Physiol-02B9 Draw a pressure volume loop for a left ventricle in a normal adult. Outline the information that can be obtained from such a loop.

The LV pressure volume loop, shown below, is a plot of LV pressure on the y-axis against LV volume on the x-axis throughout a cardiac cycle.

**Features of the LV PV loop and approximate normal values**

End-systolic volume (ESV) = 50 mL  
End-diastolic volume (EDV) = 120 mL  
Stroke volume = 70 mL  
Pressure at beginning of diastole = 3 mmHg  
Pressure at end diastole = 10 mmHg  
Pressure at AV opening = 90 mmHg  
Pressure peak during LV systole = 120 mmHg

**Five phases of the cardiac cycle**

**Mitral valve opens (#4)** – as LA pressure exceeds LV pressure

**Phase 5 (beginning of a)** – passive ventricular diastole – both LV and LA are filling up to approx 70% of SV has entered the LV

**Phase 1 (end of a)** – active ventricular diastole – LA filling has ceased and it contracts forcefully to rapidly fill the LV

**Mitral valve closes (#1)** – as LV pressure exceeds LA

**Phase 2 (b)** – isovolumetric contraction – LV contracts against close MV and AV, LVV remains same, LVP rises rapidly

**Aortic valve opens (#2)** – as LV pressure exceeds aortic pressure
**Phase 3 (c)** – ventricular systole – ongoing ventricular contraction with rapid ejection of SV into aorta with associated reduction in LVP

Aortic valve closes (#3) – aortic pressure exceeds LV pressure (at similar pressure to point #2)

**Phase 4 (d)** – isovolumetric relaxation – LV relaxes with closed AV and MV, volume remains constant, LVP falls rapidly

![Diagram of PV loop](image.png)

**Information that could be obtained from PV loop**

In addition to the above parameters, the following information could also be extrapolated from the PV loop

1. **Stroke volume** = LV output in one cardiac cycle
   = LVEDV – LVESV

2. **Ejection fraction** = fraction of LV volume ejected in one cardiac cycle
   = SV / LVEDV

3. **LVEDV** = surrogate measure of preload

4. **Arterial elastance (surrogate for LV afterload)**
   MAP = CO x SVR = SV x HR x SVR
   Rearranging gives MAP/SV = HR x SVR

MAP/SV is defined as arterial elastance and graphically it is approximately the Ea line in above diagram.
Ea is defined as **arterial elastance** - the arterial resistance to LV ejection, which is a surrogate marker for *LV afterload*

Ea (and thus afterload) is approximated from the gradient of the Ea line

**5) End systolic pressure volume relationship** (*surrogate for LV systolic function*)
ESPVR line = maximum LV pressure achievable for range of LV preload and afterload
Gradient of line = surrogate marker of *LV contractility*

**6) End diastolic pressure volume relationship** (*surrogate for LV diastolic function*)
EDPVR line = LV pressure achieved with LV filling during diastole
Line = surrogate marker of *LV stiffness*

**7) LV PV work**
PV work = area enclosed by PV loop = work done by the LV on blood to generate stroke volume

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**Examiner’s comments**

The main points expected were an **accurate pressure volume loop**, with the **phases named** and the **points of valve opening and closing marked**. In addition, an outline of the information gained from the loop was expected, such as **stroke volume**, **ejection fraction**, **left ventricular end diastolic volume** (as a measure of preload), **left ventricular diastolic pressure/volume relationship** (as a measure of elastance), **left ventricular end systolic pressure/volume line** (as an indicator of contractility), and **area within the pressure/volume loop** (as a measure of stroke work).