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

AVIATION

ATAR course examination 2024

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

Section Two: Short answer **80% (145 Marks)**

Question 21 **(4 marks)**

Knowing the correct pressure height and density height is critical when calculating aircraft performance.

(a) Calculate airfield pressure height using the following data:

- airfield elevation 1700 ft above mean sea level (AMSL)
- OAT 19 °C
- QNH 1019 hPa.

Show all workings. (2 marks)

Description	Marks
(ISA QNH – Actual QNH) × 30 ft + elevation	1
(1013 – 1019 = –6) × 30 = –180 + 1700	
pressure height = 1520 ft	1
Total	**2**
Shows above working, but mathematical error, 1 mark.	

(b) Calculate airfield density height using the following factors:

- airfield pressure height 3500 ft
- OAT 5 °C.

Show all workings. (2 marks)

Description	Marks
(ISA Temp at 3500) Temp deviation × 120 + pressure height	1
[15 – (3.5 × 2 = 7)] = 5 – 8 = –3 –3 × 120 = -360 + 3500	
density height = 3140	1
Total	**2**
Shows above working, but mathematical error, 1 mark.	

Question 22 **(4 marks)**

Using the synoptic chart supplied, identify the:

(a) meaning of the symbol  . (1 mark)

Description	Marks
trough (low pressure)	1
Total	**1**

(b) meaning of the symbol  . (1 mark)

Description	Marks
warm front	1
Total	**1**

(c) meaning of the symbol  . (1 mark)

Description	Marks
occluded front	1
Total	**1**

(d) forecast QNH at position 20 °S 155 °E. (1 mark)

Description	Marks
1012 hPa	1
Total	**1**

Question 23 **(3 marks)**

The ageing of general aviation aircraft is a significant issue in the industry. Identify **three** impacts resulting from the ageing general aviation fleet.

Description	Marks
Any three of	
• additional aircraft downtime • higher operational costs • additional maintenance required • potential aircraft corrosion, fatigue or lack of airworthiness	1–3
Total	**3**
Accept other relevant answers.	

Question 24 **(4 marks)**

Local mean time (LMT) changes depending on an aircraft's position globally. Explain how time is considered globally, particularly in relation to LMT.

Description	Marks
Earth takes 24 hours to rotate 360°	1
time is related to longitude	1
Earth rotates through 15° of longitude every hour	1
Earth is divided into 24 standard time zones (LMT) representing 15° and 1 hour	1
Total	**4**
Accept other relevant answers.	

Question 25 **(8 marks)**

Weather reports utilised in aviation are vital for flight safety. Identify the type and purpose of the following aviation weather forecasts based on their abbreviations:

(a) TAF (2 marks)

Description	Marks
Type: terminal aerodrome forecast	1
Purpose: used for meteorological conditions within 5 nm of the aerodrome reference point	1
Total	**2**
Accept other relevant answers.	

(b) GAF (2 marks)

Description	Marks
Type: graphical area forecast	1
Purpose: used for operations between the surface and 10 000 feet above mean sea level (AMSL)	1
Total	**2**
Accept other relevant answers.	

(c) SIG WX (2 marks)

Description	Marks
Type: significant weather charts	1
Purpose: used for expected significant weather between either FL100 and FL250 or FL250 and FL630	1
Total	**2**
Accept other relevant answers.	

(d) GPWT (2 marks)

Description	Marks
Type: grid point wind and temperature	1
Purpose: used for indication of wind speed/direction and temperature at specified heights above mean sea level	1
Total	**2**
Accept other relevant answers.	

Question 26 **(4 marks)**

Developing knowledge of weather patterns is vital in assisting flight planning. Describe the weather conditions most commonly experienced across southern Australia during winter.

Description	Marks
high establishes itself in the centre of Australia	1
causing moist tropical air to flow from the Northwest	1
lows move across Australia	1
causing cold fronts to move from West to East	1
Total	**4**
Accept other relevant answers.	

Question 27 **(4 marks)**

When flying for maximum range on a given amount of fuel, the aircraft must be configured appropriately. Explain why the aircraft should be flown at the best lift over drag ratio.

Description	Marks
provides a power setting to burn fuel most efficiently	1
provides the greatest airspeed for the least amount of fuel burned, so increased range	1
flying faster, the ratio of power required to speed gained becomes less	1
flying slower, the ratio of power required to speed gained becomes less	1
Total	**4**
Accept other relevant answers.	

