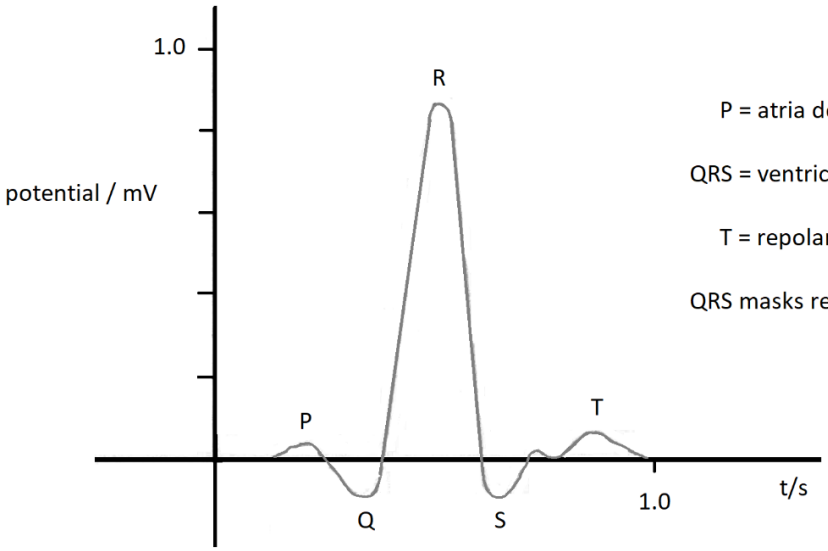
MEDICAL PHYSICS

3-1 ECG signals

1. average rate of energy supply = 2.0 W

Estimated energy supplied per day = 2.0 x 24 x 60 x 60 = 172800 J = 1.7 x 10^5 J or 1.7 kJ to 2 sf

2. (a) + (b)



P = atria depolarise and contract

QRS = ventricles depolarise and contract

T = repolarisation and relaxation of the ventricles

QRS masks repolarisation and relaxation of the atria

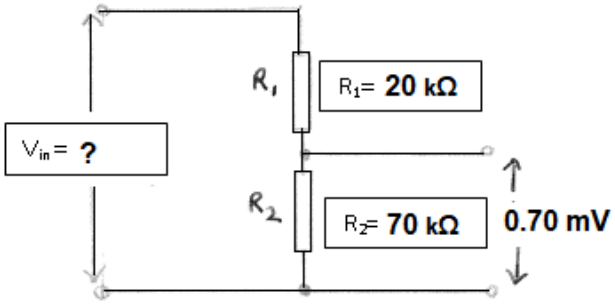
3. (a) An ECG amplifier needs to have a high impedance otherwise a significant fraction of the input p.d. would be lost due to body resistance and contact resistance between the electrodes and the skin. The impedance must be high enough so that the input p.d. to the amplifier will be a significant fraction of the source p.d.

(b) Amplifier input resistance = 70 kΩ

Patient resistance = 20 kΩ

Max p.d. across amplifier input terminals = 0.70 mV

(i) The two resistances form a potential divider:



In diagram V_{in}.= p.d generated by patient's heart

$$\frac{70}{20 + 70} \times \text{heart p.d.} = 0.70 \text{ mV}$$

$$\text{Heart p.d.} = \frac{0.70 \times 90}{70} \text{ mV}$$

$$= 0.90 \text{ mV}$$

(ii) If the patient's resistance were only 1 kΩ

$$\frac{70}{1 + 70} \times 0.90 = 0.887\ldots\text{mV} = 0.89 \text{ mV}$$

4. ECG amplifier characteristics:

- It must have a voltage gain $\left(\frac{\text{output p.d.}}{\text{input p.d.}}\right)$ of about 1000 up to about 20 Hz and filter out unwanted signals above this frequency like those due to muscle activity or the mains do not interfere with the trace obtained.
- It must have an even frequency response over this range so that the output voltage is not distorted which would spoil the trace
- It must have a high signal-to-noise ratio so that the output signal is not masked by random electrical signals generated in the amplifier itself.