1.

a) In order to define these 3 sentences into frames, I have defined some basic structures in terms of their own frames so that I can reference them. These include:

{

Home

location:
type:
owner:
size:

}

{

Agent

name:
*__age__:
*__gender__:
weight:
occupation:

}

{

Robot

name:
model:
color:
condition:
owner:

}

*Slots that are optionally applicable

{
Room

location:
size:
type:

}

I sat cross-legged on the carpet in front of it.

{
Engage

subject: Agent(Male, Robot Whisperer/Technician)
action: sitting-down
location: Room(Home, carpet/floor, living room)
beneficiary: Robot(Henry, NX-6401, blue, fair,
Family(name = unknown))
instrument: legs/overall body

}

I put my hand on its shoulder.

{

Engage

subject: Agent(Male, Robot Whisperer/Technician)
action: handToShoulder
location: Room(Home, carpet/floor, living room)
beneficiary: Robot(Henry, NX-6401, blue, fair,
Family(name = unknown))
instrument: hand

}

The Johnsons across the street bought a new robot.

{

Acquire

subject: Family(name = Johnson)
action: bought/purchase
beneficiary: Robot(model = A-01)
location: Home(acrossStreet, personal residence, Johnson's, unknown)
instrument: monetary funds
}

In each of these sentences, I tried to represent an action where the subject is the one providing the action, and the beneficiary is the recipient. Each of these represents a thematic-role system, defining what action occurred and how that effected the system overall. Each of the frames was particularly geared toward a specific sentence, but took into context the passage as a whole, as stated in the instructions.

b)

Henry - Robot
Narrator - Robot Whisperer/Technician
SittingDown(Agent): Describes that the agent is or was currently sitting.
On(Agent, Location): Describes that the Agent is at the location.
Front(Agent1, Agent2): Describes that Agent1 is in front of Agent2.
placedHand(Agent): Describes the act that the Agent moved his hand.
Bought(Agent(s), Object): Describes that the Agent(s) purchased the Object.
home(Location): Describes a home at the Location.

I sat cross-legged on the carpet in front of it.

SittingDown(Narrator) ^ On(Narrator, Carpet) ^ Front(Narrator, Henry)

I put my hand on its shoulder.

placedHand(Narrator) ^ On(Henry, Shoulder)

The Johnsons across the street bought a new robot.

Bought(JohnsonFamily, Robot) ^ home(acrossStreet)

c) There are several reasons to use frames as the your agent's knowledge representation over logic, as it definitely depends on the scenario. Frames are excellent at storing knowledge when given large amounts of facts in terms of a language, like a paragraph or a sentence. Frames can then map each of the specifics describing a category into slots and fillers, gaining even more knowledge about a subject. For instance, Watson probably has access to millions of frames describing everyday objets in the world, each with many slots and fillers. This can be applied to more than just objects, but to situations themselves, where the Agent can analogically map a past situation to help solving the present one. However, even though frames do have the ability to describe in detail objects and scenarios, the agent needs access to a lot of information to draw conclusions from frames. That's where they lack effectiveness as knowledge representations - when the agent has access to limited information, and to information it has never seen before. Logic however is a very sound knowledge representation that tries to make T/F statements about the world taking in statements of information. Unlike frames, logic is a concise knowledge representation that just states facts that hopefully will gain inference into a conclusion. Logic is great for problem solving or trying to reach a goal state, as it provides a concise way to determine if a statement is true or false. Logic is a complete knowledge representation, as all valid conclusions are proven. Logic provide a more concise conclusion then frames, but it however can be unhelpful if the information an agent has does not lead to a sound conclusion. Then logic has no way of gaining inference and determining a solution.

2.

a)

For this question we will only focus on the deliberation level of a cognitive system, where percepts are being converted directly into actions. In the deliberation layer, our agent is combining reasoning, memory, and learning to form actions. In order to develop a sample scenario, I will develop a working memory based on the short story we are given. So starting when Henry first walked into the Robot Whisperer's office, here is his probable initial working memory, with just known facts about the patient.

Initial Working Memory

agent: Protagonist/Robot Whisperer/Technician
patient: Robot
patientName: Henry
patientModel: NX-6401
modelAge: Older
modelColor: Blue
modelOwner: Family
goal: Diagnose Patient

After this point, Henry has just walked into his office, where the technician can now develop some percepts based off of his new working memory (Red fields are newly added).

Percept1: Henry's physical components/hardware do not seem to be suffering from any type of failure.

agent: Protagonist/Robot Whisperer/Technician
patient: Robot
patientName: Henry
patientModel: NX-6401
modelAge: Older
modelColor: Blue
modelOwner: Family
****physicalAppearance:** Normal
****reasonForVisit:** Acting Strange
goal: Diagnose Patient

Based off of the rule system that the technician has cognitively developed, he can then eliminate following the rules because of this initial perception:

Rule1: If the root issue is a physical component,
Action1: Then narrow down the sector of the robot where the problem evolves.