Question 28 **(8 marks)**

Understanding weather phenomena and their impact on aircraft is vital for the pilot in command of an aircraft. For the following weather phenomena, identify the most common cause and the nature of the hazard for aircraft operations.

(a) Microburst (2 marks)

Description	Marks
Cause: subsiding air from cumulonimbus cloud	1
Hazard: downdraughts of air causing windshear	1
Total	**2**

(b) Turbulence (2 marks)

Description	Marks
Cause: any one of	
• convection currents from surface heating • frictional turbulence in lower layers • disruptive air movement at high level (or atmosphere)	1
Hazard: any one of	
• disruption of flight path • loss of aircraft control	1
Total	**2**

(c) Dust devil (2 marks)

Description	Marks
Cause: fast rising warm air though colder air	1
Hazard: difficulty controlling aircraft	1
Total	**2**

(d) Tropical cyclone (2 marks)

Description	Marks
Cause: low pressure system which forms over warm tropical waters	1
Hazard: any one of	
• strong winds • heavy rain • severe icing • severe turbulence	1
Total	**2**

Question 29 **(6 marks)**

The instrument landing system (ILS) is an important navigation aid which helps pilots navigate their aircraft to a runway. The ILS consists of various components, including the glide slope. Describe the function, principle of operation and limitations of the glide slope portion of the ILS.

(a) Function (2 marks)

Description	Marks
provides vertical guidance	1
approximate 3 degree profile	1
Total	**2**
Accept other relevant answers.	

(b) Principle of operation (2 marks)

Description	Marks
Any two of	
• 2 lobes in UHF • 90 Hz and 150 Hz • equal signal from each lobe creates glideslope	1–2
Total	**2**
Accept other relevant answers.	

(c) Limitations (2 marks)

Description	Marks
Any two of	
• false glideslope • narrow beam width • no useable backcourse	1–2
Total	**2**
Accept other relevant answers.	

Question 30 **(2 marks)**

Calculate the required compass heading to be flown, given the following information:

- true track 031 °T
- variation 3 °E.

Show all workings.

DEVIATION CARD

		FOR			
N	30	60	E	120	150
		STEER			
N	32	60	88	118	148
		FOR			
S	210	240	W	300	330
		STEER			
S	212	240	272	302	330

Description	Marks
(true track – variation), magnetic track + compass deviation	
(031 °T – 3 °E = 028 °M), 028 °M + 002 °M	1
required compass heading 030 °M	1
Total	**2**
Shows above working, but mathematical error, 1 mark	

Question 31 **(7 marks)**

One way to ensure the safety of an aircraft and its occupants is to ensure it is loaded correctly within its design weight and balance limits.

(a) Complete the table below for a Piper PA-32RT-300T Turbo Lance aircraft to show the weight, position of the centre of gravity and moment at zero fuel weight. Round calculations to one decimal place. (4 marks)

Description	Marks
weight 3137.9	1
centre of gravity 92.6	1
total moment 290 684.3	1
completed moments above ZFW moment	1
Total	**4**
Note: error of addition in weights and moments may be taken into consideration for centre of gravity calculation only.	

Position	Weight (lbs)	Arm (in)	Moment (lbs/in)
Aircraft	2335.9		195 105
Front	362	85.50	30 951
Centre	67	118.1	7912.7
Rear	343	155.7	53 405.1
Forward baggage	15	42	630
Aft baggage	15	178.7	2680.5
Zero fuel weight	3137.9	92.6	290 684.3

An aircraft has a take-off weight (TOW) of 3472.9 lbs and a centre of gravity (CG) position 36.77 inches aft of the datum. The CG limits are between 33 inches and 37 inches aft of the datum. The maximum permissible TOW is 3600 lbs.

(b) State whether the aircraft can be brought to its maximum all up weight (MAUW) by placing the extra possible weight in the 'Forward baggage' compartment (station 42) and remain in limits. Justify your answer. (3 marks)

Description	Marks
yes it can remain in limits	1
centre of gravity 36.95	1
new total moment 133 036.73	1
Total	**3**

Position	Weight (lbs)	Arm (in)	Moment (lbs/in)
MAUW	3600		
– TOW	3472.9	36.77	127 698.53
= Extra weight	127.1	42	5338.2
New TOW	3600	36.95	133 036.73

Question 32 **(4 marks)**

Explain the effects of altitude on a normally aspirated engine's performance as an aircraft climbs.

