Government of **Western Australia**
**School Curriculum and Standards Authority**

# INTEGRATED SCIENCE

## ATAR course examination 2020

## Marking key

Marking keys are an explicit statement about what the examining panel expect of candidates when they respond to particular examination items. They help ensure a consistent interpretation of the criteria that guide the awarding of marks.

2020/67025

**Section One: Multiple-choice** **20% (20 Marks)**

| Question | Answer |
|---|---|
| 1 | b |
| 2 | a |
| 3 | b |
| 4 | c |
| 5 | c |
| 6 | d |
| 7 | b |
| 8 | a |
| 9 | d |
| 10 | a |
| 11 | a |
| 12 | b |
| 13 | d |
| 14 | d |
| 15 | c |
| 16 | b |
| 17 | a |
| 18 | b |
| 19 | d |
| 20 | a |

**Section Two: Short response** **50% (92 Marks)**

**Question 21** **(20 marks)**

(a) Describe how photovoltaic cells generate electrical current. (4 marks)

| Description | Marks |
|---|---|
| Photons/light hits the solar panel | 1 |
| Causes free electrons | 1 |
| The electrons flow from the n to the p layer | 1 |
| Electrons flow into circuit as electricity | 1 |
| **Total** | **4** |

(b) Complete the two missing stages involved in producing electrical current from coal. (2 marks)

| Description | Marks |
|---|---|
| Heat water to convert to steam | 1 |
| Steam drives the turbine | 1 |
| **Total** | **2** |

(c) Complete the flow diagram below to show the different energy transformations that occur in a hydro-electric power station. (3 marks)

| Description | Marks |
|---|---|
| Gravitational potential energy | 1 |
| Kinetic energy | 1 |
| Electrical energy | 1 |
| **Total** | **3** |

(d) Compare the processes of electrical generation that occur in a coal-fired power station and in a pressurised water reactor nuclear power station. (5 marks)

| Description | Marks |
|---|---|
| Both produce heat | 1 |
| Coal-fired uses combustion, while nuclear power station uses nuclear energy/nuclear fission | 1 |
| Nuclear uses two stages for heat transfer to steam, while coal-fired uses one stage for heat transfer to steam | 1 |
| Both use heat to produce steam and drive a turbine | 1 |
| Both use water | 1 |
| **Total** | **5** |

**Question 21** (continued)

(e) Define 'base load supply'. (2 marks)

| Description | Marks |
|---|---|
| Minimum amount of electricity required | 1 |
| to be supplied at any time | 1 |
| **Total** | **2** |

(f) State how coal-fired and nuclear power stations are different in terms of their efficiency and cost, providing reasons. (4 marks)

| Description | Marks |
|---|---|
| Efficiency | |
| Coal-fired is less efficient<br>due to high heat loss<br>**or**<br>Nuclear is more efficient<br>as less fuel is required for equal energy | 1–2 |
| Cost | |
| Coal-fired is cheaper to run<br>as coal is cheap<br>**or**<br>Nuclear is more expensive<br>due to building costs | 1–2 |
| **Total** | **4** |

**Question 22** **(21 marks)**

(a) Calculate the percentage of light energy stored by the seagrasses annually. Show your workings. (3 marks)

| Description | Marks |
|---|---|
| Converting 1150 MJ in to kJ | 1 |
| Working shown 22500/1150000 x 100 | 1 |
| Answer = 1.96% | 1 |
| **Total** | **3** |

(b) Draw a food chain for the energy pyramid shown in Figure 1. (1 mark)

| Description | Marks |
|---|---|
| seagrasses → shrimp → sea anemone → squid | 1 |
| **Total** | **1** |

(c) If the energy store of the seagrasses in Figure 1 is 96 000 kJ $m^{-2}$ annually, determine the approximate amount of energy transferred annually to the sea anemone. Justify your answer. (2 marks)

| Description | Marks |
|---|---|
| 960 kJ $m^{-2}$ | 1 |
| Only 10% of energy is transferred from one trophic level to the next trophic level<br>**or**<br>90% of energy is lost at each trophic level | 1 |
| **Total** | **2** |

(d) Outline **four** reasons why the squid would transfer much less energy than the seagrasses in Figure 1. (4 marks)

| Description | Marks |
|---|---|
| Any **four** reasons: | |
| • all of the organisms that are preyed upon are not consumed<br>• energy is lost during respiration<br>• energy is lost as heat<br>• energy is lost as movement<br>• energy is lost as waste material/faeces. | 1–4 |
| **Total** | **4** |
| Accept other relevant answers. | |

