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TASK 2: INTRODUCTION TO WEB APPLICATION SECURITY

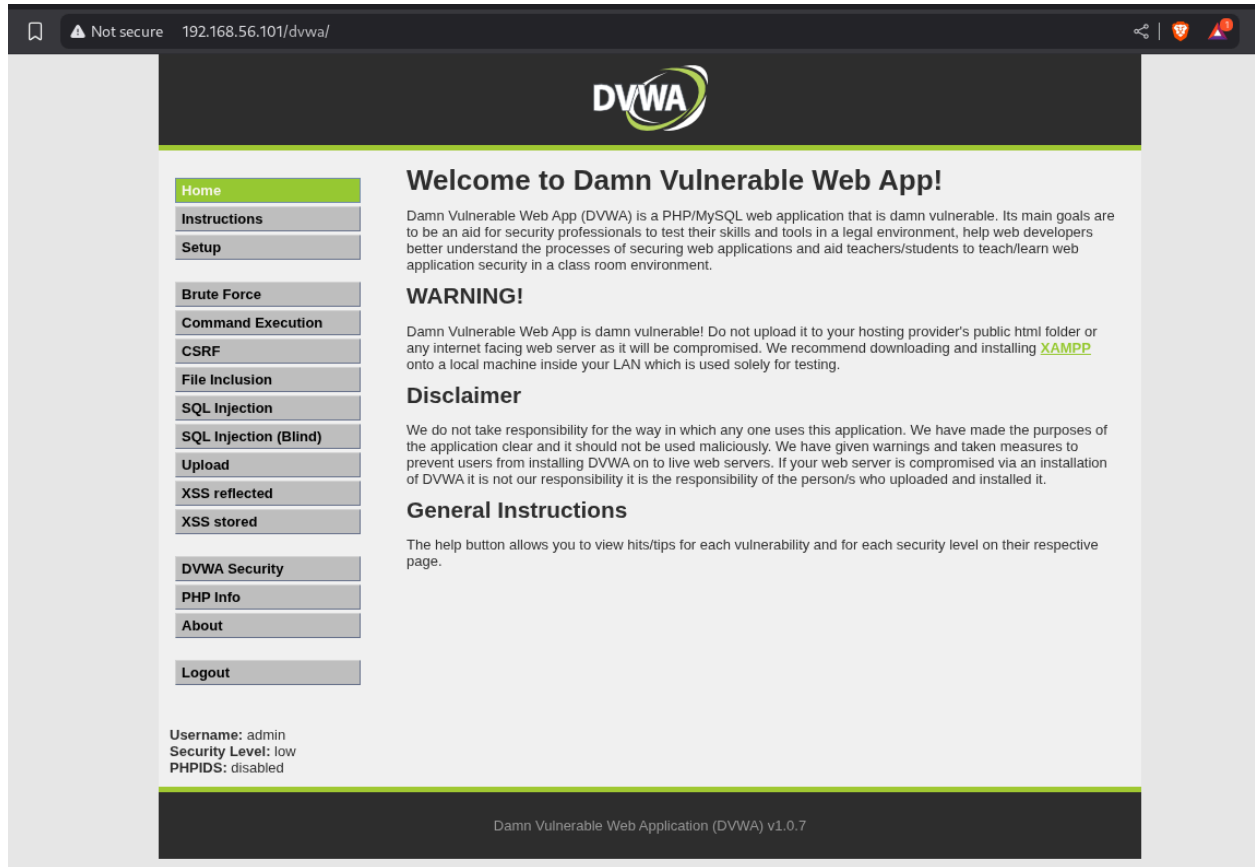
Objective: Learn about common web application vulnerabilities by analysing a simple web application. This task will help us understand how attackers can exploit weaknesses in web applications.

Tools used: OWASP ZAP, Metasploitable.

For this exercise, I have installed a vulnerable machine on my VirtualBox called “**Metasploitable 2**” which I think would be perfect for practice!

