Please read these instructions carefully!

- Answer the test questions in the separate answer sheet.
- You may use the back of all the paper sheets as drafting area (*rascunho*).
- How to:

	A	B	C	D	E
Select the answer (A):	(●	○	○	○	○)
Replace the answer (A) by (C):	(✗	○	●	○	○)
Cancel (C) and reactivate (A):	(⊗	○	✗	○	○)

- This test has 30 QUESTIONS (ignoring question zero), each question has a score of 200/30 points.
- **POINTS LOST** for each wrong answer (in percentage of the question's points):
  $\sum wrong$ $1 = 0\%$ $2 = 11.11\%$ $3 = 22.22\%$ $\geq 4 = 33.33\%$.

Name: ______________________ Number: __________

Consider the matrices presented.

$$\mathbf{M}_1 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 1/d & 0 \end{bmatrix}, \mathbf{M}_2 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & -1/d & 1 \end{bmatrix},$$

$$\mathbf{M}_3 = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & d \\ 0 & 0 & 0 & 1 \end{bmatrix}.$$

1. Which matrix could be used as a projection matrix to create a perspective or conic projection, to be used on the left of the matrix returned by function lookAt(eye, at, up), keeping the semantic of its parameters?

   A. $\mathbf{M}_1$ e $\mathbf{M}_2$. **B.** $\boxed{\mathbf{M}_1}$**.** C. $\mathbf{M}_2$. D. $\mathbf{M}_3$.

2. From the projections represented by matrixes $\mathbf{M}_1$ and $\mathbf{M}_2$, which would you choose to project an object centred at the origin?

   A. Both could be used. **B.** $\boxed{\mathbf{M}_2}$**.** C. $\mathbf{M}_1$. D. None should be used.

3. Imagine that you want to implement the projection defined by $\mathbf{M}_1$, but that you are not allowed to use that matrix. Which composition of matrices $\mathbf{M}_2$ and $\mathbf{M}_3$ would be equivalent to $\mathbf{M}_1$?

   A. $\mathbf{M}_2 \cdot \mathbf{M}_3 \cdot (\mathbf{M}_2)^{-1}$. B. $\mathbf{M}_3 \cdot \mathbf{M}_2 \cdot (\mathbf{M}_3)^{-1}$. C. $(\mathbf{M}_2)^{-1} \cdot \mathbf{M}_3 \cdot \mathbf{M}_2$. **D.** $\boxed{(\mathbf{M}_3)^{-1} \cdot \mathbf{M}_2 \cdot \mathbf{M}_3}$**.**

4. Imagine a rectangular prism (6 rectangular faces) with edges aligned with the principal axes. When the prism is projected with matrix $\mathbf{M}_2$, both edges initially aligned with the X axis and edges initially aligned with the Z axis are no longer parallel. Choose the transformation that could have been used before projection to produced the described effects.

   A. $\boxed{\mathbf{R}_y(\alpha), \alpha \in]0, \pi/2[}$**.** B. $\mathbf{R}_z(\alpha), \alpha \in]0, \pi/2[$ C. $\mathbf{I}$ no transformation. D. $\mathbf{R}_x(\alpha), \alpha \in]0, \pi/2[$

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5. What is the most appropriate name for the orthogonal projection where the scaling factors for axis x, y and z are, respectivelly: 0.88346, 0.66527 and 0.88346?

   A. perspective projection

   B. **dimetric projection**

   C. trimetric projection

   D. isometric projection

6. Which of the following sentences doesn't apply to the projection from the previous question?

   A. Distances along the X and Z directions can be measured and compared directly without further computations.

   B. **Parallel lines along the Y axis are no longer parallel to the Y axis after projection.**

   C. The angles are not preserved by the projection.

   D. Parallelism of lines aligned with X axis is preserved.

7. Consider the `ortho()`, `frustum()` and `perspective()` functions for the definition of a view volume. Choose the correct (true) sentence.

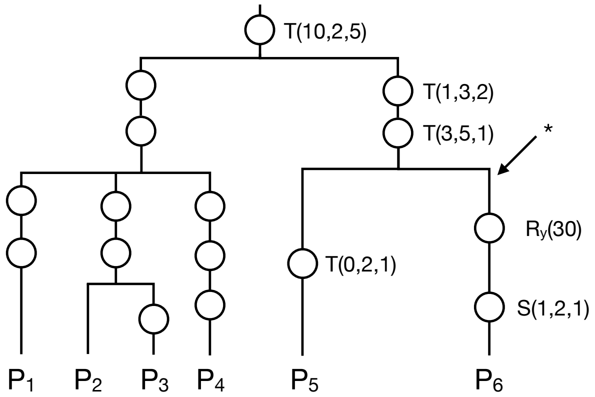
   A. **Any volume that can be specified with `perspective()` can also be specified with `frustum()`.**

   B. Each of the mentioned functions requires a distinct clipping procedure.

   C. `ortho()` projects points onto the $z = 0$ plane.

   D. `ortho()` and `frustum()` define an infinite (unbounded) volume along its depth.

Consider the scene graph shown. Assume that each primitive does not affect, in any way, the current transformation matrix.



