



INTEGRATED SCIENCE

ATAR course examination 2021

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.

Section One: Multiple-choice

20% (20 Marks)

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

Section Two: Short response

50% (113 Marks)

Question 21

(27 marks)

- (a) What effect would this decrease in rainfall have on the water cycle and water resources? (4 marks)

Description	Marks
Reducing surface run-off into lakes/dams/surface water	1–2
Reducing infiltration and/or percolation into ground water	1–2
Total	4
Accept other relevant answers.	

- (b) Identify **three** wastewater treatment processes used to remove organic matter and solids. (3 marks)

Description	Marks
Screening	1
Aeration	1
Sedimentation	1
Total	3

- (c) Identify **three** additional processes used to make wastewater potable so it can be used for aquifer recharge. (3 marks)

Description	Marks
Ultrafiltration	1
Reverse osmosis	1
Ultraviolet disinfectant	1
Total	3

- (d) (i) Describe **two** ways in which the water cycle processes act to purify water. (4 marks)

Description	Marks
Any two ways (2 marks each)	
Evaporation changes water from liquid to gas/leaves impurities behind as the gas forms	1–2
Transpiration water vapour forms/leaving impurities in the plant	1–2
Percolation acts like a filter/impurities are trapped in the rock/soil	1–2
Total	4
Accept other relevant answers.	

Question 21 (continued)

- (ii) Describe **two** ways in which the water cycle processes act to redistribute water. (4 marks)

Description	Marks
Precipitation/condensation As rain etc. falls to the ground it is moved to a new place	1–2
Surface run-off moves water through a catchment area/into water bodies	1–2
Total	4
Accept other relevant answers.	

- (e) (i) Explain why water in the solid form has the arrangement shown. (3 marks)

Description	Marks
Water molecules have polarity or a partial positive charge on the hydrogen atom and a partial negative charge on the oxygen atom	1
Repulsion and attraction occurs between neighbouring molecules	1
Results in crystalline lattice arrangement	1
Total	3

- (ii) What physical property results from this arrangement? (1 mark)

Description	Marks
Lower density than liquid water	1
Total	1

- (f) Most of the Earth’s ice is located at the poles, including sea ice, ice sheets and ice shelves. Explain how melting sea ice affects climate regulation. (5 marks)

Description	Marks
Any five of the following (1 mark each)	
Increased melting ice Decreased heat reflection Increased heat absorption by ocean/water Increased ocean temperatures Ocean temperatures affect the circulation of heat in the atmosphere Lead to changes in weather	1–5
Total	5

Question 22

(20 marks)

- (a) List
- three**
- possible sources of excess nutrients. (3 marks)

Description	Marks
Any three sources (1 mark each)	
Agricultural run-off/fertiliser run-off from crops Livestock run-off/washes waste from livestock Use of fertilisers in gardens Sewerage/discharge from wastewater treatment	1–3
Total	3

- (b) Identify
- two**
- abiotic changes and
- two**
- biotic changes that occur during eutrophication. (4 marks)

Description	Marks
Any two abiotic changes (1 mark each)	
Turbidity increases Rate of sedimentation increases A depletion in the level of oxygen Increase toxins Light penetration decreases	1–2
Subtotal	2
Any two biotic changes (1 mark each)	
Algae increase Plant species increase Algae release toxins River organisms die Increased decomposer activity	1–2
Subtotal	2
Total	4

- (c) For each of the following tests performed by the Department, name the equipment used to perform the test and describe the importance of the test in monitoring water quality. (9 marks)

Description	Marks
pH test: Equipment: pH meter, universal indicator	1
Importance: Acidity/alkalinity of the water can result in death of aquatic life/interfere with metabolic reactions/affect solubility of chemicals	1–2
Turbidity test: Equipment: Secchi disk or turbidity tube	1
Importance: Light cannot reach the plants and they die	1–2
Phosphate test: Equipment: Phosphate test strip, test meter	1
Importance: Phosphate is an essential plant nutrient Increased phosphate leads to eutrophication	1–2
Total	9

Question 22 (continued)

- (d) Macro-invertebrate sampling provides additional information on water quality. Identify **two** pieces of information that can be gained from macro-invertebrate sampling and outline what these indicate about water quality. (4 marks)

Description	Marks
The greater the number of different species/diversity indicates the healthier the waterway or Low sensitivity index macro-invertebrates present indicate a healthy waterway	1
Changes to the number of macro-invertebrates over time can indicate past conditions/changing conditions	1
Changes to the types of macro-invertebrates over time can indicate past conditions/changing conditions	1
Stage of development of macro-invertebrates can indicate how long they have been there	1
Total	4
Accept other relevant answers.	

