

Disney's "Tangled"

1. Centuries ago, a droplet of sunlight fell from the sky and landed on Earth. When it touched the ground, a radiant, glowing yellow flower blossomed. An old crone named Gothel found the flower and discovered that, when she sang a certain song to it, it emitted a power that restored her youth. What did Gothel do with the flower?
2. Time passed and a kingdom grew and prospered nearby. The King and Queen desperately wished for a child and, when the Queen became pregnant, the entire kingdom celebrated. However, the Queen soon after fell deathly ill. Upon hearing a rumor that spoke of a legendary flower created by a drop of sunlight with the potential to heal the Queen, the King spared no time and sent his soldiers out to find it. Where did they find it?
3. They brought it back to the castle where it was distilled into an elixir and given to the Queen. To everyone's great relief, the Queen recovered and soon gave birth to a beautiful baby girl who, unlike her parents, had shining golden hair. The Royal family celebrated the occasion by lighting a paper lantern and sending it into the sky with the emblem of a sun printed onto it. This is a very common thing to do in China. Why would a paper lantern rise into the sky? Explain.
4. How would you design a paper lantern to rise into the air without starting a fire? Sketch your design below:
5. Gothel was determined not to lose the magical powers that gave her eternal youth, so she crept into the castle late one night and found the baby princess lying in her crib. She recited the old song and the baby's hair glowed just as the flower had. Gothel attempted to cut just enough hair to keep. What happened to the yellow hair and its magical power?
6. Frustrated and desperate, Gothel resolved to kidnap the princess and fled with her deep into the forest. She took the baby to a secret tower hidden in an alcove where she gave her the name Rapunzel and raised her as her own daughter. She taught the girl to sing the old song to make her hair glow and restore Gothel's beauty and kept her hidden from the world, telling her that it was for her own safety and that anyone on the outside wouldn't hesitate to steal her magic hair. The only access to the world Rapunzel had was a wide window from which Mother Gothel came and went, using Rapunzel's hair as a rope ladder. Despite playing the part as 'mother', Gothel often cruelly teases Rapunzel and guilt-trips her whenever she is upset or disappointed, dramatically proclaiming, "now I'm the bad guy". Rapunzel had remarkable hair not just because of its physiologically improbable length of over 70 feet, or its magical powers, but also because of its apparently formidable tensile strength. Let's do a quick calculation to determine the amount of force exerted on Rapunzel's head as Gothel ascends her magic locks, and the approximate force exerted on an individual hair.

- a. Let's assume Gothel has a mass of 75 kg, and in order for Rapunzel to pull Gothel up, she will have periods of upward acceleration of up to 1 m/s². Sum the forces in the y-direction and show that it is equal to $F_{net} = ma$. [Note: T = Tension of the hair; and $F_w = \text{weight of Gothel} = mg$ where $g = -9.8 \text{ m/s}^2$.
 - b. Use Algebra to solve for T:
 - c. Substitute the given values and calculate the value of T in Newtons:
 - d. Because a human head has around 100,000 hairs, then calculate the force that each hair needs to withstand?
 - e. Because human hair can have a tensile strength of up to almost a Newton, would this be a problem to lift Gothel? How about any future men that may appear?
 - f. So, is Rapunzel's hair remarkable for its tensile strength?
 - g. You might of noticed. Rapunzel would even wrap her hair around a hook form the window above to eliminate what could be excessive strain on her neck, and as she got used to the activity I'll bet it didn't even hurt her head that much. However, did her apparatus give her a mechanical advantage while lifting Gothel? Do you think Rapunzel had enough strength or friction to pull Gothel up a 70ft tower? Explain.
 - h. Design a method that would give Rapunzel a mechanical advantage. (Hint: Use a simple machine) [Additionally note that the floating pulley is the only way to split the force in half]
7. As the years passed, Rapunzel became fascinated by an annual event that thousands of floating lights are released in the sky, brighter than the stars and beautiful in all their colors. Unknown to her, it was the releasing of paper lanterns that the King and Queen held in tradition of their daughter whom they hoped would return to them one day. Additionally, what day of the year was this for Rapunzel?
 8. Rapunzel grows up into a creative young woman, finding numerous ways to keep herself entertained during the day while Mother Gothel is away, including painting, cleaning, brushing, and playing hide and seek with her pet chameleon. Though she is happy with her life in the tower, she longs to someday explore the outside world and see the place where the floating lights in the sky come from. What was the name of her chameleon?

