

每題各 20 %

一、解釋說明名詞及其物理含意

- 非牛頓流體
- 分離點 (separation point)

二、在醫用流力領域中常見的流場包括迴流場 (如障礙物之後) 、彎曲管流。請就上述兩種流場說明其特性和物理含意。

三、探討血管流場問題最直覺的作法是比照水管，請說明血管流場和水管流場的差別。包括它的物性、流體、流場等。

四、Poiseuille flow in a circular pipe has a velocity profile of

$$u = \frac{(a^2 - r^2)}{4\mu} G \quad G = -\frac{dp}{dx}$$

a is the radius of the pipe, r the location, μ is the viscosity, G is the pressure gradient and is assumed to be a constant. If we define

$$\text{flow rate (Q)} = \text{Compliance (C)} \times G$$

please find C the compliance. The compliance is the reverse of the resistance R , that is,

$C=1/R$. The resistance is very critical to the load of a heart in the human body.

- find the wall shear stress in the pipe.
- find the expression for the resistance R
- use the above result to discuss when a major blood vessel is blocked partially, how the blockage affects the function of your heart?

五、你的心臟一輩子為你作多少功？算出正確答案後，看看這數字好好愛惜它。心臟所作的功率可用下式計算

$$-W = Q \Delta P$$

Q 是心臟流量， ΔP 是心房和心室的壓差。對人的心臟而言每分鐘流量是 5000 ml (cc)，左右心室心房總壓差是約 120 mmHg。假設活到 80 歲，請算出它作了多少功？以 cgs 公制單位計算。假設全世界最高的山愛佛勒斯峰是 10000 公尺，請證明這拳頭大心臟所作的功可以將大約 30 公噸重 (一輛輕坦克或一輛滿載的大貨櫃或 10 輛小轎車) 的物品自海平面舉上愛佛勒斯峰頂。

$$1 \text{ mmHg} = 1.333 \times 10^3 \text{ dyne/cm}^2 \quad 1 \text{ dyne} = 1 \text{ gm-cm/s}^2 \quad \text{重力加速度} = 980 \text{ cm/s}^2$$