



# **INTEGRATED SCIENCE**

## **ATAR course examination 2023**

### **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)

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

## Section Two: Short response

50% (97 Marks)

## Question 21

(15 marks)

- (a) Identify and discuss **three** environmental impacts related to the generation of electricity and the effect it has on the environment. (6 marks)

Description	Marks
Environmental impact: • land clearing	1
Effect on the environment any one of: • loss of habitat caused by clearing • increased land erosion due to the construction of processing facilities and/or the clearing of land related to the extraction of materials required to be extracted and processed for generation of electricity	1
Environmental impact: • consumption and contamination of water supplies	1
Effect on the environment any one of: • water may be used for the processing of electricity, resulting in lower potable water supplies available for communities • water may be contaminated through the process of generating electricity, such as desalination, where salt brines are created, these salt brines can contaminate water ways, if not disposed of appropriately	1
Environmental impact: • generation of waste	1
Effect on the environment: • may cause increases air and noise pollution through the generation of fly ash and noise associated with the production of electricity.	1
<b>Total</b>	<b>6</b>
Accept other relevant answers.	

- (b) Outline **one** example of how an economic consideration influences investment. (2 marks)

Description	Marks
States an example	1
States an impact of the example	1
<b>Total</b>	<b>2</b>
Answers could include: • cost of setting up plant and long term viability • changes to the cost of energy, impacts to the local community and businesses • changes to the local job market impacting local businesses and community, job creation for a new industry • diversifying energy sources, impacts supply, demand, reliability, and cost.	
Accept other relevant answers.	

## Question 21 (continued)

- (c) Identify **two** ways in which an electrical current can be generated. (2 marks)

Description	Marks
Any two of (2 x 1 mark)	
<ul style="list-style-type: none"> <li>• electromagnetic induction (in generators)</li> <li>• photovoltaic effect (in solar cells)</li> <li>• electrochemistry (in batteries)</li> <li>• large-scale electricity generation in power stations (that are fuelled by coal/gas/nuclear)</li> </ul>	1–2
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (d) List **three** possible long-term effects of radiation on the human body. (3 marks)

Description	Marks
Any three of (3 x 1 mark)	
<ul style="list-style-type: none"> <li>• memory loss</li> <li>• stroke-like symptoms</li> <li>• poor brain function</li> <li>• cardiovascular disease</li> <li>• changes to DNA/cancer/develop tumours</li> </ul>	1–3
<b>Total</b>	<b>3</b>
Accept other relevant answers.	

- (e) State a material used in the construction of radioactive personal protective equipment (PPE) and outline how it reduces personal exposure. (2 marks)

Description	Marks
lead	1
reduces/does not allow the gamma rays to pass through	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

Question 22

(13 marks)

- (a) State **three** claims that are made in the article above about climate change and identify evidence from the article to support each claim. (6 marks)

Description	Marks
Any three of (3 x 2 marks)	
<ul style="list-style-type: none"> <li>there is a change in average weather patterns</li> <li>rising sea levels</li> <li>Earth's average surface temperature has increased</li> <li>global land and ocean sea temperatures have increased/ice loss at Earth's poles and in mountain glaciers</li> <li>natural processes can contribute</li> <li>internal variability/external forces</li> <li>driven by human activities</li> <li>frequency and severity changes in extreme weather conditions/cloud and vegetation cover changes</li> </ul>	1-6
<b>Total</b>	<b>6</b>
Accept other relevant answers.	

- (b) (i) Define 'enhanced greenhouse effect'. (2 marks)

Description	Marks
extra greenhouse gasses released into the atmosphere and	1
trapping too much of the sun's energy	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (ii) Draw a labelled diagram to illustrate how the enhanced greenhouse effect impacts climate change. (5 marks)

Description	Marks
Labels	
Earth/ground, atmosphere and more greenhouse gases Must have all three	1
incident rays/sun rays/sun rays hit the earth	1
rays are re-radiated from the ground	1
rays are re-radiated in all directions by greenhouse gases/more re-radiated heat	1
greenhouse gases cause increased warming of the atmosphere/less heat escapes	1
<b>Total</b>	<b>5</b>
Accept other relevant answers.	