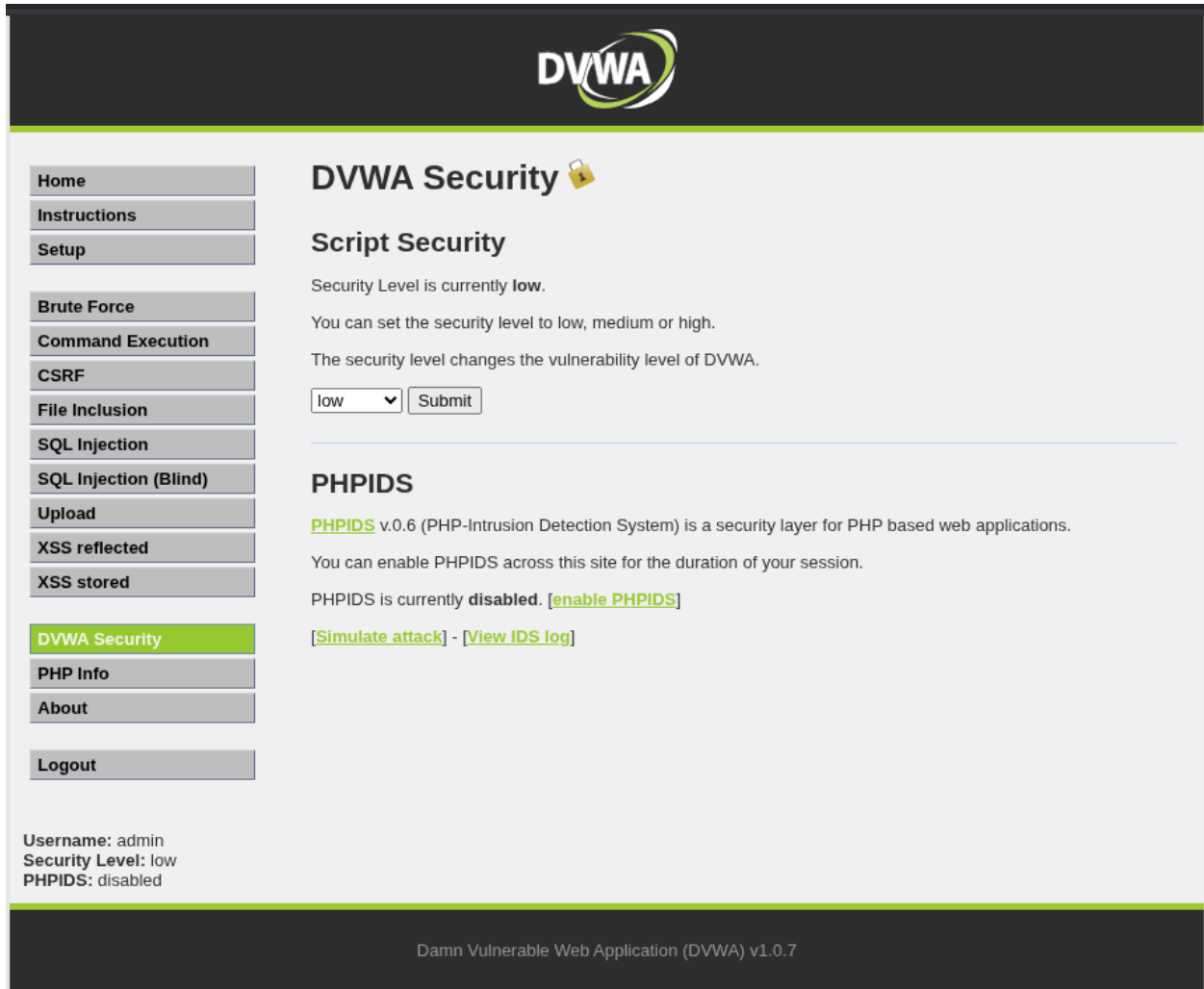
For my first exercise, I had launched a Metasploitable virtual machine and then checked what my IP was using the **ifconfig** command. After that I headed over to **DVWA** which stands for “**Damn Vulnerable Web App**”. It is a PHP/MySQL web application that is susceptible. Its main goals are to be an aid for security professionals to test their skills and tools in a legal environment, help web developers better understand the processes of securing web applications and aid teachers/students to teach/learn web application security in a safe environment. We can easily access it through the following link “<http://192.168.101/dvwa>” (IP differs) which displays a login screen. It still has the default username and password of “**admin**” and “**password**” respectively. Once in, we can see the home page of DVWA as the following.

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Since we are still starting out, we will get to learn about easy vulnerabilities and move to harder ones over time. You can do so by clicking on “**DVWA Security**” on the left hand side. Turning this setting on changes the vulnerability level of DVWA. It has a total of 3 settings, high, medium and low. As for our task, I’ll be setting it up to “**low**” for now and then click “**Submit**”.

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The screenshot displays the DVWA (Damn Vulnerable Web Application) interface. At the top, the DVWA logo is visible. The left sidebar contains a menu with the following items: Home, Instructions, Setup, Brute Force, Command Execution, CSRF, File Inclusion, SQL Injection, SQL Injection (Blind), Upload, XSS reflected, XSS stored, DVWA Security (highlighted), PHP Info, About, and Logout. The main content area is titled "DVWA Security" with a lock icon. Below this, the "Script Security" section is active, showing the current security level as "low". It includes instructions on how to set the security level to low, medium, or high, and a note that the security level changes the vulnerability level of DVWA. A dropdown menu is set to "low" with a "Submit" button. The "PHPIDS" section follows, stating that PHPIDS v.0.6 (PHP-Intrusion Detection System) is a security layer for PHP based web applications. It indicates that PHPIDS is currently disabled and provides links to "enable PHPIDS", "Simulate attack", and "View IDS log". At the bottom of the page, the footer reads "Damn Vulnerable Web Application (DVWA) v1.0.7".