Description	Marks
as altitude is gained, air becomes less dense	1
fuel/air ratio changes	1
mixture becomes richer	1
engine will produce less power	1
Total	**4**

Question 33 **(3 marks)**

A pilot wants to maintain a true track of 127°. The planned true airspeed (TAS) is 130 kts and planned fuel burn is 35 litres per hour. Given the following wind forecast of 185°T/17 kts. calculate the following:

(a) required heading to be flown in °T. (1 mark)

Description	Marks
133°T ± 1°	1
Total	**1**

(b) ground speed. (1 mark)

Description	Marks
120 kts ± 2	1
Total	**1**

(c) planned fuel burn for a cruise leg of 45 nm. (1 mark)

Description	Marks
$\frac{45}{2}$ nm/min = 22.5 mins, 22.5 min at 35 lphr = 13.13 litres required or rounded to 14	1
Total	**1**
Note: fuel cannot be rounded down so, must round up.	

Question 34 **(2 marks)**

Calculate the take-off distance required using the Piper PA 32RT-300T take-off weight chart on page 19 and the following data:

- outside air temperature 28 °C
- pressure height 3000 ft
- surface short wet grass
- slope 1% down
- 7 kt headwind
- take-off weight 1440 kg.

Show all workings.

Description	Marks
960 meters ± 20 required and shows working	2
Shows working with minimal error outside tolerance	1
Total	**2**

Question 35 **(10 marks)**

Use the chart below for a visual flight rules (VFR) flight from Smithton airport to overhead Arthur River township to Three Hummock Island airport and back to Smithton airport.

(a) Given the lowest hemispherical altitude above 3000 ft, magnetic variation of 13 °E and a cruising true airspeed (100 kt), complete the following flight plan in the table below, and use the attached scale. (5 marks)

Description	Marks
Completes all position information correctly	1
Completes all altitude information correctly	1
Completes all track true information correctly	1
Completes all track magnetic information correctly	1
Completes all distances correctly	1
Total	**5**

Position	Altitude	Track (T)	Track (M)	Distance (nm)
Smithton				
Arthur River	4500	236 °T ± 1 °	223 °M ± 1 °	28 ± 1 mm
Three Hummock Island	3500	018 °T ± 1 °	005 °M ± 1 °	46 ± 1 nm
Smithton	3500	161 °T ± 1 °	148 °M ± 1 °	29 ± 1 nm

After departing Smithton, a position fix finds you directly overhead Togari township.

(b) Using the 1:60 rule, calculate your track error to the nearest degree. Show all workings. (2 marks)

Description	Marks
$\frac{\text{distance off}}{\text{distance gone}} \times \frac{60}{1} = \frac{1.5}{13.5} \times \frac{60}{1}$	1
track error: 6.6 ° or rounded 7 °	1
Total	**2**
Note: for track error, accept a range of 6 to 7	
Shows above working, but mathematical error, 1 mark	

After travelling 25 nm of a 72 nm leg on a heading of 132 °M, a position fix finds you 4 nm off track to the right.

(c) Calculate the heading change to track direct to your destination, to the nearest degree. (3 marks)

Description	Marks
$\frac{\text{distance off}}{\text{distance gone}} \times \frac{60}{1} = \frac{4}{25} \times \frac{60}{1} = 9.6\,°$	1
$\frac{\text{distance off}}{\text{distance to go}} \times \frac{60}{1} = \frac{4}{47} \times \frac{60}{1} = 5.1$	1
total correction: 9.6 ° + 5.1 ° = 14.7 ° (round 15 °)	1
Total	**3**
Note: Accept new heading: 132 ° – 15 ° = 117 °	
Shows above working, but mathematical error, 1 mark	

Question 36 **(2 marks)**

Use the performance chart below and the following data to determine the best power cruise true airspeed (TAS) and cruise power setting.

- cruise pressure altitude of 13 000 ft
- outside air temperature (OAT) of -12 °C
- 65% power

Description	Marks
TAS 152 kts (± 3)	1
power setting mixture leaned to 150 °F rich of peak EGT (maximum 1650 °F)	1
Total	**2**

Question 37 **(5 marks)**

To relieve the force required by the pilot of a light aircraft during the climb phase, an ancillary control surface is employed.