Question 23

(12 marks)

- (a) State **one** passive design feature for each of the following. (2 marks)

Description	Marks
Any one of the following for orientation of the home	
<ul style="list-style-type: none"> <li>north facing windows</li> <li>doors/windows away from the direct sun</li> </ul>	1
<b>Subtotal</b>	<b>1</b>
Any one of the following for wall materials	
<ul style="list-style-type: none"> <li>concrete/stone/tile/other dense materials</li> <li>dark/light coloured materials</li> </ul>	1
<b>Subtotal</b>	<b>1</b>
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (b) A solar panel measuring 800 mm x 850 mm is installed on a roof. Calculate the power expected to be produced in summer if the panel is 100% efficient. Show all workings. (4 marks)

Description	Marks
Converts measurements from mm to m correctly 0.80 m, 0.85 m	1
Calculates the area of the solar panel $0.8 \times 0.85 = 0.68 \text{ m}^2$	1
Uses correct formula and show working Power = $0.68 \times 1100$	1
Provides correct answer with units = 748 W	1
<b>Total</b>	<b>4</b>
Note: Do not penalise for consequential errors.	

- (c) If an industrial solar panel produces 1500 W, calculate the amount of energy produced in 15 minutes. Show all workings. (3 marks)

Description	Marks
Shows unit conversion: $15 \text{ min} = 15 \times 60$ = 900 s	1
Shows working: Energy = $1500 \text{ W} \times 900 \text{ s}$	1
States correct answer and units = 1 350 000 J (must have units)	1
<b>Total</b>	<b>3</b>
Note: Do not penalise for consequential errors.	

- (d) If the solar panel in part (c) is 75% efficient, calculate how much useful energy is produced. Show all workings. (2 marks)

Description	Marks
Energy out = $0.75 \times 1\,350\,000$	1
Correct answer and units = 1 012 500 J (must have units)	1
<b>Total</b>	<b>2</b>
Note: Do not penalise for consequential errors.	

- (e) For the panel in part (c), where does the remaining 25% of energy go? (1 mark)

Description	Marks
converted to heat and/or sound	1
<b>Total</b>	<b>1</b>

Question 24

(17 marks)

- (a) Complete the table below by identifying each source of energy and identifying an environmental impact of each. (4 marks)

Description	Marks
<b>Definition</b>	
Renewable resource: capable of being replenished on a human time scale	1
Non-renewable resource: not capable of being replenished on a human time scale	1
<b>Environmental impact</b>	
Renewable resource: low carbon emissions/lower carbon footprint	1
Non-renewable resource: increased carbon emission/high carbon footprint/loss of habitat/reduced biodiversity	1
<b>Total</b>	<b>4</b>
Accept other relevant answers.	

- (b) Biofuels are an example of an energy source that can be used to generate electricity. Outline why they are considered 'renewable'. (2 marks)

Description	Marks
Can grow again/be replaced	1
Not permanently used up/will not run out	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (c) Geothermal energy is another renewable source of energy.

- (i) Define the term 'geothermal' energy. (1 mark)

Description	Marks
internal heat found in the Earth	1
<b>Total</b>	<b>1</b>

- (ii) Draw a flow chart to show all the energy transformations that occur when using geothermal energy to generate electrical energy (4 marks)

Description	Marks
heat/thermal energy (inside earth)	1
kinetic energy (in steam)	1
kinetic/mechanical energy (turbine and generator)	1
electrical/electric potential energy	1
<b>Total</b>	<b>4</b>
Sample Answer:	
<pre> graph LR     A[Heat energy (within the earth)] --&gt; B[Kinetic energy (within the steam)]     B --&gt; C[Kinetic energy (mechanical energy within the turbine and generator)]     C --&gt; D[Electrical energy (electric potential energy)]             </pre>	
Accept other relevant answers.	



- (iii) State **one** advantage and **one** disadvantage of using geothermal power stations. (2 marks)

Description	Marks
Advantage: any one of	
<ul style="list-style-type: none"> <li>renewable</li> <li>clean/low CO<sub>2</sub> emissions</li> <li>heat energy can be used for heating as well as electricity production</li> <li>reliable</li> <li>huge amount of energy stored below earth's surface that can be utilised</li> </ul>	1
Disadvantage: any one of	
<ul style="list-style-type: none"> <li>cost to build infrastructure</li> <li>drilling is expensive</li> <li>efficiency depends on how hot fluid is</li> <li>machinery often breaks down</li> <li>may produce hazardous waste that is hard to dispose of</li> <li>environmental disruption</li> </ul>	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (d) Outline **one** environmental consideration that could influence whether geothermal energy might be utilised in the future. (2 marks)

Description	Marks
Any one of (1 x 2 marks)	
<ul style="list-style-type: none"> <li>impact on geography of area/ flora/fauna many deep subsurface coils/holes required to generate enough heat; this type of energy impacts less surface area compared to other energy sources such as coal</li> <li>greenhouse emissions due to infrastructure, geothermal plants do not burn fuel to generate electricity; reducing air pollution.</li> </ul>	1-2
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (e) Outline **one** economic consideration that could influence how geothermal energy might be utilised in the future. (2 marks)