Username: admin
Security Level: low
PHPIDS: disabled

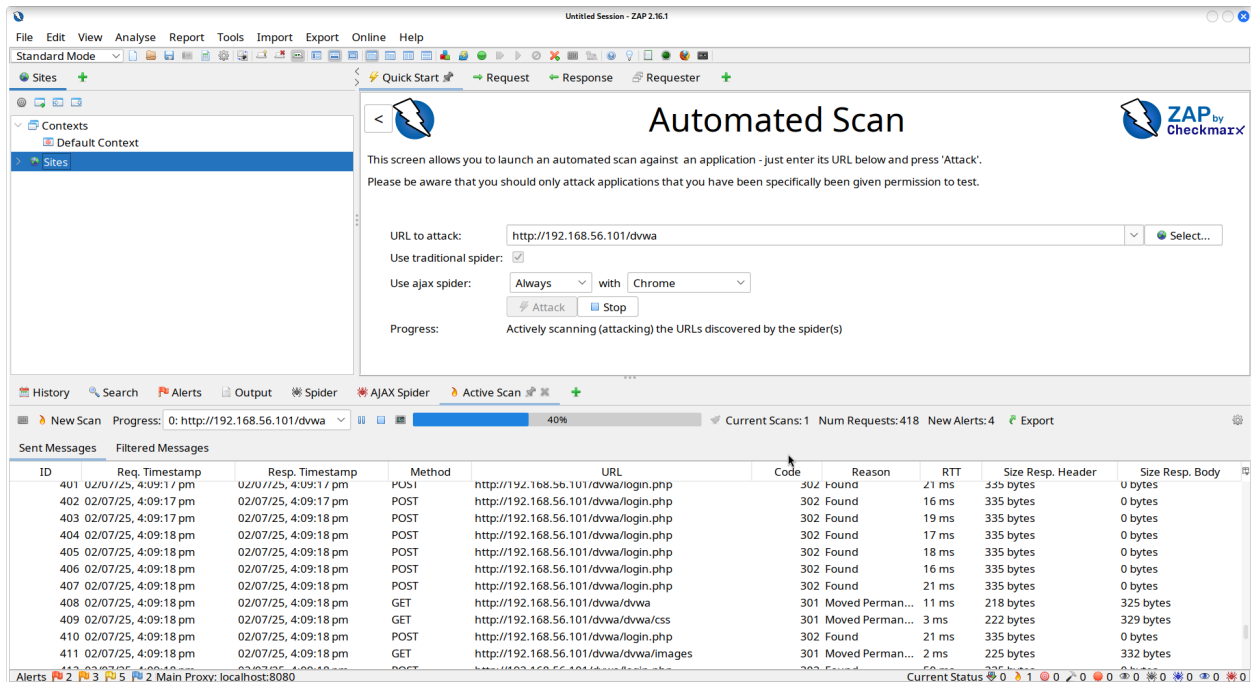
Damn Vulnerable Web Application (DVWA) v1.0.7

Once that's done, we are ready to perform some vulnerability analysis!

To perform a web scan, we will need a tool called "**OWASP ZAP**". You can download it from its official site "<https://www.zaproxy.org/>". On opening the app, we can see a URL input box and here we will enter in our DVWA website's link.

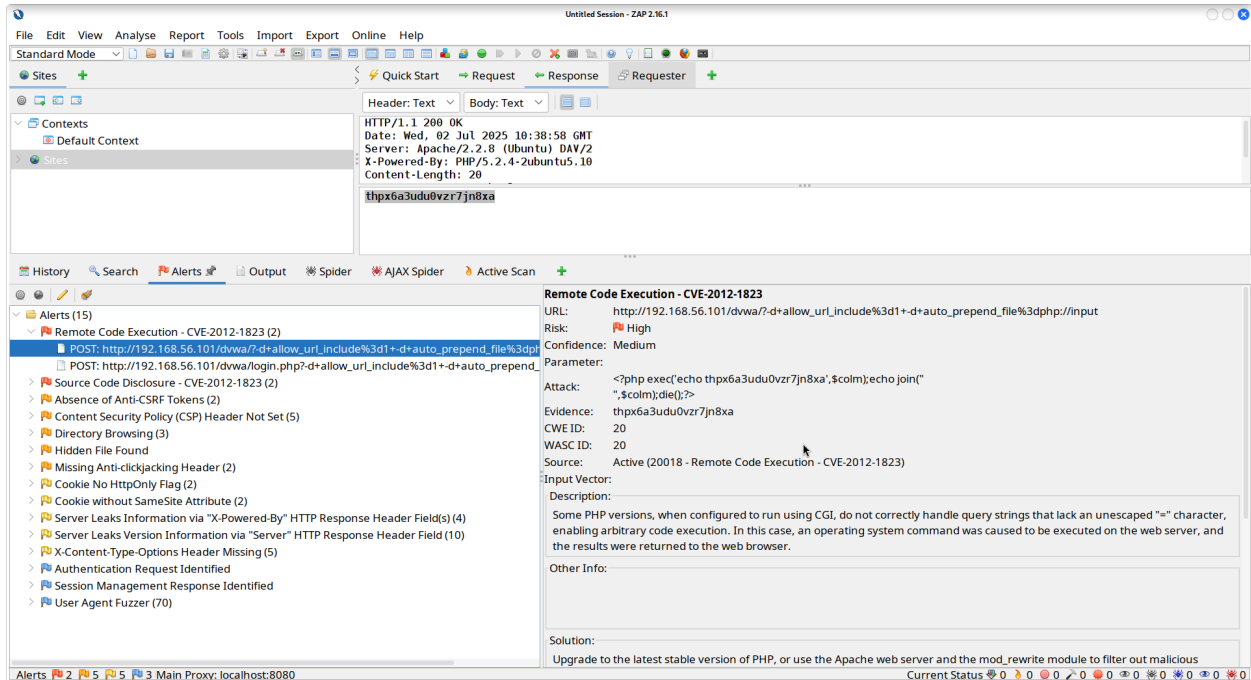
Then we click on "Attack" which starts the scan and let it run for a while since it will take a few minutes to scan the entire website for any vulnerabilities.

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Once the scan is finished, on the bottom left hand side, we can see a tab for alerts which the app found when scanning. This tab displays a list of potential security vulnerabilities (alerts) discovered during a scan. It organizes alerts by risk level (High, Medium, Low) and provides details about each vulnerability, including the URL where it was found, the description of the vulnerability, and suggested solutions as well.

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Now this was one way to scan for vulnerabilities which is more of an automated approach. Lets try to find some weaknesses in the website by manually performing some attacks on the website.

A. SQL INJECTION:

SQL injection is a code injection technique that attacks your database. It is one of the most common web hacking techniques and usually occurs when you provide an input area for the user to enter text like their username, password etc. So we will be exploiting this exact vulnerability. For this, on the DVWA website, we select the option for “SQL Injection” on the left hand side. After selecting it should display an input box on the page to enter our malicious code.