(e) Name the trophic level that is **not** represented in the food web above and outline its role in the ecosystem. (2 marks)

| Description | Marks |
|---|---|
| Decomposers | 1 |
| to break down plant and animal remains (to inorganic nutrients) | 1 |
| **Total** | **2** |

**Question 22** (continued)

(f) Describe **two** impacts this would have on the food web in Figure 2, giving reasons for your answers. (4 marks)

| Description | Marks |
|---|---|
| Any **two** impacts: | |
| Worm population increases<br>because there are less crabs to prey upon the worm population | 1–2 |
| Black bream population decreases<br>because they would have less available food or there are no alternative food sources | 1–2 |
| Whitebait population decreases<br>because they are an alternative food source for snapper | 1–2 |
| **Total** | **4** |
| Accept other relevant answers. | |

(g) Describe how seagrass beds affect the amount of dissolved oxygen and nutrients in the Shark Bay ecosystem. (4 marks)

| Description | Marks |
|---|---|
| Dissolved oxygen | |
| Seagrasses produce oxygen through photosynthesis | 1 |
| Maintain high levels of dissolved oxygen | 1 |
| Nutrients | |
| Seagrasses use excess nutrients/nitrates to grow | 1 |
| Keep nutrient levels low | 1 |
| **Total** | **4** |

(h) State **one** human activity in the Shark Bay area that could result in increased nutrients in the aquatic ecosystem. (1 mark)

| Description | Marks |
|---|---|
| Any **one** human activity: | |
| • fertilising land<br>• farming<br>• release of wastewater<br>• destruction of seagrass beds. | 1 |
| **Total** | **1** |
| Accept other relevant answers. | |

**Question 23** **(13 marks)**

(a) Describe kinetic and potential energy and provide a form of energy for each. (4 marks)

| Description | Marks |
|---|---|
| Kinetic energy | |
| the energy a moving object has | 1 |
| Form: Any one – mechanical, heat, electrical or sound | 1 |
| Potential energy | |
| stored energy | 1 |
| Form: Any one – chemical, gravitational, elastic or nuclear | 1 |
| **Total** | **4** |
| Accept other relevant answers. | |

(b) State the Law of Conservation of Energy. (2 marks)

| Description | Marks |
|---|---|
| Energy can neither be created nor destroyed | 1 |
| It can be transferred or transformed | 1 |
| **Total** | **2** |

(c) Use the Law of Conservation of Energy (assuming no friction) to determine the amount of energy at **A**, **B**, **C** and **D** on the diagram above. (4 marks)

| Description | Marks |
|---|---|
| **A**: 450 J | 1 |
| **B**: 50 J | 1 |
| **C**: 500 J | 1 |
| **D**: 0 J | 1 |
| **Total** | **4** |

(d) Determine whether each of the situations below demonstrates work being done. **Circle** the correct answer for each situation. (3 marks)

| Description | Marks |
|---|---|
| No | 1 |
| Yes | 1 |
| Yes | 1 |
| **Total** | **3** |

**Question 24** **(15 marks)**

(a) Identify the **three** methods of heat transfer from the heater and describe how each method assists in increasing the air temperature in a room. (6 marks)

| Description | Marks |
|---|---|
| Conduction<br>• heat transfers through contact between particles (from metal to air particles) | 1<br>1 |
| Convection<br>• the hot air around the heater heats up and rises/displaced by cooler air, as it cools it falls, creating a convection current | 1<br>1 |
| Radiation<br>• heat is emitted from the burners/heats outer surface and increases temperature of the air surrounding/energy travels as waves in all directions from the source | 1<br>1 |
| **Total** | **6** |

(b) Identify passive solar design features that would keep a building warm during winter. Include **two** that would prevent heat loss and **two** that would increase heat gain. (4 marks)

| Description | Marks |
|---|---|
| Features preventing heat loss | |
| Any **two** of:<br>• double glazed windows<br>• double brick<br>• insulation in roof/walls. | 1–2 |
| Features increasing heat gain | |
| Any **two** of:<br>• eaves to allow the lower winter sun to enter the building<br>• windows facing north to allow winter sunlight to enter (orientation)<br>• use building materials with large thermal mass for absorbing and storing energy. | 1–2 |
| **Total** | **4** |
| Accept other relevant answers. | |

(c) Explain what is meant by the enhanced greenhouse effect. (3 marks)