Description	Marks
Any one of (1 x 2 marks)	
<ul style="list-style-type: none"> <li>initial cost to build infrastructure and supply energy</li> <li>impact on local businesses creates an economy and the development of jobs and infrastructure</li> <li>diversify energy supply and reduce dependence on fossil fuels.</li> </ul>	1-2
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

Question 25

(26 marks)

- (a) Name a process in the water cycle that produces the following changes of state. (2 marks)

Description	Marks
Liquid to gas any one of	
<ul style="list-style-type: none"> <li>transpiration</li> <li>evaporation</li> </ul>	1
Gas to liquid	
<ul style="list-style-type: none"> <li>condensation</li> </ul>	1
<b>Total</b>	<b>2</b>

- (b) Describe, with the use of a diagram, the term 'surface tension.' (4 marks)

Description	Marks
based on attractions between molecules/cohesive forces at surface of a liquid	1
molecules at surface of a liquid have no molecules above them therefore bond more strongly together with closest neighbours/molecules (on either side)/net forces between each neighbour is stronger	1
<p>Diagram</p> <ul style="list-style-type: none"> <li>surface layer with arrows to each molecule (left and right at the surface)</li> <li>molecules showing stronger bonds (shorter arrows) to those molecules which are closer, no arrows to those molecules further away</li> </ul> <p>For example</p> <div style="border: 1px dashed gray; padding: 10px; text-align: center; margin: 10px auto; width: fit-content;"> <p>For copyright reasons this image cannot be reproduced in the online version of this document but may be viewed at the following link  <a href="http://ch301.cm.utexas.edu/imfs/#liquids/surface-tension.html">http://ch301.cm.utexas.edu/imfs/#liquids/surface-tension.html</a></p> </div>	1-2
<b>Total</b>	<b>4</b>
Accept other relevant answers.	

- (c) Name the bond indicated by the letter 'X'. (1 mark)

Description	Marks
hydrogen bond	1
<b>Total</b>	<b>1</b>

- (d) Outline how this bond results in solid water being less dense than water in its liquid form. (2 marks)

Description	Marks
hydrogen bonds (in solid water/ice)	1
are further apart (than in liquid water)	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (e) Define 'specific heat of water' and explain the impact polarity has on the specific heat of water. (5 marks)

Description	Marks
specific heat is the heat required to raise the temperature of 1 gram of a substance by 1 °C	1
water has a high heat capacity	1
water molecules are held together with hydrogen bonds/high polarity	1
hydrogen bonds need to be broken before the temperature rises	1
a lot of energy is required to break bonds/increase water temperature	1
<b>Total</b>	<b>5</b>
Accept other relevant answers.	

- (f) Define the term 'potable water'. (1 mark)

Description	Marks
drinking water/suitable for drinking	1
<b>Total</b>	<b>1</b>
Accept other relevant answers.	

- (g) (i) Using the data provided in the table above, explain why there was a decrease in the amount of water being supplied from dams between 1980 and 2022. (3 marks)

Description	Marks
dams catch rainfall runoff/streamflow	1
changed rainfall patterns	1
less water is draining/running into dams	1
<b>Total</b>	<b>3</b>
Accept other relevant answers.	
Note: Students may write about the use of alternative water sources.	

- (ii) Using the data provided in the table above, explain why there was an increase in the amount of water being supplied from desalination between 1980 and 2022. (2 marks)

Description	Marks
increased population size has resulted in an increase in Perth's water usage/changes to water availability	1
new sources (desalination) are required to meet water demands	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

**Question 25** (continued)

- (h) State
- one**
- benefit of managed aquifer recharge. (1 mark)

Description	Marks
the purified recycled water is then stored in underground aquifers until required/water is not lost via evaporation	1
<b>Total</b>	<b>1</b>
Accept other relevant answers.	

- (i) State
- two**
- managed aquifer recharge methods. (2 marks)

Description	Marks
water is pumped into the aquifer/injection bores	1
water is allowed to infiltrate from the surface to recharge the underlying aquifer (recharge ponds/infiltration basins/infiltration trench)	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (j) Explain the process of managed aquifer recharge, starting from abstraction. (3 marks)

Description	Marks
the source water (surplus water, wastewater or sea water) is treated	1
treatment removes impurities and contaminants	1
water is returned to the aquifer/aquifer is recharged (via injection bores/infiltration)	1
<b>Total</b>	<b>3</b>
Accept other relevant answers.	