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Home

Instructions

Setup

Brute Force

Command Execution

CSRF

File Inclusion

SQL Injection

SQL Injection (Blind)

Upload

XSS reflected

XSS stored

DVWA Security

PHP Info

About

Logout

Vulnerability: SQL Injection

User ID:

More info

<http://www.securiteam.com/securityreviews/5DP0N1P76E.html>
http://en.wikipedia.org/wiki/SQL_injection
<http://www.unixwiz.net/techtips/sql-injection.html>

Username: admin
Security Level: low
PHPIDS: disabled

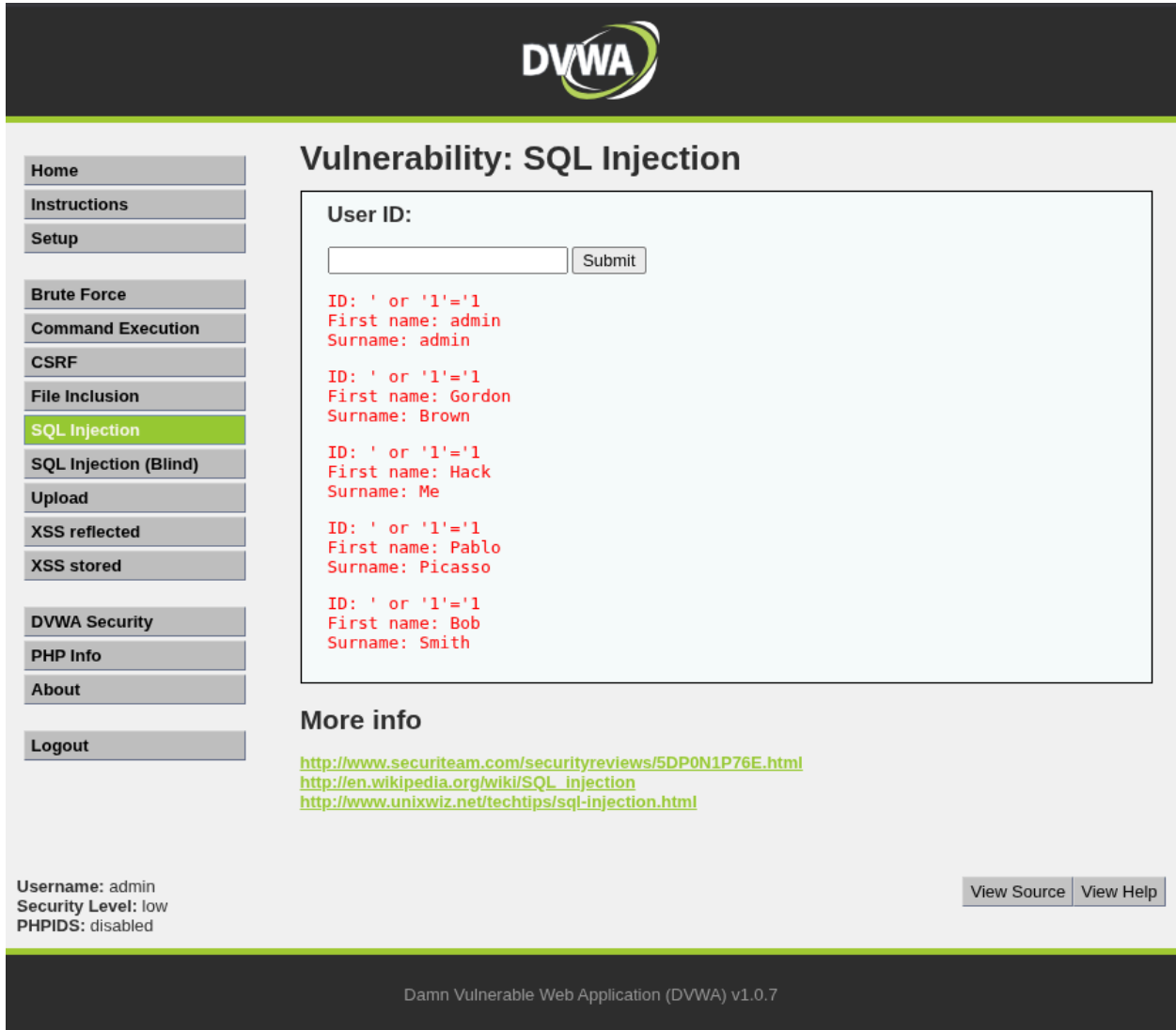
Damn Vulnerable Web Application (DVWA) v1.0.7

Here, in the input field, I entered a code “ or '1'=1” which when submitted, displayed the information regarding other user’s first and last name. The code specifically is a malicious SQL query which always evaluates true i.e “1=1”. Since '1'=1' is always true, the query ignores the real username/password check and returns the first row from the database.

This basically means that an attacker can log in without knowing any valid credentials of any user accounts and with an SQL injection attack be able to see confidential information of employees like company email addresses and their passwords listed right away for them.

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The multiple records that were returned shows that our attempt for SQL injection was successful.