Now, the technician still thinks it might be a care issue by the owner, or a computational issue from the robot. He will dive further by developing more perceptrons by asking a few initial questions. From there, his working memory will look something like this after making a few more observations:

Percept2: However, Henry's owner(s) seem to think very strongly that he is acting out of the ordinary.

agent: Protagonist/Robot Whisperer/Technician
patient: Robot
patientName: Henry
patientModel: NX-6401
modelAge: Older
modelColor: Blue
modelOwner: Family
physicalAppearance: Normal
reasonForVisit: Acting Strange
****familySupport:** Very Concerned
****physicalComponet:** Unlikely
goal: Diagnose Patient

After this, the technician can eliminate this rule and action sequence, because it's obvious that the owners understand Henry and how to care for him.

Rule2: If the root issue lies in the care of the robot,
Action2: Then consult the owner further trying to further identify the misconceptions.

Finally, the technician will dive deeper and assume that Henry must have a computational issue. From more questioning, his knowledge base will expand to something like this based on the new percept:

Percept3: Henry seems to be knowledgeable about the Johnson's purchase of a new robot.

agent: Protagonist/Robot Whisperer/Technician
patient: Robot
patientName: Henry
patientModel: NX-6401
modelAge: Older
modelColor: Blue
modelOwner: Family
physicalAppearance: Normal
reasonForVisit: Acting Strange
familySupport: Very Concerned
physicalComponet: Unlikely
****patientDemeanor:** Sad, Unconfident
****patientResponseTime:** Normal
goal: Diagnose Patient

Now, the technician has now found a rule that fits the case, and will interview the robot and his family further to understand why this occurred.

Rule3: If the root issue seems to be a computational under-performance,
Action3: Then further interview the robot and owner to narrow down the subject space.

From here the technician asks the family how long this has been occurring and the little girl said he just stopped responding. Henry doesn't seem to fail in a particular category, so the technician will just apply the general rule-action sequence:

Rule4: If there seems to be no particular subject issue under-performance,
Action4: Then question the robot in particular about his/her thoughts on the case.

After this, the technician will find out from the family that the Johnson's bought a new robot across the street. Henry then acknowledged and referenced this new purchase to his own failures, admitting that he is failing! From this knowledge, the technician must see a strange tendency that the robot knows he is under-performing, but yet has not acted differently. From there the technician will apply something similar to Rule 5 which comes with a new action sequence:

Rule5: If the robot expresses concerns about particular changes or occurrences,
Action5: Then consult the owner to determine the background behind these changes.

Finally from Action 5, the technician will learn that the new robot was indeed an A-01, a much more powerful robot then Henry, who is a NX-6401. From here the technician sees that it's not a problem with Henry or their owners, just his mindset or viewpoint on his productivity role. From there the technician will consult Henry telling him how humans base decisions off of love and emotion, and not always logic. It was easy to apply Rule and Action 6 to talk with Henry and get his spirits back up.

Rule6: If the issue is a misconception and can be resolved easily,
Action6: Then direct helpful advice and care to the robot and the owner on how to move forward.

This was just a possible action sequence for the Robot Whisperer/technician/ protagonist solving Henry's case using Production System architecture based on a Rule System. There are so many ways in which this could be solved, but in reality as the agent gains more insight through percepts, they can form and follow the rule-action sequences more closely.

b)

For part b, I will walk through an example scenario of how the technician would use Case-Based reasoning to help diagnose a robot that he is seeing. Here are some general cases with percepts and actions attached to each:

Case 1:
{
The robot has a hardware issue.

percept1: the robot's physical structure is visibly damaged:
percept2: the robot is not functioning correctly when entering the office.
percept3: the robot may not be responding or is hesitant in his response.

action1: Visually assess the robot to see if the if the obviously damaged part exists.
action2: Verbally ask the robot to perform actions that seem suspiciously damaged.
action3: Once a physical component of the robot is suspected, examine further and ask more questions to get a detailed knowledge base on why the robot is damaged.
}

Case 2:
{
The owner of the robot does not have a good understanding of how to use it.

percept1: the relationship between the owner and robot seems uncharacteristically odd or strange.
percept2: the owner is asking questions about the robot that they should already know.
percept3: there seems to be a communication issue that has visibly frustrated the robot or owner.