(a) Name the ancillary control employed. (2 marks)

Description	Marks
elevator trim tab	2
trim tab or elevator trim	1
Total	**2**
Note: if response is 'tab', award zero marks.	

(b) In the space below, draw a diagram to show the position that the ancillary control surface must be in during a climb to relieve the control force required to maintain the intended attitude. Ensure that your diagram includes the:

- position of the ancillary control surface
- position of the related primary control surface
- related stabiliser that the primary control is attached to. (3 marks)

Description	Marks
Shows horizontal stabiliser, elevator and elevator trim tab in correct positions	3
Shows elevator and trim tab in correct position	2
Shows horizontal stabiliser, elevator and elevator trim tab but incorrect positions	1
Total	**3**

Question 38 **(7 marks)**

There are many factors that affect longitudinal, lateral and directional stability.

For each of the factors described in the table below, identify whether it will affect longitudinal, lateral or directional stability.

Factor	**Stability affected:** • **longitudinal** • **lateral or** • **directional.**	**Marks**
High and low wing configurations	Lateral	1
Surface area of the vertical fin and rudder	Directional	1
Movement in the centre of pressure	Longitudinal	1
Dihedral/anhedral	Lateral	1
Changes in thrust	Longitudinal	1
Distance of the fin and rudder from the centre of gravity	Directional	1
Distance of horizontal stabiliser from the centre of gravity	Longitudinal	1
	Total	**7**

Question 39 **(6 marks)**

Slots are high lift devices that are employed on the aerofoils of an aircraft.

(a) Name the **two** types of wing flaps that use slots to improve their efficiency. (2 marks)

Description	**Marks**
leading edge slats	1
fowler flap	1
Total	**2**
Accept other relevant answers	

(b) Identify whether a leading-edge slot increases or decreases the stalling angle of an aerofoil. (1 mark)

Description	**Marks**
increase	1
Total	**1**

(c) State the number of degrees that a leading-edge slot can affect the stalling angle of an aerofoil. (1 mark)

Description	**Marks**
10 degrees or 10°	1
Total	**1**

(d) Outline how slots affect the control of an aerofoil's boundary layer. (2 marks)

Description	**Marks**
directs airflow from below the aerofoil to flow over its upper surface	1
delays the separation of laminar flow	1
Total	**2**
Accept other relevant answers.	

Question 40 **(6 marks)**

To hover a helicopter stationary over a fixed position, simultaneous use of all controls by the pilot is required. For the following controls, describe the movement of the associated aerodynamic surface and how it affects control of the hovering helicopter.

(a) Cyclic pitch control (2 marks)

Description	Marks
Movement: alters the pitch of each rotor blade by different amounts creating differential lift	1
How it affects control: controls the lateral position of the helicopter when in the hover	1
Total	**2**
Accept other relevant answers.	

(b) Collective pitch control (2 marks)

Description	Marks
Movement: alters the pitch of each rotor blade by the same amount	1
How it affects control: control the height of a hovering helicopter	1
Total	**2**
Accept other relevant answers.	

(c) Anti-torque or tail rotor pedals (2 marks)

Description	Marks
Movement: alters the pitch of the tail rotor blades	1
How it affects control: controls the direction or heading when in the hover	1
Total	**2**
Accept other relevant answers.	
Note: award zero marks if candidate states that the anti-torque pedals counter the torque effect of the main rotor.	

Question 41 **(7 marks)**

A helicopter is transitioning from the hover to forward flight. Starting from zero knots, it continues to accelerate until it reaches its maximum speed. During the acceleration, the amount of power required changes.

(a) Name the term given to the type of lift that causes this change in power requirements. (1 mark)

Description	Marks
translational	1
Total	**1**

(b) Describe the changes in the amount of power required as the helicopter moves from the hover to its maximum speed. (2 marks)

Description	Marks
power requirement will drop initially up to the minimum power required speed	1
power required will then begin to increase as the helicopter continues to accelerate up to the maximum speed	1
Total	**2**