9. Within the kingdom, standing on the roof of the castle, young thief Flynn Rider goes over the plans to his latest heist with his associates, the Stabbington brothers. They lower Flynn into the throne room where the missing princess's prized tiara sits on a guarded pedestal. Flynn steals the priceless artifact and is hoisted back to the roof with the palace guards in pursuit, led by the Captain of the Guard and his loyal horse, Maximus. The thieves make it outside the kingdom and seek refuge in the forest but soon come to a dead end. The Stabbington brothers tell Flynn that, if he gives them the satchel with the tiara in it, they'll hoist him up to the high ledge above. Once at the top, what does Flynn do?

10. Seeking refuge, Flynn comes to Rapunzel's tower and climbs the vines to the open window above. There, he is seemingly alone and takes the tiara out of his satchel to admire it, but not before he is knocked out by a blow to the head. What hits him to knock him out?

11. Rapunzel finds nothing outwardly menacing about the man and hides him in her closet as Mother Gothel comes home. Rapunzel decides that she will show Mother Gothel the young man, proving that she can take care of herself, in hopes that she will be let out of the tower for her approaching 18th birthday. However, when Rapunzel plucks up the courage to ask to leave the tower and see the floating lights, What was Mother Gothel's response?

12. Rapunzel solemnly promises not to ask to leave the tower again and, thinking it pointless now, keeps from telling Mother Gothel that she has a stranger locked away in her closet. Instead, she asks if Mother Gothel could restore her white paint by collecting special white seashells for her birthday. Mother Gothel is hesitant about making the three day journey to the shore, but acquiesces and leaves. Once out of sight, Rapunzel takes Flynn out of the closet. What does she use to tie Flynn to the chair?
13. When he comes to, she proposes a deal. She will give him his satchel with the tiara back (which she has hidden) if he takes her to see the floating lights and brings her back to the tower before Mother Gothel returns. Does Flynn agree?.

14. Outside the tower, Rapunzel digs her toes into grass for the first time and runs about the forest in bursts of elation and panic while Flynn can only watch. While excited to be out in the world for the first time, Rapunzel feels equally ashamed for having defied her mother. Despite her guilt and confusion, she assures Flynn that she is fine enough to continue the journey. Hoping to dissuade her, Flynn takes her to the nearby Snuggly Duckling Inn which is frequented by an assortment of thugs and bandits. Does Flynn's plan to scare Rapunzel into going back to the tower work? Explain.

15. When the thugs recognize him from wanted posters and attempt to hold him for a reward while one of their associates goes to inform the guards. Rapunzel pleads with them to release Flynn and asks if any of them have ever had a dream. What was their reaction?

16. When the guards arrive at the inn, the thugs help Rapunzel and Flynn escape through a secret tunnel and encourage her to live her dream. However, Maximus arrives at the inn and sniffs Flynn's trail to the secret passage behind the bar. He leads the guards to a large quarry where they corner Rapunzel and Flynn. Maximus unhinges a large wooden beam to try and get to them but this renders the dam overlooking the quarry unstable. What happens to the dam?
17. How does the Law of Conservation of Energy become a problem for Flynn? (Hint: Pendulum)
18. Rapunzel and Flynn become trapped inside a cave as falling rocks block the entrance. Water begins to flood into the cave and, realizing their doom, Rapunzel and Flynn each admit a secret to the other. Flynn confesses that his true name is Eugene Fitzherbert while Rapunzel tells him that her hair glows when she sings. However, how does she use this bioluminescence for her escape from the cave? Explain in detail. (Note: Flynn manages to dislodge the rocks, injuring his hand slightly, and break out the other side.)
19. Meanwhile, Mother Gothel returns to the tower early, having found seashells at a nearby market. She is shocked to discover Rapunzel gone and even more surprised when she finds the tiara hidden under the staircase with a satchel and a wanted poster of Flynn. Bent on retrieving Rapunzel, Gothel takes the satchel and tiara and sets out to search for her. She manages to track Rapunzel to the Snuggly Duckling, through the secret passage, into the quarry, and through the cave into the forest once more. There, she is confronted by the Stabington brothers. How does the Stabington brothers and Gothel get along?
20. That evening, Rapunzel and Flynn set up camp and Rapunzel reveals to Flynn that her hair does not just glow as she wraps it around his injured hand. She sings and, as her hair glows, it heals Flynn's injury, to his shock.
- Apparently, the Rapunzel's hair can regenerate large damaged or even destroyed areas of tissue. Cell growth is dependent on protein synthesis, which in turn, dependent on ribosome synthesis. Ribosomes are particles rich in ribonucleic acid (RNA) which participate in the synthesis of proteins within cells. RNA plays a key role in cell metabolism, specifically during the stages of division and protoplasmic growth so important to healing damaged tissue. How do you suppose Rapunzel's glowing hair can act at a distance and stimulate cell growth in another person? Can electromagnetic waves do this? Explain.
 - A wide variety of hormones play a major role in the stimulation of cell growth which is what causes healing. Steroids are one group that stimulate a certain type of cell growth---muscle cells in particular, and we can assume that Rapunzel's hair can cause another person to hype-up steroidal activity, stimulated by damage to bodily tissues. Enzymes are complex catalysts of biological origin, protein in nature and found in all cells and the blood, which