action1: Ask the owner what tasks they give the robot on a daily basis.
action2: Ask the owner specific questions about their robot that would reveal if they lacked general knowledge about the unit and it's limitations.
action3: Ask the robot to reveal some of it's frustrations or suspicions of why it's failing.
action4: Inform the owner and robot of the knowledge gaps about each other that is hindering their relationship.
}

Case 3:
{
The robot has a computational/algorithmic issue.

percept1: There is nothing visibly wrong with the robot, yet the owner seems to think so.
percept2: The robot passes all of the physical tasks and obvious movements.
percept3: The robot's characteristic or nature seems hindered by an issue.

action1: Physically check the robot to make sure their is no hardware issue.
action2: Question the owner on it's lack of functioning: when did it start happening? What did you do about it? What was the robot's reaction?
action3: Question the robot to identify when it started to not function properly, and what caused it to computationally under-perform.
}

So in the situation of this particular story, we will assume that the technician has access to these 3 general cases in his history. When Henry was first brought in, the technician would first visually assess the robot to check for physical damage. That first percept would tell him that Henry didn't have a hardware issue because "It was large and bulky, a few years old but in decent enough shape". As he assessed further he would confirm that there was no hardware or physical components that were damaged on Henry. After that, he could eliminate Case 1. For Case 2, when the technician was engaging with the family, he clearly saw that they were concerned for Henry, and that they thought he was acting differently. It seemed that the family knew Henry well enough and how he was suppose to behave, but he was just under performing/acting oddly. Therefore the technician would then assume percept3 for Case 3 was the main root cause, where he started to perform an action sequence from that case. The technician was constantly retrieving old cases from memory, and picking the one that was most adaptable to the situation. He chose Case 3 to adapt to the current situation, and then evaluated Henry further with the action sequence that had worked in the past for similar situations. He asked the owners when Henry had stopped behaving normally, and then further assessed Henry to find out it was a psychological/computational problem rooted in an insecurity. He then went to comfort Henry and remind him that being the "newest" or "best-looking" robot doesn't mean that's what your owner wants. The technician most likely used Case-Based Reasoning to solve many cases, including Henry's diagnosis.

c)

Again, using the appropriate knowledge representations vary greatly on the type of problem your agent is attempting to solve. When the agent is given a fixed input or one that can be controlled, it is very effective to use a Rule-Based system. For example, if you know your agent is getting a controlled boolean describing a certain characteristic or perceptron, it would be easy to build a decision tree to model how the agent should act. The use of the If Then decision/goal tree can predict the outcome or action sequence based on the situation. The rules can then be formed at each branch of the tree to decide how the situation is moving down the tree. Simple inputs that can easily be quantified can be evaluated to adhering to the rules that are formed per situation. In this situation, rules could be used to evaluate the physical component of a robot, and then check to see if an issue was found. If not, then it must be something else so you would keep looking, but otherwise you would evaluate further until the particular broken component was found. However, rules do have their limitations, especially when the input is not from a fixed finite space where the rule can be applicable. In situations where a robot is searching for a rabbit in a maze, there are a finite amount of possibilities that the robot will encounter. Therefore, rules can be developed and evaluated so that the robot can have actions based on it's perceptions at each stage. However in our scenario of the technician treating a robot, Rule-Based knowledge representations may not be the best fit. For example, there are many different types of robots or models, all experiencing different problems. You can't make a rule for every model of robot, and the rule is no use if it's a brand new model like A-01 from the story. There are many other issues as well, such as what if the robot is experiencing a personal problem based on it's owner? Because the possible state space of rules has to account for human influence, it's almost impossible to develop a Rule-Based system that would effectively design an agent to diagnose a robot. However, Case-Based Reasoning can be extremely useful in the scenario from the story. As the technician treats more and more robots, his ability to immediately find a solution will improve, as he has more cases to reference. Case-Based Reasoning is about applying a memory and analogically mapping the problem to the current situation, obviously choosing the most similar one. For this example, the technician obviously saw that what was bothering Henry was not a hardware error, but was just his own computations causing an insecurity, which seems that he had experienced a robot before that had self-conscious issues. Case-Based reasoning allows an agent to quickly come up with a solution by indexing into their knowledge base retrieving a similar experience. However, if a new situation is completely different than the one they have experienced, the agent will most likely taking longer to diagnose the problem and find a solution. But, next time that situation arises, the agent has an action plan ready to be applied. Both Rule-Based and Case-Based reasoning can be effective knowledge bases for agents, you just need to understand the complexity of the state space for possible perceptions.

d)

For this problem, we will eliminate a rule from the working memory of our agent, and show how the case-base could still be used to solve the diagnosis. Instead of using the patient story of Henry, let's say another robot Sally was brought in to see the technician. However, the owner has said nothing except that she's broken. And for the sake of this problem, let's say that the technician is missing this rule from it's working memory:

Rule2: If the root issue lies in the care of the robot,
Action2: Then consult the owner further trying to further identify the misconceptions.