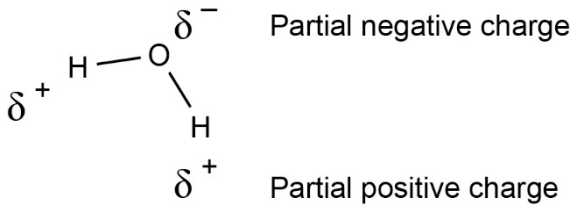
| Description | Marks |
|---|---|
| Increased levels of greenhouse gases | 1 |
| Causing additional heat being retained in the atmosphere | 1 |
| Results in an increase in the average global temperature of the atmosphere | 1 |
| **Total** | **3** |

(d) Provide **two** advantages of burning wood instead of coal for the generation of electricity. (2 marks)

| Description | Marks |
|---|---|
| Any **two** advantages: | |
| • wood is renewable<br>• burning wood produces less pollutants<br>• wood can be sourced locally. | 1–2 |
| **Total** | **2** |
| Accept other relevant answers. | |

**Question 25** **(23 marks)**

(a) Draw a labelled diagram of a water molecule to illustrate its polarity. (3 marks)

| Description | Marks |
|---|---|
| Bent shape | 1 |
| Oxygen and hydrogen symbols | 1 |
| Partial positive and negative labels | 1 |
|  | |
| **Total** | **3** |

(b) Explain how the specific heat capacity of water provides a desirable environment for aquatic organisms. (2 marks)

| Description | Marks |
|---|---|
| Water has a high specific heat capacity | 1 |
| Aquatic environments have a relatively stable temperature/are resistant to temperature change | 1 |
| **Total** | **2** |

(c) Use your knowledge of water polarity to explain why water striders can walk on water. (3 marks)

| Description | Marks |
|---|---|
| Surface tension | 1 |
| There is a strong attraction between water molecules (hydrogen bonding) | 1 |
| Water forms polar molecules/regions of positive and negative charges | 1 |
| **Total** | **3** |

(d) A light piece of wood floats in fresh water at 4 °C. Describe the change in buoyancy of the wood as the temperature of the water increases above 4 °C. (2 marks)

| Description | Marks |
|---|---|
| Buoyancy decreases | 1 |
| The light piece of wood will float lower in the water/sink further into water | 1 |
| **Total** | **2** |

(e) Explain why the density of fresh water decreases as the temperature drops below 4 °C. (3 marks)

| Description | Marks |
|---|---|
| Beginning to change state/forming crystalline lattice (solid structure) | 1 |
| Water molecules become spaced further apart | 1 |
| Spacing due to repulsion between like charges of water molecules | 1 |
| **Total** | **3** |

(f) What effect has this change had on dissolved oxygen and carbon dioxide gas levels in aquatic environments? (1 mark)

| Description | Marks |
|---|---|
| Lower dissolved gas levels | 1 |
| **Total** | **1** |

(g) Describe **three** characteristics of structures that enable efficient gas exchange. (6 marks)

| Description | Marks |
|---|---|
| Large surface area to volume ratio<br>provides a larger area for gas to diffuse across | 1–2 |
| Counter current exchange<br>ensures a high concentration gradient is maintained | 1–2 |
| Thin membrane<br>allows small gas molecules to diffuse more easily | 1–2 |
| **Total** | **6** |

(h) State **three** osmoregulation mechanisms these fish utilise to balance internal salt concentration. (3 marks)

| Description | Marks |
|---|---|
| Drinking large amounts of sea water | 1 |
| Excreting small amounts of concentrated urine | 1 |
| Active transport of salt from gills | 1 |
| **Total** | **3** |

**Section Three: Extended response** **30% (63 marks)**

**Question 26** **(34 marks)**

(a) Identify **two** main ways in which surface water is stored for drinking. (2 marks)

| Description | Marks |
|---|---|
| Any **two** of: | |
| • rainwater tanks<br>• dams<br>• reservoirs. | 1–2 |
| **Total** | **2** |

(b) Explain how water is collected in catchment areas. (3 marks)

| Description | Marks |
|---|---|
| It flows over land as surface run-off | 1 |
| Soaks into ground/infiltrates/percolates | 1 |
| Collects in valleys/dams | 1 |
| **Total** | **3** |

(c) Describe a management strategy that could be used to prevent the likelihood of water being affected by dry land salinity, turbidity and eutrophication. (6 marks)

| Description | Marks |
|---|---|
| Dry land salinity | |
| Ensure catchment area has sufficient long rooted trees to keep water table low<br>**or**<br>Prevent over-irrigation to keep water table low/prevent water table rising | 1–2 |
| Turbidity | |
| Ensure recreational activities in dams/water sources/rivers/lakes/streams do not cause disturbance to sediment<br>**or**<br>Ensure enough vegetation to stop soil being washed into dams/water sources/rivers/lakes/streams | 1–2 |
| Eutrophication | |
| Ensure enough vegetation to stop excess nutrients being washed into dams/water sources/rivers/lakes/streams<br>**or**<br>Ensure no agricultural activities will wash organic matter containing nutrients into dams/water sources/rivers/lakes/streams | 1–2 |
| **Total** | **6** |
| Note: Answers must include a strategy and impact. | |