DVWA

Vulnerability: SQL Injection

User ID:

ID: ' or '1'='1
First name: admin
Surname: admin

ID: ' or '1'='1
First name: Gordon
Surname: Brown

ID: ' or '1'='1
First name: Hack
Surname: Me

ID: ' or '1'='1
First name: Pablo
Surname: Picasso

ID: ' or '1'='1
First name: Bob
Surname: Smith

More info

<http://www.securiteam.com/securityreviews/5DP0N1P76E.html>
http://en.wikipedia.org/wiki/SQL_injection
<http://www.unixwiz.net/techtips/sql-injection.html>

Username: admin
Security Level: low
PHPIDS: disabled

Damn Vulnerable Web Application (DVWA) v1.0.7

Ways to defend it:


- Using prepared statements and parameterized queries.
- Having input validation setup so as to skip out any special characters attackers might input.
- Principle of least privilege.

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B. CROSS-SITE SCRIPTING

Cross site Scripting(XSS) is another common web vulnerability that attackers use to target a user's browser. It may seem similar to SQLi but they both target different parts of a web app and are used for different purposes. There's different types of XSS attacks but for this exercise, we will be performing an “**XSS- Reflected**” attack.

On the left sidebar, click on XSS(Reflected)



Home

Instructions

Setup

Brute Force

Command Execution

CSRF

File Inclusion

SQL Injection

SQL Injection (Blind)

Upload

XSS reflected

XSS stored

DVWA Security

PHP Info

About

Logout

Vulnerability: Reflected Cross Site Scripting (XSS)

What's your name?

More info

<http://hackers.org/xss.html>
http://en.wikipedia.org/wiki/Cross-site_scripting
<http://www.cgisecurity.com/xss-faq.html>

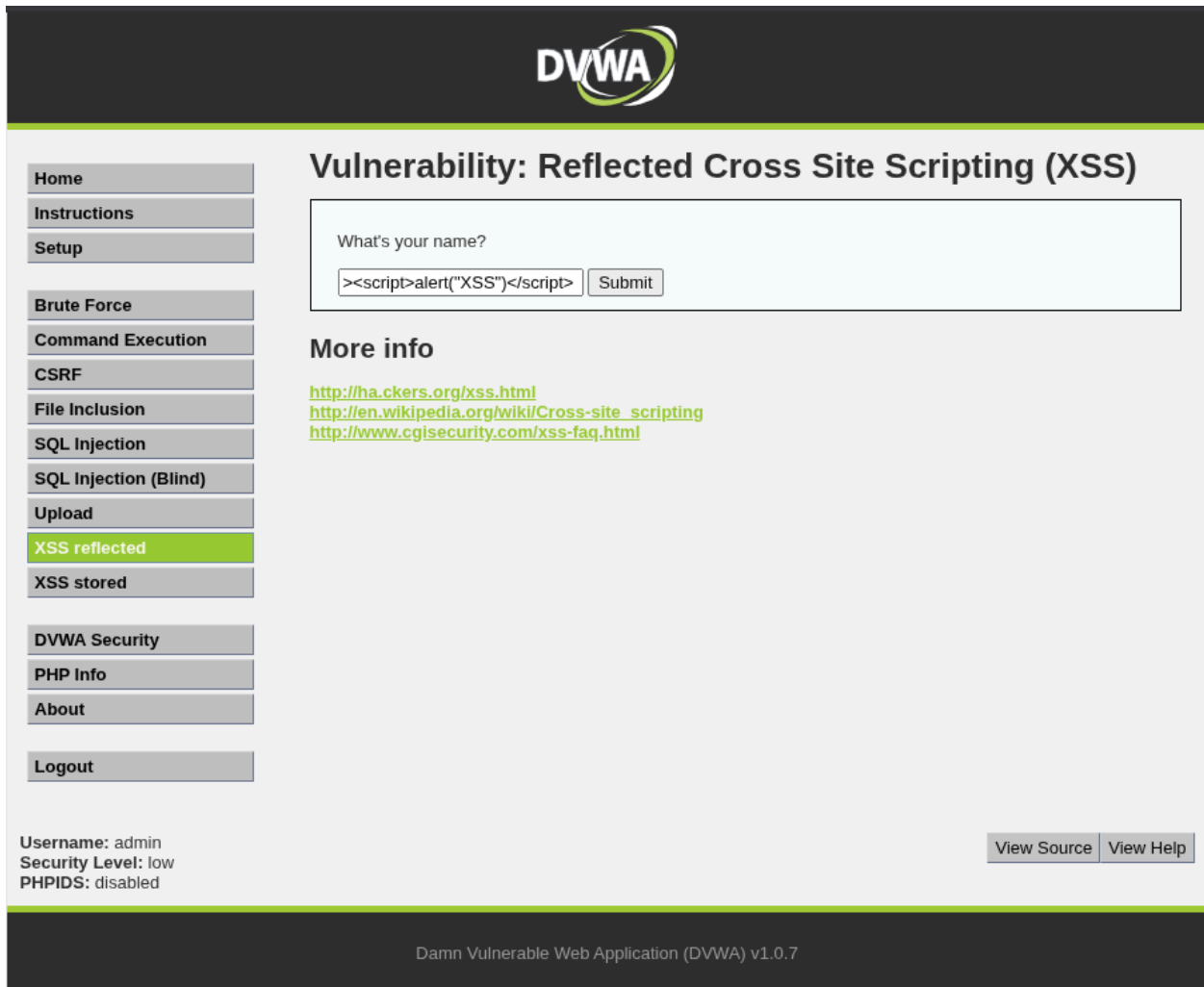
Username: admin
Security Level: low
PHPIDS: disabled

Damn Vulnerable Web Application (DVWA) v1.0.7

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In the input field, I will be entering a javascript code which is not malicious but instead the website will take my prompt and it will act as a code that is inbuilt to the website.

For example, I entered "<script>alert('XSS')</script>".