So from here, the technician would first assess Sally physically to understand if the issue is a hardware component. After a slight inspection, the technician would see that Sally seems to be experiencing no physical issues, so it would label Rule 1 as false and go to Rule 3. For Rule 3, the technician would then ask Sally a series of questions, trying to gage what category her software is failing. However, if Sally's issue doesn't lie in her programming, then she won't fail any of the tests. The technician would then engage the owner of Sally to try to see where she is under-performing, however let's say the owner didn't give much feedback. From here the technician is stuck, because both rules of hardware and software are both false in this situation, leaving him with no actions to perform. However from Case-Based Reasoning, if no general rules apply to the situation, he can analogically map a case from the past and apply the action sequence to the present time. Let's say that the technician had experienced a case similar to this, and here is a general outline of how he treats patients involved in this type:

Case 2:
{
The owner of the robot does not have a good understanding of how to use it.

percept1: the relationship between the owner and robot seems uncharacteristically odd or strange.
percept2: the owner is asking questions about the robot that they should already know.
percept3: there seems to be a communication issue that has visibly frustrated the robot or owner.

action1: Ask the owner what tasks they give the robot on a daily basis.
action2: Ask the owner specific questions about their robot that would reveal if they lacked general knowledge about the unit and it's limitations.
action3: Ask the robot to reveal some of it's frustrations or suspicions of why it's failing.
action4: Inform the owner and robot of the knowledge gaps about each other that is hindering their relationship.

}

From here, the technician may see that the issue does not lie within Sally, but actually just the relationship with her owner. Then, the technician would follow the action sequence by asking specific questions to the owner the tasks he assigns Sally, and where that conflicts with her design. From there, he can find the root issue that the owner wants Sally to pick up heavy objects, but her physical design was not meant for that kind of work. This is just a simple example that agents and humans use past cases all of the time when specific rule-based systems just don't apply to a situation. Humans especially are gifted at solving Case-Based problems as are minds are powerful enough to quickly map to a previous similar scenario. When trying to apply rules to a sequence, there sometimes can be failure as rules tend to be general and not applicable to certain situations. Therefore, Case-Based reasoning may be the only option to developing an agent's action sequence for a particular problem. This can be implemented in our required projects through using the checkAnswer function, which will allow our agent to see the right answer, and then correctly categorize the problem. From there, our agent can store the problem and answer so that it can reference it later when a similar problem arises.

3.

First of all, this is an excellent question that hopefully will have to be answered by AI researchers in the future because of the advancement of intelligent agents. And my answer based on the story is no. I honestly had not thought that the protagonist or technician from the story could possibly not be a human. Because the wife asked “Can you fix him, doctor?”, I automatically assumed that the protagonist in the story was a male human character. However, it could very well be a robot too, because a robot agent given more masculine characteristics such as a deeper voice might be referred to as a male, and obviously a female if the opposite exists. However, I feel that the design of my cognitive systems would apply both to a human and a robot technician. When applying frames to sentences in the problem, I described the protagonist as an agent, that had characteristics of a robot and a human. The thought process of logic and Case-Based reasoning would be the exact same design if it was for an intelligent agent or for a human “doctor”. If in fact I was designing a thought process for an expert knowledge system (like the protagonist), then I would definitely try to understand exactly how a human doctor solves problems and keep it as similar to that approach as possible. Because human intelligence is the most sophisticated system we know, when designing an agent I would want to be as close as possible to that level. Even though I am not a doctor, when I am trying to solve case type situations, I use a combination of both rules and case-based reasoning to find a conclusion. If my perceptrons reveal detailed knowledge about a situation, I then store these facts in a logic type scenario, seeing if they equate to a True/False conclusion. However, if enough of these perceptrons map to my knowledge base in the past of a similar problem, I simply analogically map the resolution of that frame to the current problem. So when trying to design a knowledge base for an agent in question 1 and 2, I would take the exact same approach. Because many of the strategies for designing knowledge bases for agents are based on how humans make cognitive decisions, it doesn’t make a difference in a lot of implementation strategies when trying to design an extremely intelligent agent. If may make a difference in minor details when designing the slots of certain frames or the limitations of If Then cases for rules, but this again should be limited when dealing with advanced intelligent agents (like the protagonist if he was a robot). It’s hard to define intelligence in behavioral terms, but I don’t think anyone would argue that the protagonist in the story was indeed intelligent, being able to reason the root cause of Henry’s insecurity issue. So when designing the knowledge base for an extremely intelligent agent or for human cognition, knowing which one does not drastically alter the way I design a solution.