(d) Explain **two** negative effects the increased use of groundwater would have on lakes and their ecosystems. (6 marks)

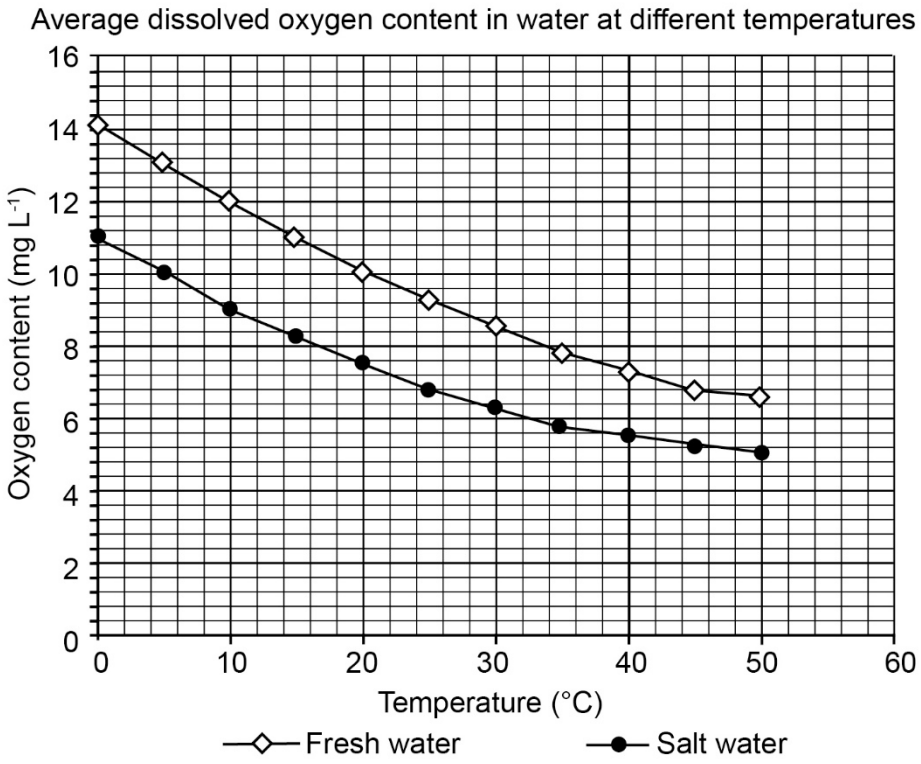
| Description | Marks |
|---|---|
| Any **two** negative effects: | |
| Water table drops<br>Causing lakes to dry out<br>aquatic organisms die | 1–3 |
| Water table drops<br>Vegetation around area dies out<br>increasing erosion | 1–3 |
| Less available water around wetlands<br>Decrease in diversity in ecosystem<br>change in ecosystem | 1–3 |
| **Total** | **6** |
| Accept other relevant answers. | |

(e) On the basis of the results in Table 1, describe the trend in salinity levels over the three years and propose a reason for this trend. (3 marks)

| Description | Marks |
|---|---|
| Salinity levels have increased over time | 1 |
| Any **one** reason described: | |
| Greater evaporation due to higher water temperatures<br>results in higher salt concentration<br>**or**<br>Increased water temperature increases solubility<br>resulting in more dissolved salt | 1–2 |
| **Total** | **3** |

**Question 26** (continued)

(f) Graph the data from Table 2 on the following grid. (6 marks)




| Description | Marks |
|---|---|
| Correct title – includes relationship of independent and dependent variable | 1 |
| Accurate plotting | 1 |
| Appropriate graph drawn – two lines | 1 |
| Correct labels on axes including units | 1 |
| Even scales on axes | 1 |
| Key to lines | 1 |
| **Total** | **6** |

(g) Identify **one** trend shown in the graph. (1 mark)

| Description | Marks |
|---|---|
| | |
| As temperature increases oxygen content decreases<br>**or**<br>As temperature decreases oxygen content increases | 1 |
| **Total** | **1** |

(h) Use your graph to predict the missing 2019 dissolved oxygen content for the freshwater lake in Table 1 on page 23. (1 mark)

| Description | Marks |
|---|---|
| 28 °C = 8.6–9.0 mg $L^{-1}$ | 1 |
| **Total** | **1** |