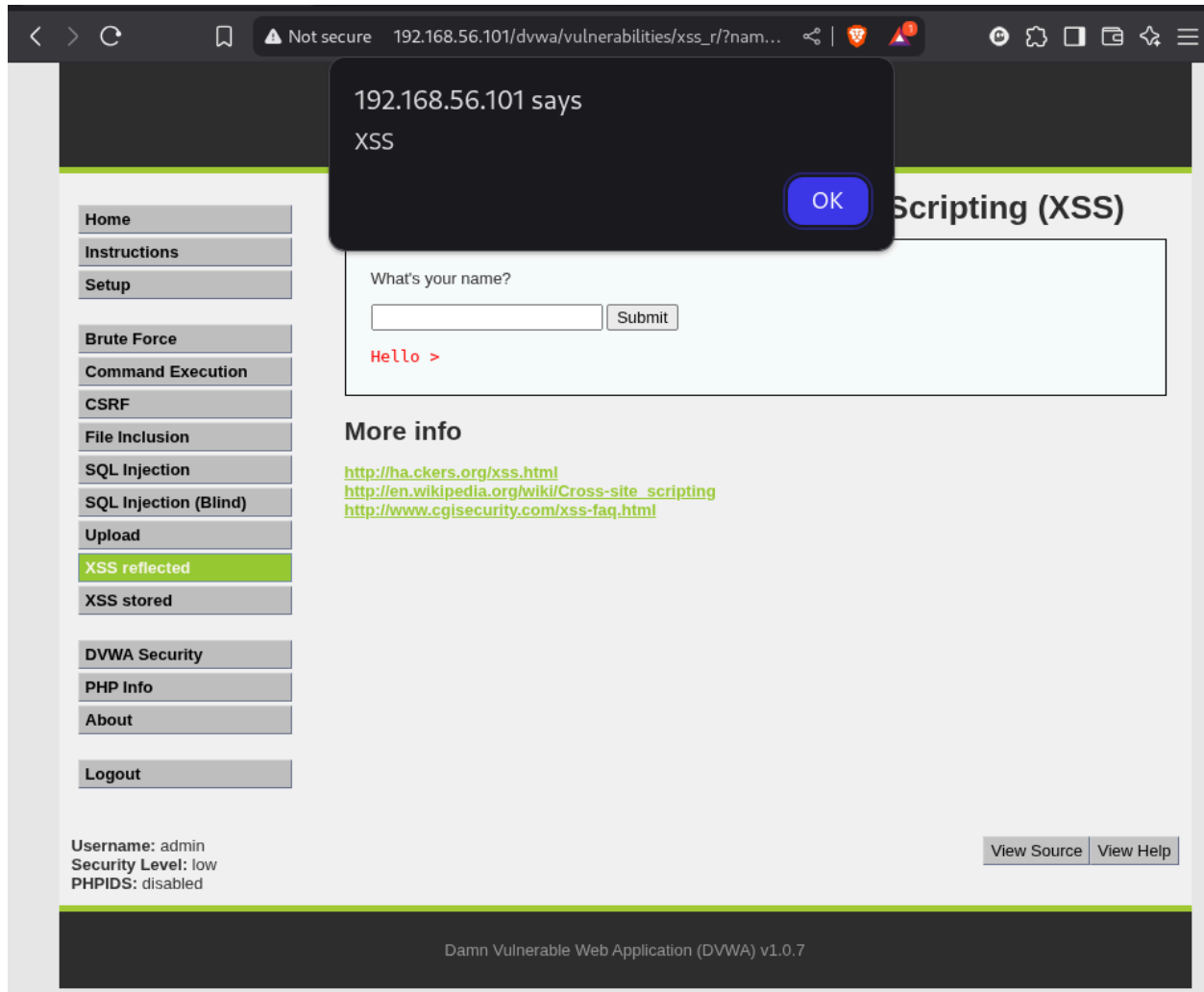


The screenshot shows the DVWA (Damn Vulnerable Web Application) interface. The top header features the DVWA logo. On the left, there is a sidebar with navigation links: Home, Instructions, Setup, Brute Force, Command Execution, CSRF, File Inclusion, SQL Injection, SQL Injection (Blind), Upload, XSS reflected (highlighted in green), XSS stored, DVWA Security, PHP Info, About, and Logout. The main content area is titled "Vulnerability: Reflected Cross Site Scripting (XSS)". It contains a form with the label "What's your name?" and an input field containing the payload "<script>alert('XSS')</script>". A "Submit" button is next to the input field. Below the form, there is a "More info" section with three links: <http://ha.ckers.org/xss.html>, http://en.wikipedia.org/wiki/Cross-site_scripting, and <http://www.cgisecurity.com/xss-faq.html>. At the bottom left, the user information is displayed: "Username: admin", "Security Level: low", and "PHPIDS: disabled". At the bottom right, there are two buttons: "View Source" and "View Help". The footer at the very bottom states "Damn Vulnerable Web Application (DVWA) v1.0.7".

Once we click on submit, your browser will not display a popup with the word "XSS" in it.

This popup is proof that the website is vulnerable to cross site scripting and instead of our payload an attacker may be able to execute actual malicious code to get sensitive info like cookies, session tokens etc.

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Ways to defend:

- Using Content Security Policy(CSP) (Defines what content is allowed to load on a webpage)
- Sanitizing/Validating input and output.
- Preventing Javascript from accessing session cookies by using HTTPOnly Cookies.

