Question Number	Answer	Additional Guidance	Mark
1 (a) (i)	1. idea that you can see the { heart / internal organs / eq} ; 2. Daphnia {are simple organisms / have less developed nervous system / can't feel pain / eq} ; 3. idea that there are fewer ethical concerns because it is an { invertebrate / eq} ; 4. idea that they are abundant / used as fish food / eq ; 5. idea that they can absorb chemicals from the surrounding solution quickly ;	1. ACCEPT they are transparent 3. NB. needs to be linked to something about the *Daphnia* and not just because it is a *Daphnia* e.g. a simple organism 4. ACCEPT easy to reproduce / easy to keep / readily available / eq; 5. ACCEPT they are small so chemicals can affect them quickly	**(2)**

Question Number	Answer	Additional Guidance	Mark
1(a)(ii)	suitable variables identified ; suitable control method ; Examples: • temperature ; heat shield ; • volume of caffeine (solution) ; (use pipette to measure) stated volume e.g. 2 cm^3 ; • { age / species / source /size / gender } of *Daphnia* ; hatched from eggs at the same time ; • pre-treatment / acclimatisation ; same time ; • reduce movement of Daphnia ; use of cotton wool strands ; • method of measuring heart rate ; count number of heartbeats in 30 seconds / eq ; • {concentration / source} of caffeine ; one caffeine tablet in 10 cm^3 of water ;	**Other variables may be given e.g. stress, oxygen, pH** **The methods shown are examples others may be seen** **IGNORE** water bath, room temperature etc **ACCEPT** keep lamp off except when needed **DO NOT ACCEPT** number of drops **ACCEPT** water bath used in acclimatisation **DO NOT ACCEPT** just stated concentration	**(4)**

Question Number	Answer	Additional Guidance	Mark
1(b)	1. reference to mass flow ; 2. name a suitable substance transported e.g. oxygen ; 3. comment on {blood pressure / fast movement of blood to cells /eq} ; 4. idea of increased concentration gradient of solutes e.g. oxygen ; 5. idea that diffusion alone would be too slow ; 6. has high metabolic rate / eq ;	1. **ACCEPT** mass transport 2. **IGNORE** oxygenated blood 3. **IGNORE** pump alone 4. **ACCEPT** improved gaseous exchange 5. **ACCEPT** surface area to volume ratio too small 6. **IGNORE** activity level	**(3)**

Question Number	Answer	Mark
2(a)	1. heart rate increases / eq ; 2. {stroke volume / eq} increases / eq ; 3. {SAN /eq} activity increases / ; 4. AVN time delay decreases / eq ; 5. idea that more blood returning (to the heart) causes {heart / muscle} to stretch ; 6. idea that ventricles contract with greater force ;	**(4)**

Question Number	Answer	Mark
2(b) (i)		**(2)**

Approximate value for	**0.1 dm^3**	**0.5 dm^3**	**6 dm^3 min^{-1}**	**6 breaths min^{-1}**	**12 breaths min^{-1}**
Resting breathing rate					☒
Resting tidal volume		☒			

Question Number	Answer	Mark
2(b)(ii)	1. more {peaks / eq} in the same time / higher frequency / distance between (consecutive) peaks would decrease ; 2. idea of distance from peak to trough would increase ;	**(2)**

Question Number	Answer	Mark
2(c)	Any **two** from the following: 1. how often they play 2. age 3. body size / BMI / eq 4. gender / eq 5. fitness level / eq 6. health status / eq 7. lifestyle e.g. smoker or swimmer ; ;	**(2)**

Question Number	Answer	Additional Guidance	Mark
3(a)	1. idea that stimulation generated from within (muscle) ; 2. idea that this results in depolarisation ;		(2)

Question Number	Answer	Additional Guidance	Mark
3(b)	1. idea that it shows electrical activity of the heart ; 2. idea of how to identify {one heart beat / time for one heart beat} ; 3. count the number of { these / peaks / eq } in a {set time / stated time} or how long from one set of electrical activity to the next ; 4. description of how to obtain heart rate e.g. beats divided by time ;	**ACCEPT for 2:** from one {P wave / QRS complex / T wave } to the next	(3)

Question Number	Answer	Additional Guidance	Mark
3(c)	**QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence** 1. the concentration of carbon dioxide in the *alveoli* is higher / eq ; 2. the concentration of carbon dioxide in the blood is higher / pH of blood is lower / eq ; 3. detected by *chemoreceptors* in {*medulla* /*carotid* artery / *aorta* }; 4. reference to {*cardiovascular / cardiac}* control centre in *medulla* ; 5. reference to *autonomic* nervous system / *sympathetic* nerve ; 6. more impulses to *SAN* / eq ; 7. { *noradrenalin(e)* / *norepinephrine* } released onto *SAN* ; 8. *SAN* (excitation) rate increased / eq ; 9. heart rate will increase / eq ;	**QWC Emphasis is on spelling of technical terms** **1 ACCEPT** {diffusion / concentration} gradient increased	(5)

Question Number	Answer	Additional Guidance	Mark
4(a)	1. idea that initiates electrical activity over atria ; 2. causes atria to contract / eq ; 3. {forcing / eq} the (oxygenated) blood into the left ventricle / eq ; 4. electrical activity from SAN {received by AVN / travels through {bundle of His / Purkyne fibres / eq }} ; 5. causing left ventricle to contract (forcing blood into aorta) / eq ;	1. **ACCEPT** initiates impulse / initiates depolarisaton 2. **ACCEPT** systole for contract 4. **ACCEPT** Purkinje for Purkyne 5. **ACCEPT** systole for contract **NOT** left and right	**(4)**

Question Number	Answer	Additional Guidance	Mark
*4(b)	**(QWC – Spelling of technical terms must be correct and the answer must be organised in a logical sequence)** 1. increase in *respiration* rate in *muscle* cells ; 2. more {CO_2/*carbonic* acid/eq} in blood ; 3. more {*lactate* / *lactic acid*} in blood / eq ; 4. idea that *chemoreceptors* in *medulla* stimulated ; 5. ref to *cardiovascular* control centre in *medulla* ; 6. ref to *autonomic nervous system* /*sympathetic nerve* ; 7. more *impulses* from {*medulla* / *cardiovascular* control centre} to SAN OR along neurones to SAN ; 8. More {*noradrenaline* / *norepinephrine*} released onto SAN ; 9. SAN (excitation) rate increased / eq ; 10. (causing an) increased {heart rate / eq} / eq ; 11. Comment on other mechanism e.g. presence of adrenaline, stretch receptor role ;	**QWC emphasis is on spelling** 2 OR 3 **ACCEPT** reduced blood pH 4. **ACCEPT** in *aorta, carotid* 6. **ACCEPT** *accelerator* nerve 10. **ACCEPT** beats per min for heart rate	**(6)**

Question Number	Answer	Additional Guidance	Mark
4(c) (i)	Correct answer with units gains 2 marks 1 beat = 0.81 sec / 60 ÷ 74 / eq ; 8.1 seconds ;	**ACCEPT** 8.11 seconds	(2)

Question Number	Answer	Mark
4(c) (ii)	mV / millivolts / eq ;	(1)