8. What is the minimum number of Push() and Pop() pairs needed to transpose the graph into the code that draws the scene?

   A. 6 B. 3 **C.** $\boxed{\mathbf{4}}$ D. 5

9. During the scene graph traversal, what is the value of the current transformation matrix at the location pointed by the arrow ?

   A. $\mathbf{T}(3,5,1)\cdot\mathbf{S}(1,3,2)\cdot\mathbf{T}(10,2,5)$

   B. $\mathbf{R}_y(30)\cdot\mathbf{S}(1,2,1)$

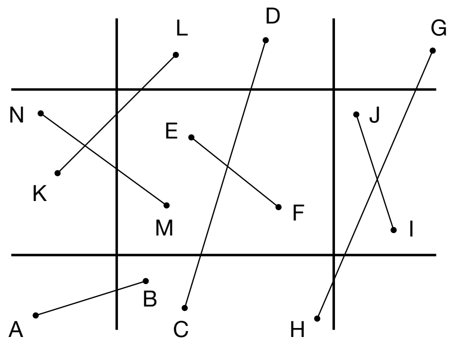
   C. $\boxed{\mathbf{T}(10,2,5)\cdot\mathbf{S}(1,3,2)\cdot\mathbf{T}(3,5,1)}$

   D. $\mathbf{T}(0,2,1)$

10. Suppose we want to get rid of the transformation immediately before P_5 by moving it upwards and merging it with $\mathbf{T}(3,5,1)$ to become $\mathbf{T}(3,7,2)$. What would be the topmost transformation on the lower level branch leading to P_6?

    A. $\mathbf{T}(0,2,1)$. B. $\mathbf{T}(-3,-5,-1)$. C. $\mathbf{T}(-3,-7,-2)$. **D.** $\boxed{\mathbf{T}(0,-2,-1).}$

The Cohen-Sutherland algorithm is going to be used to clip the line segments presented in the figure. The lines delimiting the clipping window are also visible. The order of the bits in the code is (from left to right): TOP, LEFT, BOTTOM, RIGHT.



11. How many line segments are trivially rejected?

    A. 1 B. 3 C. none **D.** $\boxed{\mathbf{2}}$

12. How many line segments are trivially accepted?

    A. 2 B. none **C.** $\boxed{\mathbf{1}}$ D. 3

13. Which line segments are effectively clipped 3 times?

    A. $\boxed{\textbf{none}}$ B. $\overline{GH}$. C. $\overline{CD}$ and $\overline{GH}$. D. $\overline{CD}$.

14. Which line segments are effectively clipped 1 time?

    A. $\overline{AB}$. B. none **C.** ~~$\overline{AB}$ **and** $\overline{NM}$.~~ D. $\boxed{\overline{NM}.}$

Apenas o segmento NM será recortado uma única vez:
- AB é trivialmente rejeitado
- CD é recortado por cima e depois por baixo
- EF é trivialmente aceite
- GH é recortado por cima e depois por baixo
- IJ é trivialmente rejeitado
- KL é recortado por cima e depois à esquerda.

15. Choose the wrong sentence from the following:

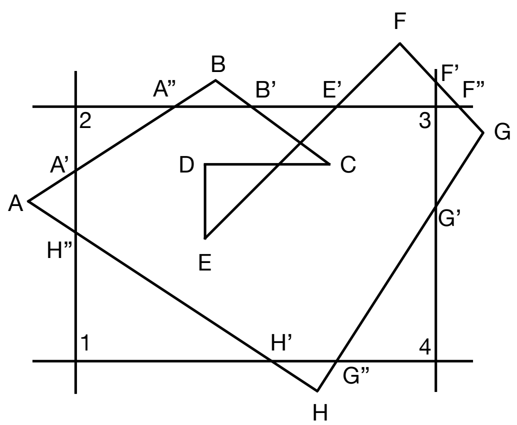
    A. cod(E) = cod(F).

    B. cod(A) = 0110, cod(G) = 1001, cod(N) = 0100.

    C. cod(L) = 1000, cod(J) = 0001, cod(B) = 0010.

    D. $\boxed{\textbf{[cod(A) AND cod(B)] = 0000.}}$

Consider the polygon P = [A, B, C, D, E, F, G, H], which is going to be clipped by the window Q = [1, 2, 3, 4] using the Sutherland-Hodgeman algorithm. Consider that the clipping order is LEFT, TOP, BOTTOM, RIGHT.