Question 23

(19 marks)

- (a) Calculate the energy wasted by the halogen bulb. (1 mark)

Description	Marks
$750 - 400 = 350 \text{ J}$	1
Total	1

- (b) Name the form of wasted energy. (1 mark)

Description	Marks
Heat	1
Total	1

- (c) Where does the wasted energy produced by the halogen bulb go? (1 mark)

Description	Marks
The environment	1
Total	1

- (d) Calculate the energy efficiency of the halogen bulb. Show
- all**
- workings. (2 marks)

Description	Marks
$400/750 \times 100$	1
53.33%	1
Total	2

- (e) Calculate the time taken to run the study. Show
- all**
- workings. (3 marks)

Description	Marks
$t = E/P$	1
$t = 750/40$	1
$t = 18.75 \text{ s}$	1
Total	3

- (f) Using the information provided in the table, state which bulb would be best to use, outlining
- two**
- reasons for your choice. (3 marks)

Description	Marks
LED bulbs	1
Any two reasons (1 mark each)	
Uses less power Lasts longer CFL costs more in energy consumption	1-2
Total	3

Question 23 (continued)

- (g) Determine the energy saved in a classroom each day, if all the bulbs are replaced with LED bulbs. Show **all** workings. (4 marks)

Description	Marks
Calculates the number of seconds in 7 hours	1
Calculates energy used by both bulbs	1
Determines energy difference	1
Determines the energy saved	1
Total	4
<p>Sample working:</p> <p>Number of seconds in 7 hours $T = 7 \times 60 \times 60 = 25\,200\text{ s}$</p> <p>Energy used by 40 W = $40 \times 25\,200 = 1\,008\,000\text{ J}$ $40\text{ W} - 8\text{ W} = 32\text{ W}$ Energy used by 8 W = $8 \times 25\,200 = 201\,600\text{ J}$ or $32 \times 25\,200 = 806\,400\text{ J}$ Difference = $1\,008\,000\text{ J} - 201\,600\text{ J} = 806\,400\text{ J}$</p> <p>Ten bulbs $806\,400\text{ J} \times 10 = 8\,064\,000\text{ J}$ (8064 kJ)</p> <p>Note: Multiplying by 10 can occur in an earlier step of the calculation.</p>	

- (h) Suggest **two** passive solar design methods that could be used to reduce energy consumption in the existing buildings. Describe how each method achieves a reduced energy consumption. (4 marks)

Description	Marks
Method: roof insulation	1
Reduces heat transfer through roof	1
Method: double glazing	1
Reduces heat transfer through windows	1
Total	4
Accept other relevant answers.	

Question 24

(22 marks)

- (a) Identify the components labelled A and C. (2 marks)

Description	Marks
A: Magnet	1
C: Coil/wire loop	1
Total	2

- (b) What would component B be attached to in a power station? (1 mark)

Description	Marks
Turbine/fan/wheel/pulley	1
Total	1

- (c) Name the principle that is applied in a generator for the production of electricity. (1 mark)

Description	Marks
Electromagnetic induction	1
Total	1

- (d) Explain how an electric current is produced in the simple generator shown above. (4 marks)

Description	Marks
A conductor/metal wire/coil	1
Spins/moves through a magnetic field	1
A voltage difference is induced	1
A movement of electrons occurs/a current is created	1
Total	4

- (e) Label the diagram of the dry cell with the components listed above. (3 marks)

Description	Marks
Labels in order from top to bottom:	
Zinc anode	1
Graphite rod	1
Electrolyte paste	1
Total	3

- (f) What process occurs at the zinc anode within the dry cell? (1 mark)

Description	Marks
Oxidation/electrons are released	1
Total	1

Question 24 (continued)

- (g) What happens during the reactions in a dry cell to produce an electrical current? (2 marks)

Description	Marks
A potential difference is created	1
allows flow/transfer of electrons	1
Total	2

- (h) Give **two** benefits batteries provide over other forms of electricity generation. (2 marks)

Description	Marks
Any two benefits (1 mark each)	
Portable Rechargeable Come in different voltages Versatile Compact Different sizes	1–2
Total	2
Accept other relevant answers.	