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C. CSRF(Cross-Site Request Forgery)

Cross-Site Request Forgery (CSRF) is an attack that forces an end user to execute unwanted actions on a web application in which they're currently authenticated/logged in. With a little help of social engineering (such as sending a link via email or chat), a threat actor may trick the users of a web application into executing actions of the actor's choosing. If the victim is a normal user, a successful CSRF attack can force the user to perform state changing requests like transferring funds, changing their email address, and so forth.

To test this out, we will be using bWAPP instead, which is also a buggy web app to practice and exploit vulnerabilities. I have installed it using **Docker** so it can run right on my localhost without having the need for the internet. The default username and password for the site are “**bee**” and “**bug**” respectively. After logging in, on the left hand drop down security menu choose the security level as **low** and from the drop-down bug menu select “**CSRF - Change password**”.

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The screenshot shows the bWAPP web application interface. At the top, there is a yellow header with the text "Choose your bug:" and a dropdown menu showing "bWAPP v2.2". To the right of the dropdown is a "Hack" button. Below this, the text "Set your security level:" is displayed, followed by a dropdown menu showing "low" and a "Set" button. To the right of the "Set" button, the text "Current: low" is shown. Below the header, there is a dark navigation bar with the following links: "Bugs", "Change Password", "Create User", "Set Security Level", and "Reset". The main content area is white and features the title "/ CSRF (Change Password) /". Below the title, the text "Change your password." is displayed. This is followed by two input fields: "New password:" and "Re-type new password:". Below these fields is a "Change" button. Below the button, the text "The password has been changed!" is displayed in green. At the bottom of the page, there is a dark footer with the text "bWAPP is licensed under" followed by a Creative Commons license icon (CC BY-NC-ND), the text "© 2014 MME BVBA / Follow @MME_IT on Twitter and ask for", and a small "bWAPP" logo.

After entering the new password and retyping it again to finally click on “**Change**” we can observe in the URL our changed password! This means that the application is letting you change your password via GET-requests. This flaw can easily be used by attackers to exploit your web app.

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The screenshot shows the bWAPP web application interface. The header is orange with the bWAPP logo and a bee icon, and the text "an extremely buggy web app!". The navigation bar is dark grey with links: Bugs, Change Password, Create User, Set Security Level, Reset, and a partially visible "C". The main content area is light grey and titled "/ CSRF (Change Password) /". It contains a form with the following elements:

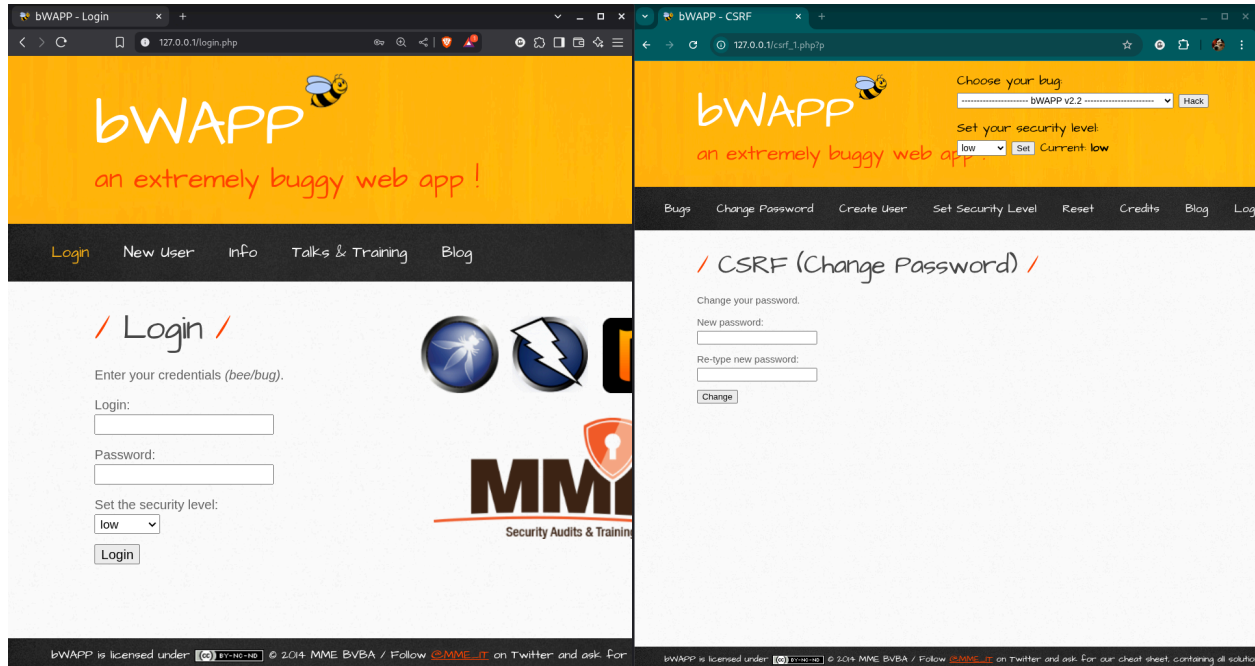
- Text: "Change your password."
- Text: "New password:" followed by a text input field.
- Text: "Re-type new password:" followed by a text input field.
- Text: "Change" button.
- Text: "The password has been changed!" (in green).