## Question 26

(14 marks)

- (a) Name the biological being illustrated by the example above. (1 mark)

Description	Marks
biomagnification	1
<b>Total</b>	<b>1</b>

- (b) Discuss why eating a large fish is more likely to cause poisoning in humans than eating a small fish. (5 marks)

Description	Marks
larger fish has eaten/will eat more of the smaller affected fish	1
large fish ingests more toxins	1
toxin accumulates in tissues/it cannot be broken down or excreted	1
larger fish tissues will contain more toxin	1
therefore, have a great impact on humans	1
<b>Total</b>	<b>5</b>

- (c) Explain the likely impacts on the aquatic ecosystem if the environment in which the algae live becomes polluted with organic matter. (4 marks)

Description	Marks
algae will bloom/reproduce faster	1
more algae mean more toxins will be produced	1
more algae are available to be eaten by fish	1
fish will have a higher level of toxins building up in tissues	1
<b>Total</b>	<b>4</b>

- (d) Define the term 'eutrophication'. (2 marks)

Description	Marks
when a water body contains an excess of nutrients	1
resulting in an increase in algal growth	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (e) Outline how nutrients can enter aquatic environments such as rivers and estuaries. (2 marks)

Description	Marks
run-off	1
from agriculture/farming activities/fertilisers/animal waste	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

Section Three: Extended response

30% (57 Marks)

Question 27

(27 marks)

- (a) List **four** ways in which the transformation of electrical energy can be utilised in the home. (4 marks)

Description	Marks
lighting	1
heating	1
cooling	1
communication	1
<b>Total</b>	<b>4</b>
Accept other relevant answers.	

- (b) Describe how the structure and function of the internal combustion engine takes advantage of energy transformations to generate motion. (7 marks)

Description	Marks
<ul style="list-style-type: none"> <li>• fuel is ignited in a cylinder</li> <li>• chemical energy to heat</li> </ul>	1–2
<ul style="list-style-type: none"> <li>• gases expand causing a piston to move within the cylinder</li> <li>• heat energy transformed to kinetic</li> </ul>	1–2
<ul style="list-style-type: none"> <li>• piston is attached to a shaft</li> <li>• changes up and down motion to circular motion</li> </ul>	1–2
<ul style="list-style-type: none"> <li>• shaft causes wheels to move</li> </ul>	1
<b>Total</b>	<b>7</b>
Accept other relevant answers.	

- (c) List **three** ways in which energy is wasted during internal combustion. (3 marks)

Description	Marks
friction	1
heat	1
sound	1
<b>Total</b>	<b>3</b>
Accept other relevant answers.	

- (d) (i) Construct a table to organise the student's results. (3 marks)

Description		Marks
all data entered correctly – show initial and final temperature		1
columns correctly labelled – temperature including units and materials		1
title – insulating effect of different materials		1
<b>Total</b>		<b>3</b>
Insulating effect of different materials		
Material	Initial temperature (°C)	Final temperature (°C)
Glasswool	90	67
Wool	90	72
Nylon	90	45
Cotton wool	90	68
Polystyrene	90	85
Accept other relevant answers.		

- (ii) State **two** improvements the student could make to the experiment. (2 marks)

Description		Marks
measurement of temperature over a longer period of time		1
add a control/beaker with no insulation		1
<b>Total</b>		<b>2</b>
Accept other relevant answers.		

- (iii) State **two** possible sources of error in the student's experiment. (2 marks)

Description		Marks
not leaving the thermometer in long enough to reach the temperature of the water		1
not using beakers that are at room temperature/same temperature to begin with		1
<b>Total</b>		<b>2</b>
Accept other relevant answers.		

- (iv) On the basis of the results of the student's investigation, identify which material is the best insulator. Justify your answer. (3 marks)

Description		Marks
polystyrene		1
explains a trend in the data		1
compares to how the polystyrene performed compared to another material – holds a higher temperature at the end compared to other materials		1
<b>Total</b>		<b>3</b>
Accept other relevant answers.		

**Question 27** (continued)

- (v) This experiment represents a practical example of energy transfer. Identify the type of energy transfer and explain how this energy transfer is occurring during the experiment. (3 marks)

Description	Marks
conduction	1
the transfer of heat via the direct collision of molecules/heat transfer occurring via physical contact with another object	1
an area of higher kinetic energy (the water the beaker) will transfer thermal energy to areas of lower kinetic energy (the insulation/beaker)	1
<b>Total</b>	<b>3</b>
Accept other relevant answers.	



