appropriate response. Identifies farm number correctly, but explanation is incomplete (e.g. mentions some consequences of eutrophication but fails to mention sedimentation).
0 marks	Inappropriate response.

Question 20

Examples of appropriate responses

Action	Explanation
Increase the mass of the car or push down on it while it is in motion.	Increasing the perpendicular force will increase the amount of friction between the wheels and the floor.
Put rubber tires on the wooden wheels or change the wooden wheels to rubber wheels (or a similar material).	Changing the nature of the material from wood to rubber will increase the friction between the two surfaces and prevent sliding on the hardwood floor.
Use a different surface on which to pull the cart, for example cement or carpet.	A varnished hardwood floor is very slippery therefore changing the nature of the material on which the cart is rolling to something less slippery will increase friction.
Create a rougher wheel surface by etching lines into the wooden wheel.	Etching lines into the wooden wheels will make them rougher, so changing the state of the surfaces in contact in such a manner will increase friction.
Add oil (or another lubricant) between the axle rod and its guiding component.	Adding a lubricant between the axle rod and its guiding component will decrease the friction between the two parts allowing for easier rotation of the wheels and axle.

Note: *Accept any other appropriate response.*

Action #1 with explanation

Marking Scale	
2 marks	Complete and appropriate explanation.
1 mark	Partially appropriate explanation.
0 marks	Inappropriate explanation, or action without explanation.

Action #2 with explanation

Marking Scale	
2 marks	Complete and appropriate explanation.
1 mark	Partially appropriate explanation.
0 marks	Inappropriate explanation, or action without explanation.

Appendix