- (i) Both devices shown below use a battery. Complete the diagram for each device by:
- showing the initial energy transformation that occurs
 - identifying one useful form of energy and one wasted form of energy that results from the energy transformation.
- (6 marks)

Description	Marks
Device 1 (mobile phone)	
Energy transformation: Chemical → Electrical	1
Useful energy: light/sound	1
Wasted energy: heat	1
Device 2 (fan)	
Energy transformation: Chemical → Electrical	1
Useful energy: mechanic/kinetic	1
Wasted energy: sound/heat	1
Total	6

Question 25

(25 marks)

- (a) Identify the independent and dependent variables for this investigation. (2 marks)

Description	Marks
Independent variable (IV): insulating material	1
Dependent variable (DV): the temperature change of water	1
Total	2

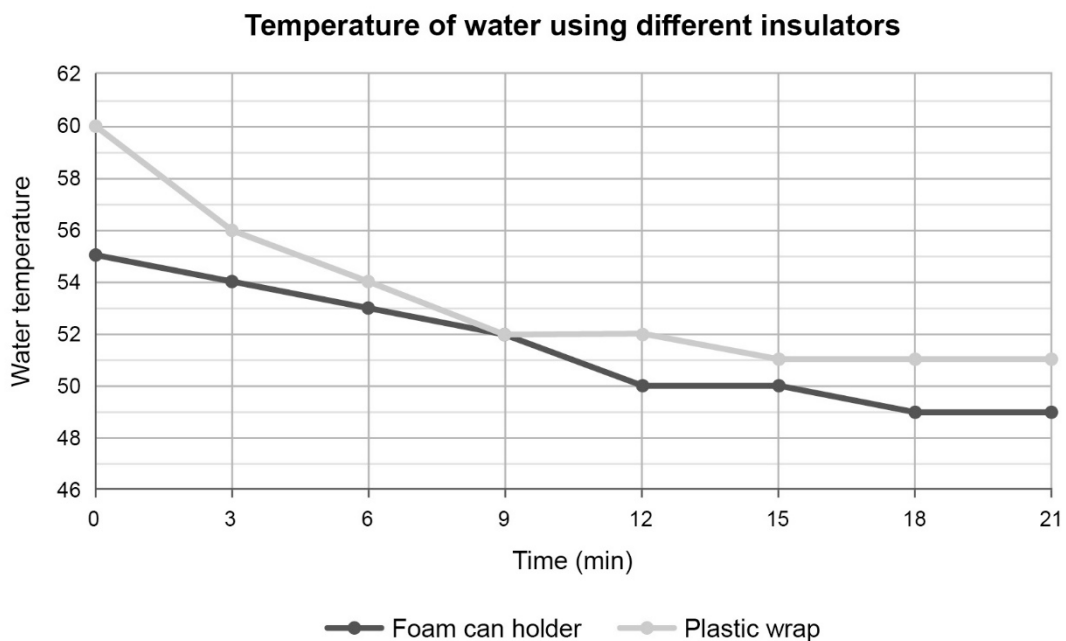
- (b) Write a possible hypothesis for the experiment. (1 mark)

Description	Marks
The cotton wool insulation (IV) will show less heat loss (DV) compared to other insulation materials or The cotton wool insulation (IV) will have a smaller change in water temperature (DV) compared to other insulation materials	1
Total	1
Accept any reasonable hypothesis showing a relationship between independent and dependent variables.	