To test it out, I created a dummy html file which mimics the bWAPP web application to see if I am able to change passwords from this dummy file which in turn affects the original web app. Wrote a basic html code for some GUI.

```
File Edit Selection Find View Goto Tools Project Preferences Help
csrf_test.html
1 <html>
2 <body>
3 <h1>CSRF fake page</h1>
4 <form action="http://127.0.0.1/
  csrf_1.php?password_new=bug&password_conf=bug&action=change
    " method="POST">
5 <input type="hidden" name="new_password" value="">
6 <input type="hidden" name="retype_password" value="">
7 <input type="submit" value="Hacked!">
8 </form>
9 <script>
10 document.forms[0].submit();
11 </script>
12 </body>
13 </html>
```

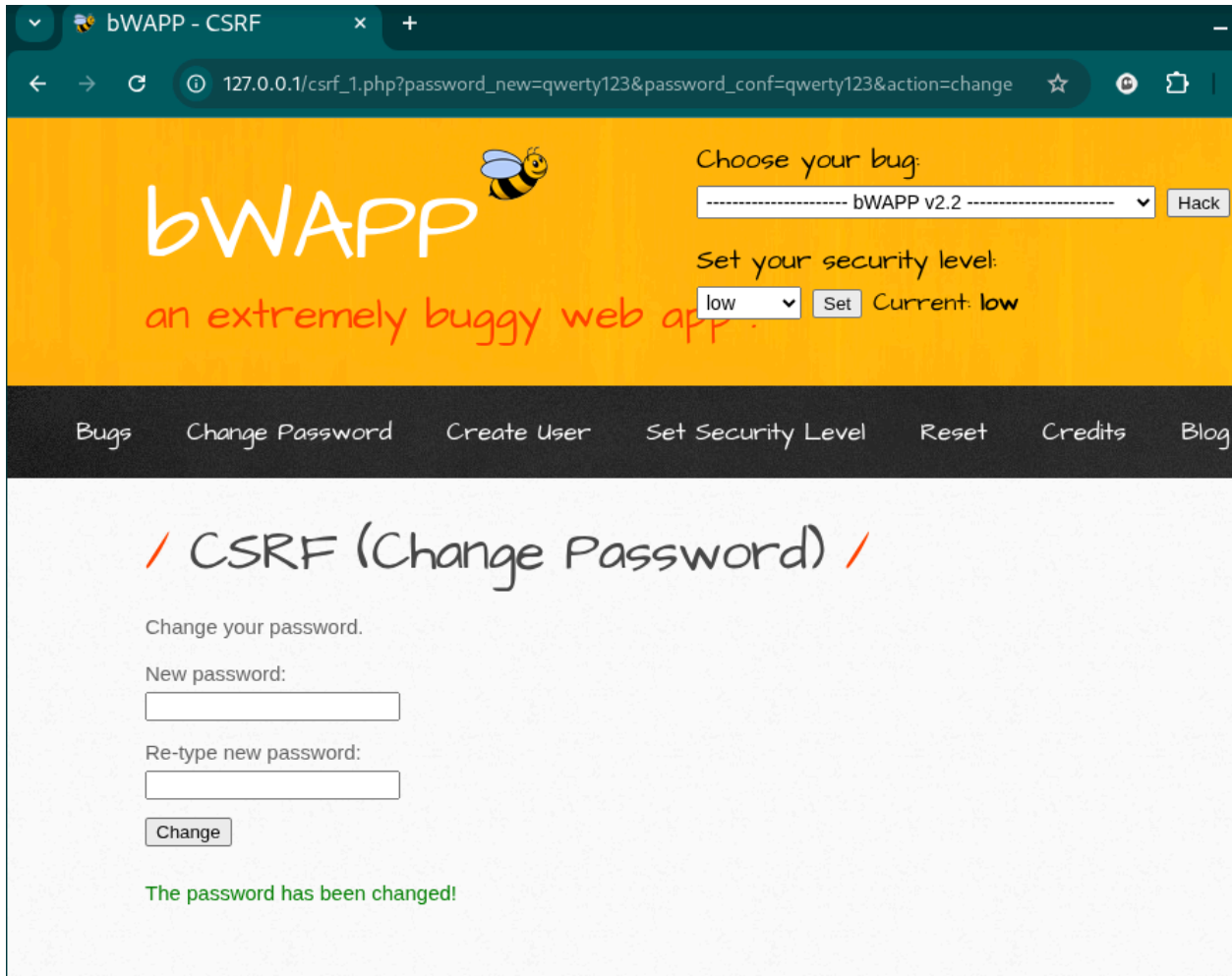
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Here, I have provided a form action to Post the details provided in the form to the bWAPP app I am hosting on localhost(opened on Brave Browser). After opening this html file in a different browser(Chrome), it looks the same as the real one without the icons for other apps.



Now, we can try changing the password for the login on the Chrome browser where we have our local html opened and see if it actually affects the original web app.

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Once clicking on “**Change**” we can confirm that the password was changed by the prompt “**The password has been changed**”, another way to confirm is by checking the URL, which we can confirm that the new password set is now “**qwerty123**”.

Lets try to login on the original web app which we have opened on our Brave Browser with the password “**qwerty123**” which we set earlier.

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And voila! We are in! Hence using GET methods to change states is harmful. GET requests should never be allowed to perform actions, especially sensitive ones like password resets. Which is why OWASP also recommends that all state-changing actions must use POST methods and to include CSRF tokens to validate if the request is from a legit site.

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Some popular frameworks that use standardized header names for CSRF protection:

- X-CSRF-Token - Ruby on Rails, Laravel, Django
- X-XSRF-Token - AngularJS
- CSRF-Token - Express.js (csrf middleware)
- X-CSRFToken - Django

Ways to Defend:

- Using CSRF tokens which confirms the legitimacy of a request.
- Origin Checks to detect illegitimate/suspicious requests
- Making use of CORS(cross-origin requests) controls to prevent untrusted site's access to sensitive information.