MODULE J HARDWARE AND EMERGING TECH · J7

Expert systems: mark scheme

21 marks · Cambridge 0478 syllabus 6.3.2 (the main characteristics of AI: a collection of data and the rules for using that data, the ability to reason, and it can include the ability to learn and adapt) and 6.3.3 (the basic operation and components of AI systems; expert systems have a knowledge base, a rule base, an inference engine and an interface)

How to use. One mark per creditworthy point up to the maximum shown. **/** separates alternative words; **//** separates alternative answers. Words in (brackets) are not needed for the mark. **...** at the start of a point means it builds on the point before. Credit any other valid answer that shows the same understanding. Components must be named in full: "knowledge", "rules" or "engine" alone is not credited.

QUESTION	ANSWER	MARKS	GUIDANCE
1 0478 6.3.3	One mark for each correct line: inference engine → Applies the rules to the facts and to the user's answers to reach a conclusion knowledge base → Stores the facts about the specialist area interface → Lets the user enter data and shows the user questions and results rule base → Stores the rules that are used to reason with the facts	**4**	A component with more than one line drawn from it scores 0 for that component. "Automatically changes its own processes and data as it is given more data" describes machine learning and is not used.
2 0478 6.3.3	One mark for each correct row: Screen where the engineer taps Yes or No: interface "Pump type K normally runs at ...": knowledge base Part that decides which question to ask next: inference engine "IF the pump is vibrating AND ... THEN ...": rule base	**4**	A row with more than one tick scores 0.

QUESTION	ANSWER	MARKS	GUIDANCE
3 0478 6.3.2	Any two characteristics, max 2 marks each (1 for the characteristic, 1 for how this expert system shows it): **A collection of data // stores facts** ... e.g. the knowledge base holds facts about pumps / faults (e.g. normal motor temperatures) **Rules for using the data** ... e.g. the rule base holds IF ... THEN rules linking symptoms to faults **The ability to reason // makes decisions** ... e.g. the inference engine applies the rules to the facts and the engineer's answers to reach a conclusion about the cause of the fault // to decide which question to ask next	**4**	max 4. One mark for naming or clearly stating each characteristic, one mark for describing how this expert system shows it. Accept a description in context without the exact syllabus wording. Accept "a collection of data and the rules for using that data" given as one characteristic: 1 mark for the characteristic, 1 for the knowledge base / rule base in context. Do not credit "it can learn and adapt": the scenario says the senior engineers add the new facts and rules, so the system does not change them itself. Do not credit "it thinks like a human" alone.
4 0478 6.3.3	Any five from: The answer (Yes) is input through the interface ... and passed to the inference engine The inference engine searches / compares the answer with the facts in the knowledge base // links the answer to facts about copper-bearing rocks / minerals The inference engine applies the rules in the rule base (to the facts and the answer) // e.g. IF green minerals AND ... THEN copper (likely) It uses this answer together with the previous answers (given by the geologist) If there is not enough data to reach a conclusion // more than one result is still possible, it chooses the next question to ask ... based on the answers given so far ... and the (next) question is displayed on the interface If the conditions of a rule are met, it reaches a conclusion / decision (e.g. the site is likely // not likely to contain copper) ... and the conclusion / suggestion is output on / displayed by the interface The output may show how likely the result is // how the result was reached	**5**	max 5. A component named with no description of what it does with the answer scores 0, so a bare list of the four components scores 0. Do not credit "the knowledge base decides" or "the rule base stores the facts" (components confused). Accept "user interface" for interface.

QUESTION	ANSWER	MARKS	GUIDANCE
5(a) 0478 6.3.3	Any two from: Displays / asks the questions to the technician / user Lets the technician / user input data // answers // details of the problem / symptoms Outputs / displays the result // conclusion // the likely fault // advice on what to repair Displays an explanation of how the result was reached	**2**	max 2. Two answers that make the same point (e.g. "shows questions" and "displays questions") score 1. Do not credit "decides the fault" or "stores the rules" (that is the inference engine / rule base).
5(b) 0478 6.3.3	Any two from: The answers so far are not enough (data) to reach a conclusion // more than one fault is still possible // the answers match more than one rule A rule needs more facts / conditions to be checked before it gives a result // the conditions of a rule have not all been met / checked yet The (next) question gets the missing data // narrows down / rules out possible faults The inference engine chooses the next question based on the previous answers	**2**	max 2. Do not credit "the system is slow", "to check the technician's answers are correct" or "so it can learn".

Total: 21 marks