16. How many vertices contains the final clipped polygon P'?

    A. 11 B. 10 C. 9 **D.** $\boxed{\mathbf{12}}$

17. Which one is the first vertex of the output from stage 1 of the algorithm (clip LEFT)?

    A. A" B. B **C.** $\boxed{\textbf{A'}}$ D. A

18. Choose the correct sequence of vertices in the polygon that comes out of the 3rd stage (Clip BOTTOM).

A. ... C D E E' 3 G' G" ...

B. ... C D E F F' G' G" ...

C. $\boxed{\textbf{... C D E E' F" G G" ...}}$

D. ... C D E E' F' G' G" ...

The same polygon P (before clipping) is going to be painted by using the Fill Area algorithm.

19. How many entries in the edges table (TA) will be non empty?

    A. $\boxed{\mathbf{5}}$ B. 8 C. 7 D. 6

20. Which edges are stored in entry Y_D of the edges table (TA[Y_D])?

    A. $\overline{\text{DE}} \to \overline{\text{DC}} \to \overline{\text{CB}}$ **B.** $\boxed{\overline{\text{CB}}}$ C. $\overline{\text{DE}} \to \overline{\text{CB}}$ D. $\overline{\text{EF}} \to \overline{\text{CB}}$

21. Choose the last non empty entry in the edges table (TA).

    A. TA[Y_C] B. TA[Y_B] C. TA[Y_F] **D.** $\boxed{\textbf{TA}[Y_G]}$

22. What is the maximum length of the active edges table (TAA) during the execution of the algorithm?

    A. 2 B. 3 **C.** $\boxed{\mathbf{4}}$ D. 5

23. What is the contents of the active edges table (TAA) immediately before filling line Y_G?

    A. $\boxed{\overline{\text{AB}} \to \overline{\text{BC}} \to \overline{\text{EF}} \to \overline{\text{FG}}}$

    B. $\overline{\text{AB}} \to \overline{\text{FG}}$

    C. $\overline{\text{AB}} \to \overline{\text{EF}} \to \overline{\text{BC}} \to \overline{\text{GH}}$

    D. $\overline{\text{AB}} \to \overline{\text{EF}} \to \overline{\text{BC}} \to \overline{\text{FG}}$

24. Assuming that the polygon vertices lie at exact pixel locations, which vertices correspond to pixels that will be filled during execution of the algorithm?

    A. A,D and E B. A,C and D C. B,F,G and H **D.** $\boxed{\textbf{A,C,D and E}}$

Consider the Phong illumination model computed by the expression below, for direct illumination (surfaces directly visible to the eye):

$$\mathbf{I} = \mathbf{I}_a \mathbf{K}_a + \mathbf{I}_p[\mathbf{K}_d \cos(\alpha) + \mathbf{K}_s \cos(\phi)^n].$$

25. What is the color of the light source?

    A. $\boxed{\mathbf{I}_p}$ B. $\mathbf{K}_d$ and $\mathbf{K}_s$ C. $\mathbf{I}_a$ D. $\mathbf{K}_a$

26. The amount of light given by the difuse reflection term is directly proportional to the cosine of the angle formed between:

    A. **R** and **V**. B. **N** and **H**. C. **L** and **V**. **D.** $\boxed{\textbf{N and L.}}$

27. The amount of reflected light given by the specular term is porportional to the n^{th} power of the cosine of the angle formed between:

    A. **V** and **L** **B.** $\boxed{\textbf{N and H}}$ C. **R** and **L** D. **N** and **L**

28. Suppose you want to assign material parameters to a red object that has some amount of specular reflection with the same colour as the light source. Choose a set of appropriate parameters.

    A. $\mathbf{K}_a = \mathbf{K}_d = (0.3, 0, 0)$, $\mathbf{K}_s = (1, 0, 0)$.

    B. $\mathbf{K}_a = \mathbf{K}_d = (1, 1, 1)$, $\mathbf{K}_s = (1, 0, 0)$.

    C. $\mathbf{K}_a = \mathbf{K}_d = (1, 1, 1)$, $\mathbf{K}_s = (0.3, 0, 0)$.

    D. $\boxed{\mathbf{K}_a = \mathbf{K}_d = (0.3, 0, 0),\ \mathbf{K}_s = (1, 1, 1).}$

29. What would you do to spread the specular reflection of an object through a larger area?

    A. increase n.

    B. increase $\mathbf{K}_d$.

    C. $\boxed{\textbf{descrease } n\textbf{.}}$

    D. decrease $\mathbf{K}_d$.

30. What is the purpose of the expression `max(dot(N,L), 0)`, instead of the simpler `dot(N,L)` in the implementation of the presented illumination model in a WebGL-GLSL shader?

    A. Compute the maximum intensity for diffusely reflected light.

    B. Prevent light from entering the camera directly.

    C. Prevent surfaces that aren't visible from being illuminated.

    D. $\boxed{\textbf{Prevent surfaces from being illuminated from the back side.}}$

Boa Sorte!