- (c) Graph the data of the foam can holder and the plastic wrap on the following grid. (5 marks)

Description	Marks
Data plotted accurately	1
Appropriate title that includes the IV and DV	1
Suitable scales used	1
Axes labelled correctly	1
Key provided/lines identified clearly	1
Total	5

Sample graph:



Question 25 (continued)

- (d) Describe how the **four** methods of heat transfer act to cool the water in the can. (8 marks)

Description	Marks
Conduction <ul style="list-style-type: none"> the heat of the water is transferred through the solid can as the particles collide/come into contact 	1–2
Convection <ul style="list-style-type: none"> the air surrounding the can heats and convection currents form in the air surrounding the can, moving heat away from the can 	1–2
Radiation <ul style="list-style-type: none"> the hot can gives off/radiates heat energy to the surroundings due to temperature differences 	1–2
Evaporation <ul style="list-style-type: none"> the liquid at the surface uses heat energy to change to a gas 	1–2
Total	8

- (e) Use the results from the table to calculate the heat energy, in joules, lost by the water when using the foam can holder for insulation. Show **all** workings. (3 marks)

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

Description	Marks
$\Delta T = 55 - 49 = 6$	1
$Q = mc\Delta T = 300 \times 4.180 \times 6$	1
$Q = 7524 \text{ J}$	1
Total	3

- (f) Another group of students also tested the foam can holder using a different amount of water. They recorded a temperature change from $55 \text{ }^\circ\text{C}$ to $51 \text{ }^\circ\text{C}$ and an energy loss of 5852 J . Calculate the mass, in grams, of the water used. Show **all** workings. (4 marks)

Description	Marks
$m = Q/(c\Delta T)$	1
$m = 5852/(4.180 \times 4)$	1
$m = 5852/16.72$	1
$m = 350 \text{ g}$	1
Total	4

- (g) Identify **two** factors that should be considered to ensure the validity of the results for this investigation. (2 marks)

Description	Marks
Any two factors (1 mark each)	
Carry out the experiments at the same room temperature Use measuring cylinder to accurately measure the volume of water Use a heat shield to reduce heat loss	1–2
Total	2
Accept other relevant answers.	

Question 26 (continued)

- (ii) Explain how these gases contribute to the enhanced greenhouse effect. (4 marks)

Description	Marks
Greenhouse gases in the atmosphere absorb infra-red radiation	1
Infra-red radiation is re-emitted	1
An increase in greenhouse gases results in more absorption	1
Causing an increased warming of the planet	1
Total	4

- (e) Classify the fuels in the graph as renewable or non-renewable. (2 marks)

Description	Marks
Classifies all fuels correctly	2
Classifies four fuels correctly	1
Total	2
Answer:	
Renewable	Non-renewable
Wind Solar Hydro	Gas Coal

- (f) Using the data in the graph, account for the decrease in annual emissions for electricity generation shown in the table on page 24. (3 marks)

Description	Marks
Reduced the use of coal/fossil fuels (which produces carbon dioxide)	1
Increased the use of renewable resources like wind and solar	1
Overall result was a decrease in carbon dioxide/greenhouse gases	1
Total	3

- (g) Name the device that can produce electricity from solar energy and explain how this device generates electricity. (5 marks)

Description	Marks
Device: solar cells/solar panels/photovoltaic cells	1
Light/photons hit the panel	1
produce moving/free electrons	1
The electrons move from the 'n' to the 'p' side via external wires	1
creating an electric current/flow of electrons	1
Total	5

- (h) Give **one** economic and **one** environmental consideration for using wind for energy production. Justify your consideration. (4 marks)

Description	Marks
Any one economic consideration (2 marks)	
Cost of infrastructure – more expensive set-up costs Free resource – once set-up low cost of production Inconsistent production of electricity – dependent on wind Visual impact – could deter tourism Less land use – cost is cheaper	1–2
Subtotal	2
Any one environmental consideration (2 marks)	
Noisy – interferes with birds and other animals Less land use – smaller footprint than other energy production sources	1–2
Subtotal	2
Total	4
Accept other relevant answers.	