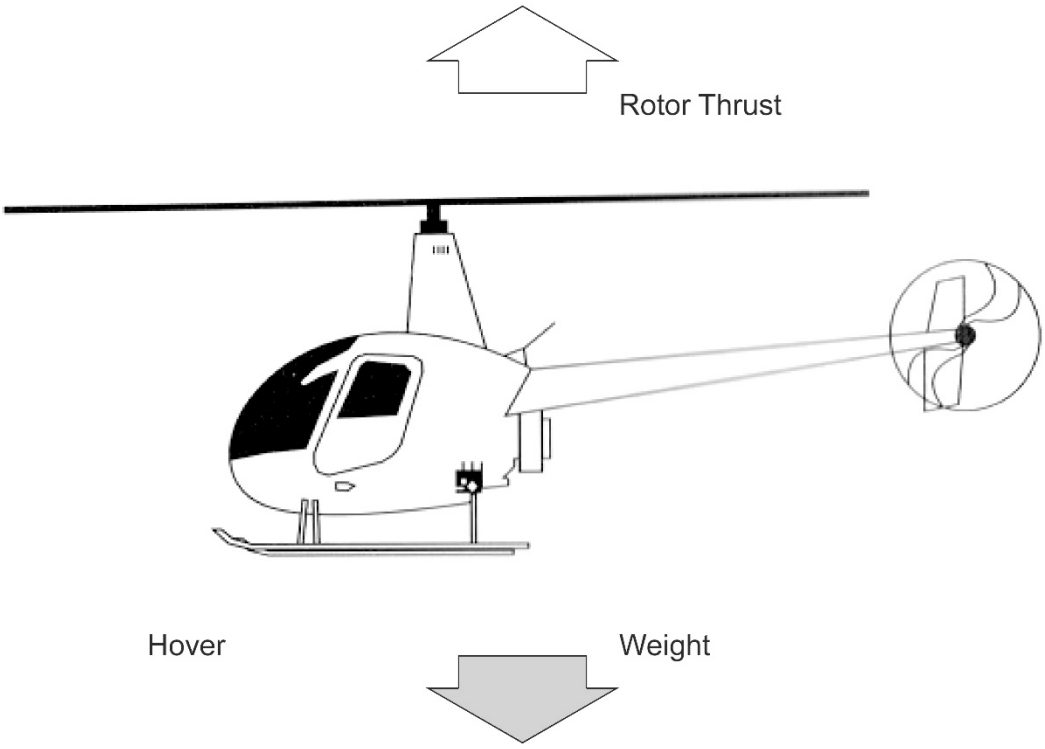
(c) Explain why the amount of power required changes as the helicopter moves from the hover to its maximum speed. (4 marks)

Description	Marks
as the helicopter accelerates, the additional volume of air moving into the rotors increases their efficiency	1
this reduces the power required	1
the increased parasite drag begins to override this efficiency	1
requiring the increasing input of power to allow the helicopter to reach its maximum speed	1
Total	**4**
Accept other relevant answers.	

Question 42 **(5 marks)**

(a) Using the diagram below draw and label the vectors of force that would be acting on the helicopter hovering in nil wind. (4 marks)

Description	Marks
Diagram shows vector arrows above and below the helicopter	1–2
Arrow below the helicopter is labelled 'Weight'	1
Arrow above the helicopter is labelled 'Rotor Thrust' or 'Thrust'	1
Total	**4**



(b) State the relative magnitude of the forces acting on a helicopter hovering in nil wind. (1 mark)

Description	Marks
rotor thrust is equal to weight	1
Total	**1**

Question 43 **(6 marks)**

The ability of a pilot to see colour is an important aspect of operating an aircraft.

(a) Name the cells in the eye that are responsible for detecting colour. (1 mark)

Description	Marks
cones	1
Total	**1**

(b) Identify **three** colours that the light receptors in the eye are sensitive to. (3 marks)

Description	Marks
red	1
green	1
blue	1
Total	**3**

(c) State **two** primary reasons why pilots with defects in the colour detectors in the eye are barred from holding a pilot licence. (2 marks)

Description	Marks
pilot would be unable to distinguish aircraft navigation lights	1
pilot would be unable to distinguish light signal from the tower	1
Total	**2**
Accept other relevant answers.	

Question 44 **(3 marks)**

Aviation safety has been significantly improved by the inclusion of ergonomic considerations in the cockpit.

Name **three** methods used by aircraft manufacturers to assist aircrew to avoid the misidentification of engine controls.

Description	Marks
colour	1
shape	1
standardised position	1
Total	**3**
Accept other relevant answers.	

