# Part 1

HW 1 Readings →

1. OpenGL: A cross-platform graphics API for rendering 2D and 3D graphics.

   OpenGL ES: A version of OpenGL specifically for embedded systems (ES) like mobile devices.

   WebGL: An API for JavaScript, used for 3D graphics.

   They are all similar APIs for 3D graphics, with OpenGL ES being a subset of OpenGL.

2. Difference between a regular webpage and a WebGL webpage is, a regular webpage and WebGL webpage both use
   - HTML
   - CSS for styling
   - JavaScript

   But WebGL webpages have an additional element called <canvas>, it includes Javascript from WebGL API, with GPU shaders as well. Essentially, it uses a GPU for graphics instead of DOM render.

3. <canvas> (element) defines a drawable area in HTML where JavaScript can render graphics.

4. One line of code that writes to retrieve a 2D rendering context is →

```
const context = canvas.getContext("2d");
```

## Part 2

HW-1: Linear Algebra

1. $v = [1, 2, 3]$ $\quad |\vec{v}|^2 = 1^2 + 2^2 + 3^2 =$
$\Rightarrow |\vec{v}| = \sqrt{14}$

$$\text{Magnitude} = \frac{v}{|\vec{v}|} = \frac{1}{3.74}, \frac{2}{3.74}, \frac{3}{3.74}$$

$$= [0.269, 0.53, 0.80]$$

2.

(a) $[3, 3] + [-2, 2] = [1, 5]$

(b) $\sqrt{1^2 + 5^2} = \sqrt{26} \approx 5.09$

3.

(a) $\begin{vmatrix} i & j & k \\ 0 & 1 & 1 \\ 1 & 1 & 0 \end{vmatrix}$ $i(0-1) - j(0-1) + k(0-1)$

$= [-1, 1, -1]$

(b) $\begin{vmatrix} i & j & k \\ 2 & 3 & 4 \\ 1 & 0 & 0 \end{vmatrix}$ $i(0-0) - j(0-4) + k(0-3)$

$= 4j + (-3k)$

$= [0, 4, -3]$

(c) $\begin{vmatrix} i & j & k \\ 0 & 3 & 4 \\ 2 & 2 & 2 \end{vmatrix}$ $i(6-8) - j(0-8) + k(0-6)$

$= -2i + 8j - 6k$

$= [-2, 8, -6]$

4.

(a) $[1, 0, 1] \cdot [0, 1, 1] = 0 + 0 + 1 = 1$

(b) $[0, 3, 4] \cdot [1, 0, 0] = 0$

(c) $[2, 3, 4] \cdot [6, 4, 3] = 12 + 12 + 12 = 36$

$$\begin{vmatrix} i & j & k \\ 1 & 0 & 0 \\ 1 & 1 & 1 \end{vmatrix}$$

$= i(0) - j(1-0) + k(1-0)$

5. $(0,0,0)$ $(1,0,0)$ $(1,1,1)$ $= 0i - j + k$

(a) Area $= \frac{1}{2} \times$ base $\times$ height

base: $(1,0,0)-(0,0,0)$ height: $(1,1,1)-(0,0,0)$

$= \frac{1}{2} |((1,0,0) \times (1,1,1))|$

$= \frac{1}{2} |0i - j + k| = \frac{\sqrt{0+1+1}}{2} = \frac{\sqrt{2}}{2}$

(b) A vector perpendicular with positive $\vec{z}$ direction can just be the normal vector, $\vec{n} = 0i - 1j + 1k$ or $(0,-1,1)$

6. (a) $\begin{bmatrix} 1 & 2 & 5 \\ -1 & -1 & 1 \\ 4 & 4 & -2 \end{bmatrix}_{3\times3} \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}_{3\times1} = \begin{bmatrix} 1+4+15 \\ -1-2+3 \\ 4+8-6 \end{bmatrix} = \begin{bmatrix} 20 \\ 0 \\ 6 \end{bmatrix}$

(b) $\begin{bmatrix} 2 & 0 & 3 \\ 0 & -1 & 2 \\ 3 & 2 & -2 \end{bmatrix}_{3\times3} \begin{bmatrix} -1 & -4 & 1 \\ 1 & -1 & 4 \\ 0 & 0 & 5 \end{bmatrix}_{3\times3}$

$= \begin{bmatrix} -2+0+0 & 0-1+0 & -3+2+0 \\ -8+0+0 & 0+1+0 & -12-2+0 \\ 2+0+15 & 0-4+10 & 3+8-10 \end{bmatrix}$

(This → transposed)

(b) (Cont.)

$$= \begin{bmatrix} -2 & -8 & 17 \\ -1 & 1 & 6 \\ -1 & -14 & 1 \end{bmatrix}$$

7.

(a) $y = \frac{4}{3}x - 1$ & $y = 0$

$0 = \frac{4}{3}x - 1 \Rightarrow \frac{4}{3}x = 1 \Rightarrow x = \frac{3}{4}$

Point of intersection is $\left(\frac{3}{4}, 0\right)$

(b) $y = mx + b$

Slope of $y = \frac{4}{3}x - 1$ is $\frac{4}{3}$

~~Slope of~~ Slope of $y = 0$ is $0$

If they are perpendicular, then their product would be $-1$. Since it is not $\left(\frac{4}{3} \times 0\right) = 0$, then they aren't perpendicular.