- (i) Explain what occurs during the power/combustion stage of the four-stroke internal combustion engine, as shown in the diagram above. (4 marks)

Description	Marks
Spark plug fires	1
Ignites the fuel and oxygen	1
Causes a small explosion	1
Forces the piston down	1
Total	4

- (j) Identify an existing alternative engine and describe how its design assists in the reduction of greenhouse gas emissions. (3 marks)

Description	Marks
Any one engine design (3 marks)	
Electric motor does not burn fuel uses electricity from a battery (therefore no greenhouse gas emissions)	1–3
Hybrid engine uses both an internal combustion engine and electric motor, electric motor reduces amount of fuel used (therefore reduces greenhouse gas emissions)	1–3
Hydrogen fuel cell uses hydrogen as a fuel produces electricity for the electric motor (therefore no greenhouse gas emissions, not including production of H ₂)	1–3
Total	3

Question 27

(26 marks)

- (a) Name **three** activities on or around the dam that could cause contamination to its water. (3 marks)

Description	Marks
Any three activities (1 mark each)	
Activities on the dam <ul style="list-style-type: none"> • swimming • boating/skiing Activities around the dam <ul style="list-style-type: none"> • camping near the dam • motorbike riding/four-wheel driving • pollution from residential use • gardening by residents • farming/clearing of land 	1–3
Total	3
Accept other relevant answers.	

- (b) Explain where the salt has come from to cause the salinity problem in the dam. (5 marks)

Description	Marks
Clearing of land	1
Water table rises	1
Dissolving salts from the soil	1
Increasing salinity of groundwater	1
Groundwater flows into rivers leading to the dam	1
Total	5

- (c) Describe **one** strategy to reduce dry land salinity and outline how this strategy works to achieve this reduction. (4 marks)

Description	Marks
Any one strategy (2 marks)	
Planting deep-rooted trees/salt-tolerant trees/salt-tolerant plants Removes soil water by transpiration	1–2
Trenches/ditches/shallow relief drains Salty water flows into the drains	1–2
Pumping/redirecting water flow Removes excess water	1–2
Subtotal	2
Results (2 marks)	
Lowers water table/prevents saline water reaching the surface	1
Reducing dissolved salts in soil/at soil surface	1
Subtotal	2
Total	4

- (d) Apart from salinity, another risk of contamination to the dam water is turbidity. Give **one** possible cause of turbidity. (1 mark)

Description	Marks
Recreation in the water/erosion/sediment entering water	1
Total	1

- (e) Describe the effect higher salinity would have on the buoyancy of aquatic animals. (2 marks)

Description	Marks
Increased salinity leads to increased density of water	1
Increased buoyancy/floatation	1
Total	2

- (f) Electrical conductivity can be used to determine salinity levels. Describe what a low electrical conductivity reading indicates. Justify your answer. (2 marks)

Description	Marks
Low salt/salinity	1
Low concentration of salt/ions to conduct electric current	1
Total	2

- (g) The high salt concentration of the water would affect the freshwater fish that live in the dam.

- (i) Name the process that fish use to balance internal salt and water concentrations. (1 mark)

Description	Marks
Osmoregulation	1
Total	1

Question 27 (continued)

- (ii) Use the diagram of the fish below to show how freshwater fish perform this process. (3 marks)

Description	Marks
Drinks small amounts of water	1
Expels (large amounts of) dilute urine	1
Absorbs water through gills	1
Total	3

Sample diagram:

- (h) Provide **one** valid reason for this reduction in water inflow to the dam. (1 mark)

Description	Marks
Altered rainfall patterns/less annual rainfall/redirection of water elsewhere	1
Total	1

- (i) Identify a strategy that could be used to process the saline water in the dam to provide potable water. (1 mark)

Description	Marks
Desalination/reverse osmosis/distillation	1
Total	1

- (j) Describe **one** process for treating the saline water from the dam to produce potable water. (3 marks)

Description	Marks
Pre-treatment filtration to remove large and small particles	1
Filtered saline water is pushed at high pressure through reverse osmosis membranes to remove salt and minerals/bacteria/viruses/impurities	1
The fresh water is treated to meet Australian Drinking Water Guidelines (and health requirements)/chlorine and fluoride added	1
Total	3
Accept other relevant answers.	

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