## Question 28

(30 marks)

- (a) Propose a hypothesis for this investigation. (2 mark)

Description	Marks
Written as a testable statement	1
Includes both dependent and independent variables	1
<b>Total</b>	<b>2</b>
Sample answer:	
As the salt concentration increases, the number of dead shrimp increases.	
Accept other relevant answers.	

- (b) Determine the following for this investigation. (3 marks)

Independent variable:

Description	Marks
Independent variable	
Salt concentration/solution salinity/concentration of salt solution	1
Any two of the control variables (2 x 1 mark)	
<ul style="list-style-type: none"> <li>• amount of solution used</li> <li>• number of shrimp</li> <li>• age of shrimp</li> <li>• time of checking beakers</li> </ul>	1–2
<b>Total</b>	<b>3</b>
Accept other relevant answers.	

Question 28 (continued)

- (c) Draw a column graph showing the class mean for the number of dead brine shrimps in each salt concentrate solution on the grid below. (5 marks)

Description	Marks
title must include both variables	1
data plotted correctly	1
labelling both axes correctly (X and Y)	1
appropriate scale	1
drawing – drawn accurately as a column graph	1
<b>Total</b>	<b>5</b>

  

Average number of dead brine shrimp in solutions of different salt concentration

Concentration (mg L <sup>-1</sup> )	Number of dead shrimp
50	0.4
100	1.8
250	5.0
500	7.0
1000	8.5
4000	9.5

- (d) Outline the purpose of Solution 6 with a salt concentration of 50 mg L<sup>-1</sup>. (2 marks)

Description	Marks
control	1
used to compare results of other solutions/establish the independent variable is producing changes in data	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (e) Construct a conclusion for the investigation that would be supported by the results presented in the table on page 29 and/or your graph. (2 marks)

Description	Marks
increasing the salinity/salt concentration of water increases the number of shrimp that die (within three days)	1
some data stated to support conclusion	1
<b>Total</b>	<b>2</b>
Sample answer:  At 50 mg L <sup>-1</sup> most shrimp survive as the class mean for deaths at this level was 0.4. Increasing salt concentration increases death rate significantly until most shrimp die within three days in 4000 mg L <sup>-1</sup> salinity. Accept other relevant answers.	

- (f) Should the students be concerned about the effects of dry land salinity on the macro-invertebrate survival rate in the river? Justify your answer. (3 marks)

Description	Marks
dry land salinity increases salt levels in topsoil	1
salt then moves/leaches into the river system	1
results from this experiment show that even a small increase in salinity from 50 mg L <sup>-1</sup> to 100 mg L <sup>-1</sup> increases the rate at which shrimp die	1
<b>Total</b>	<b>3</b>
Accept other relevant answers.	

- (g) Describe **two** methods of reducing dry land salinity in the natural environment. (4 marks)

Description	Marks
Any two of (2 x 2 marks)	
<ul style="list-style-type: none"> <li>• plant trees, with various rooting depths to lower the water table</li> <li>• reduce clearing to prevent water table rise</li> <li>• construct trenches to remove surface water/direct to other areas for supplementary management</li> <li>• increase water demands/pumping preventing the water rising to the surface, prevents water table rise</li> </ul>	1–4
<b>Total</b>	<b>4</b>
Accept other relevant answers.	

- (h) Use the food web to answer, the following.

- (i) Identify all producers in the food web. (1 mark)

Description	Marks
algae and macrophytes	1
<b>Total</b>	<b>1</b>
Note: Must identify both.	

- (ii) Outline why producers are so important to any food web (2 marks)

Description	Marks
convert solar energy to chemical energy	1
chemical energy passed on to consumers	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

- (i) Describe the importance of monitoring turbidity in aquatic ecosystems. (2 marks)

Description	Marks
turbidity affects the amount of light that can reach water plants	1
this reduces their ability to photosynthesise	1
<b>Total</b>	<b>2</b>
Accept other relevant answers.	

**Question 28** (continued)

- (j) Using the following headings, outline how macro-invertebrates could be sampled to monitor aquatic health. (4 marks)

<b>Description</b>	<b>Marks</b>
States suitable sampling equipment: e.g. scoop net	1
States suitable sampling technique: e.g. random sampling	1
States data collected: e.g. abundance of macro-invertebrates	1
States analysis of results in relation to aquatic health: e.g. links to sensitivity index	1
<b>Total</b>	<b>4</b>
Accept other relevant answers.	

## ACKNOWLEDGEMENTS

**Question 25(b)** [Schematic of the molecular view of surface tension]. (n.d.). Retrieved September, 2023, from <http://ch301.cm.utexas.edu/imfs/#liquids/surface-tension.html>

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