Question 45 **(6 marks)**

The threat and error management (TEM) model has been developed in the aviation industry as an important means of implementing crew resource management (CRM) theory.

(a) Using the TEM model, from the perspective of a crew operating an aircraft, identify whether the situations in the table below would be categorised as a threat, error, undesirable aircraft state or countermeasure. (5 marks)

Situation	**Category:** • **threat** • **error** • **undesirable aircraft state or** • **countermeasure.**	**Marks**
An air traffic controller clears an aircraft to land on an occupied runway	Threat	1
An aircraft is recovered after a stall warning sound	Countermeasure	1
The crew misreads a taxi sign and lines up for take-off on a runway that is not in use	Error	1
An aircraft is high and fast on an approach due to wind shear	Undesirable aircraft state	1
There is low visibility at an aerodrome	Threat	1
	Total	**5**

(b) State the reason why TEM is incorporated in flight crew training. (1 mark)

Description	**Marks**
to train flight crew to maintain safe operations by detecting and responding to threats and errors	1
Total	**1**
Accept other relevant answers.	

Question 46 **(6 marks)**

The global navigation satellite system (GNSS) is an integral part of modern aircraft navigation systems. GPS is an example of one such system

(a) Outline the principle of operation of GPS. (5 marks)

Description	Marks
GPS carry atomic clocks for accurate positioning	1
satellite position is cross referenced by ground stations	1
GPS receiver in the aircraft awaits transmissions from satellites	1
once signals are received from a number of satellites	1
the time delay from the satellite is used to calculate receiver position	1
Total	**5**
Accept other relevant answers.	

(b) State the minimum number of satellites required for three-dimensional navigation using GPS. (1 mark)

Description	Marks
relies on receiving signals from at least four satellites	1
Total	**1**

Question 47 **(7 marks)**

Flying after a period of scuba diving can have a negative effect on the human body due to an inhaled gas dissolving in the bloodstream.

(a) Name the gas that has the potential to have a negative effect after scuba diving. (1 mark)

Description	Marks
nitrogen	1
Total	**1**

(b) Name the term given to this negative effect. (1 mark)

Description	Marks
Any one of	
• the bends • dysbarism • decompression sickness	1
Total	**1**

(c) Describe the process by which the debilitating negative effect named in part (b) occurs when flying after a period of scuba diving. (4 marks)

Description	Marks
as the scuba diver descends nitrogen is dissolved into the blood	1
as the scuba diver ascends nitrogen forms bubbles in the blood	1
these bubbles become lodged in the joints causing pain	1
the effect is caused by changes of pressure on the body	1
Total	**4**

(d) If the negative effect named in part (b) were to occur during the flight of an unpressurised aircraft, state the most effective remedy. (1 mark)

Description	Marks
descend the aircraft	1
Total	**1**

Question 48 **(6 marks)**

The Asia-Pacific region airlines recorded a 283% increase in aircraft movements in March 2023 compared with 2022. Describe **two** resulting impacts on each of the following:

(a) Aviation industry (2 marks)

Description	Marks
Any two of	
• increased airport/airspace congestion • use of underutilised airports or requirements to build new airports or • expand existing airports • increased delays or holding • increased traffic during traditionally quieter times to balance workload	1–2
Total	**2**
Accept other relevant answers.	

(b) Community (2 marks)

Description	Marks
Any two of	
• increased noise or different noise areas or additional flights • increased unusual hours flights • new airports being built resulting in altered noise profiles • different airports being utilised causing new noise areas	1–2
Total	**2**
Accept other relevant answers.	

(c) Environment (2 marks)

Description	Marks
Any two of	
• increased carbon dioxide emissions • increased pollutants into ground/water sources • increased land clearing or dredging to establish new airports	1–2
Total	**2**
Accept other relevant answers.	

ACKNOWLEDGEMENTS

Question 42(a) Adapted from: Yeo, M., Bowers, G., & Bennett, K. (2001). [Diagram of a helicopter]. *Handbook of Flight* (2nd ed.). WestOne Services, p. 45. Not for operational purposes.

Question 48 Information adapted from: International Air Transport Association. (2023, May 4). *Air Travel Growth Continues in March*. Retrieved July, 2024, from https://www.iata.org/en/pressroom/2023-releases/2023-05-04-01/#:~:text=%EE%80%80Asia-Pacific%EE%80%81%20airlineshad

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