function to increase the speed of a reaction without being used in the reaction itself. Can you assume that Rapunzel's hair causes/controls exotic enzymes in a different body to contribute to the remarkable healing powers? Explain. (No.....you can't just say it was magic)

21. When Flynn leaves to gather more firewood, Mother Gothel appears to Rapunzel from the nearby bushes and tells her that they must return to the tower. Rapunzel refuses to leave and tells Mother Gothel that she thinks Flynn likes her. What was Mother Gothel's reaction to this? .

22. The next morning, Flynn wakes to see a soaking wet Maximus glaring angrily down at him. Maximus attempts to carry Flynn off but Rapunzel befriends the horse and convinces him to let Flynn stay with her until after she sees the floating lights. How does Maximus react to this way of thinking?

23. While she and Flynn tour the kingdom, she notices a large tile portrait of the Royal family, including a baby with golden hair. Flynn finds himself growing fond of Rapunzel and, as the time for the lanterns to be released approaches, takes her out on a boat to the middle of the lake surrounding the castle. There, they watch in awe as the lights are released and the sky is filled with a soft orange glow. Rapunzel reveals the satchel she had been hiding to Flynn. How does Flynn react when he sees the satchel?

24. Why aren't the Stabington brothers interested in the tiara anymore?

25. Before the brothers can grab her, Mother Gothel appears and renders both of them unconscious. What did Rapunzel do after this?

26. Flynn's boat, meanwhile, docks just outside the palace. Maximus watches from nearby as Flynn comes to, having been knocked out and tied to the mast of the boat with the tiara beside him. Where does Flynn end up?

27. Back within the confines of the tower, Mother Gothel comforts Rapunzel and tells her that they shall put this whole experience behind them. As she walks up to her room, Rapunzel notices a recurring theme: all around her, painted on the walls and embroidered on her bed sheets, is the same sun emblem that she saw within the kingdom and on the very lantern she pushed skyward. What does Rapunzel remember and how does she react?

28. When Rapunzel asks what's to become of Flynn, what does Gothel tell her?
29. As he is led to the gallows, Flynn sees the Stabington brothers incarcerated in their own cell. He demands to know what has happened to Rapunzel and they admit that they were acting under the promises of Mother Gothel to get Rapunzel back. Flynn struggles to escape, knowing that Rapunzel is in danger, but is unable to. How does he finally escape?
30. Beneath the tower, he calls out to Rapunzel and her hair is let down for him to climb. When he reaches the top, how does he find Rapunzel?
31. Before Rapunzel can warn Flynn, Gothel emerges from the shadows and stabs Flynn in the side with her dagger. He reels back, falling against a vanity mirror and breaking the glass. Gothel then tells Rapunzel that she will take her far away where no one will ever find her. Struggling against her gag, Rapunzel promises that she will go with Gothel willingly if she is allowed to heal Flynn. Gothel agrees and Rapunzel goes to the dying Flynn. Before she can begin singing what does Flynn do?
32. What happens to Gothel?. What was her acceleration at that time?.
33. With his dying breath, Flynn tells Rapunzel that she was his new dream and she tells him the same. Crying over him, Rapunzel recites her song one last time. How does she finally save him?
34. Do you think that she introduced that exotic enzyme that I mentioned in #19 (b)? Is this more likely than an emitting an electromagnetic wave and activating the chemicals to heal a knife wound?
35. How does the movie end? Explain.