(i) Describe the stages in the process of eutrophication that lead to decreased dissolved oxygen levels. (6 marks)

| Description | Marks |
|---|---|
| Increased nutrient levels | 1 |
| Causes an algal bloom | 1 |
| Algae use up nutrients and die | 1 |
| Decomposer activity increases | 1 |
| Photosynthesis reduced due to turbidity | 1 |
| Decomposer respiration increases/consume more oxygen | 1 |
| **Total** | **6** |

**Question 27** **(29 marks)**

(a) Referring to the diagram and Table 3, write a possible procedure for this experiment. (6 marks)

| Description | Marks |
|---|---|
| Change fuel type | 1 |
| Measure and record starting temperature of water | 1 |
| Measure and record final temperature of water | 1 |
| Measure mass of water (20 g) | 1 |
| Burn 2 g of fuel | 1 |
| Other controlled variables – distance between wick/flame and test tube or any other relevant controlled variable | 1 |
| **Total** | **6** |

(b) Using the data from Table 3, calculate the heat energy in joules, absorbed by the water from the bioethanol. Show your working. (3 marks)

Use the formula $Q = mc\Delta T$, where the specific heat capacity of water is 4.180 J $g^{-1}$.

| Description | Marks |
|---|---|
| Temperature change = 38.6 – 20.2 = 18.4 | 1 |
| $Q$ = 20 x 18.4 x 4.180 | 1 |
| = 1538.24 J | 1 |
| **Total** | **3** |

(c) (i) Provide **one** reason why the experimental results are lower than the theoretical values. (1 mark)

| Description | Marks |
|---|---|
| Heat loss | 1 |
| **Total** | **1** |

(ii) Referring to the data in Table 4, state whether the differences between values could be a result of random or systematic errors. (1 mark)

| Description | Marks |
|---|---|
| Systematic errors | 1 |
| **Total** | **1** |

(iii) Why is bioethanol considered to be a biofuel? (1 mark)

| Description | Marks |
|---|---|
| Produced from organic matter/biomass/plant materials/animal waste | 1 |
| **Total** | **1** |

(d) State **two** disadvantages of using biofuels. (2 marks)

| Description | Marks |
|---|---|
| Any **two** disadvantages: | |
| • high cost of production<br>• use of fertilisers/other resources<br>• shortage of food<br>• use of water<br>• industrial pollution. | 1–2 |
| **Total** | **2** |

(e) State what is occurring during each of the four strokes of the engine cycle. (4 marks)

| Description | Marks |
|---|---|
| Intake: Air and fuel enter the cylinder/the piston moves down and intake valve opens | 1 |
| Compression: Piston moves up reducing the cylinder volume/pushes fuel and air close together | 1 |
| Combustion: Fuel and air is ignited (spark plug)/the explosion pushes piston down | 1 |
| Exhaust: Waste products (and extra reactants) are expelled as the piston moves up and exhaust valve opens | 1 |
| **Total** | **4** |

(f) Describe the differences between an electric vehicle motor and an internal combustion engine, referring to:
- efficiency
- environmental impact
- impact on resources. (6 marks)

| Description | Marks |
|---|---|
| Efficiency | |
| Electric vehicle (EV) is more efficient/less heat loss<br>**or**<br>Internal combustion engine (ICE) is less efficient/more heat loss | 1–2 |
| Environmental impact | |
| EV is more environmentally friendly/no exhaust waste<br>**or**<br>ICE is less environmentally friendly, high $CO_2$/there are pollutants produced in exhaust gases | 1–2 |
| Impact on resources | |
| EV can be run renewably/can use solar to charge/requires batteries that use minerals such as mining (lithium)<br>**or**<br>ICE is non-renewably run/less fossil fuel available over lifetime | 1–2 |
| **Total** | **6** |

**Question 27** (continued)

(g) Explain how a hydrogen fuel cell functions to produce electricity. In your answer, provide a general description of the processes that occur, referring to the diagram above.

(5 marks)

| Description | Marks |
|---|---|
| Hydrogen reacts and produces electrons<br>**or**<br>Oxidation occurs at the anode producing electrons | 1 |
| Electrons flow from the anode to the cathode | 1 |
| Produces an electrical current | 1 |
| Oxygen reacts at the cathode/reduced with hydrogen ions<br>**or**<br>Reduction occurs at the cathode using electrons | 1 |
| Forms water | 1 |
| **Total** | **5** |

*Published by the School Curriculum and Standards Authority of Western Australia*
*303 Sevenoaks Street*
*CANNINGTON WA 6107*