QUESTIONSHEET 1

(a) (i) mean increase in pulse rate = 35.4, mean pulse rate = 72;

$= \frac{35.4 \times 100}{72} = 49.2\,\%$; **2**

(ii) additional activity/use of muscle uses more energy;
respiration increases to supply additional energy/ATP;
increased circulation supplies additional oxygen/glucose;
removes carbon dioxide/heat/lactic acid; **max 3**

(b) (i) regular exercise improves heart performance/efficiency;
increased heart force/stronger beat/greater stroke volume;
more blood circulates per beat so rate falls;
muscles work more efficently so require less O_2/glucose; **max 3**

(ii) less force/contraction needed to circulate blood at lower pressure/reduces load on heart muscle; **1**

TOTAL 9

QUESTIONSHEET 2

(a) (i) muscle contraction requires more ATP;
produced by oxidative phosphorylation;
aerobic respiration/respiratory chain/electron transport chain require more oxygen; **max 2**

(ii) must restore oxygen debt;
by re-oxidising accumulated lactic acid;
oxygen content of haemoglobin/myoglobin is restored;
ATP/creatine phosphate stores built up;
increased temperature causes increased metabolic rate; **max 3**

(b) increased diameter of fibres;
increased number of fibres;
increased number/size of mitochondria;
increased stores of creatine phosphate/glycogen;
increased myoglobin concentration;
increased number of blood vessels/increased vascularisation; **max 3**

TOTAL 8

QUESTIONSHEET 3

(a) (i) cardiac output = heart rate x stroke volume;
both heart rate and stroke volume increase;
vasodilatation of coronary arteries;
allows increased contractability of cardiac muscle;
increased return of blood from veins/means more blood must be pumped out/ref cardiac output = venous return /ref to law of the heart; **max 3**

(ii) exercising muscles/contraction require more oxygen/glucose;
for aerobic respiration/to produce ATP;
blood carries oxygen/glucose to muscles; **max 2**

(b) greater production/blood content of lactic acid/HCO_3^- / CO_2;
due to increased muscle respiration;
ref oxygen debt resulting in lactic acid formation; **max 2**

TOTAL 7

QUESTIONSHEET 4

(a) exercise caused increased temperature (which shifts curve to the right);
increased CO_2 concentration at tissue level (due to greater respiration);
decreased CO_2 concentration at alveolar level (due to faster/deeper breathing);
causes shifts in blood pH/Bohr shift/to pH 7.6 in lungs/pH 7.2 in tissues;
(thus) curve moves to the right in tissues/to the left in lungs; **max 3**

(b) in the tissues/at any partial pressure O_2 haemoglobin now less saturated/blood releases more oxygen;
enables tissues to resume/continue aerobic respiration/carries out faster respiration;
to produce ATP quicker;
to allow greater muscle activity/contraction;
ref greater uptake of O_2 (by haemoglobin) at alveolar level; **max 4**

TOTAL 7

QUESTIONSHEET 5

(a) (i) the volume of blood (in cm^3) pumped out of the heart/ventricles in one beat/ventricular contraction; **1**

(ii) the volume of blood (in dm^3) pumped out of the heart/ventricles per minute; **1**

(b) (i) cardiac output = 90 x 109 ;
= 9.81 $dm^3 min^{-1}$; **2**

(ii) cardiac output must be equal to the venous return;
otherwise heartbeat is inefficient/not pumping out all the blood received;
or blood is being held up/dammed in the circulation; **max 2**

(c) cardiac efficiency greater in athlete/converse;
training develops more/stronger cardiac muscle/converse;
coronary circulation becomes more efficient in athlete/no plaques/reductions in arteriole diameter due to lipid deposits/converse;
more efficient ventilation/breathing in athlete means CO_2 chemoreceptors do not increase cardiac output as much (by negative feedback); **max 3**

TOTAL 9

QUESTIONSHEET 6

(a) fat; **1**

(b) (i) liver;
muscles; **2**

(ii) branched polymer of many glucose units;
breakdown/hydrolysis to many single glucose molecules is rapid;
especially of end chain glucoses;
rapid respiration of glucose to yield ATP; **max 3**

(c) (i) percentage of energy supplied by fat increases with time; **1**

(ii) contains more H-C-H bonds/more high energy bonds;
glycogen has a core of indigestible (limit) dextrin which cannot be respired easily/complete fat /triglyceride molecules can be respired; **2**

TOTAL 9

QUESTIONSHEET 7

(a) energy use each day should balance energy intake;
excess carbohydrate intake, if not used for energy will be converted to fat and stored;
excess protein/amino acid intake will be deaminated and the CHO components/residues will be respired for energy/converted to fat and stored;
excess fat intake, if not used for energy will be stored;
exercise should be used to ensure that daily energy use exceeds (or equals) intake/used to prevent development of obesity/heart disease/equivalent statement; **max 4**

(b) excess dietary fat will be stored and this could lead to obesity;
saturated fatty acids tend to stimulate (blood) cholesterol levels;
raised blood cholesterol levels are associated with the laying down of fat in arterioles/
development of (atheromatous) plaque;
vegetable fats/oils tend to contain less saturated fatty acids/fat compared to animal products;
ref HDL/high density lipids and LDL/low density lipids;
HDL (good cholesterol/unsaturated fats) will tend to reduce blood levels of LDL (bad cholesterol/saturated fat); **max 4**

(c) excess sugar/glucose, if not respired for energy will be converted to fat and stored;
sugar/glucose has to be released from starch/glycogen by digestion (before it is available);
digestion is not 100% efficient/some glucose from complex carbohydrate remains unavailable;
cellulose/pectins cannot be digested and make up dietary fibre;
reduces risk of constipation/diverticulosis/ulcerative colitis/cancer of the colon/enhances formation/removal of faeces/
slows down fat absorption; **max 4**

TOTAL 12

QUESTIONSHEET 8

(a) creatine phosphate releases energy immediately/most quickly;
releases most energy/correct ref to figures/but supply used up by 28 seconds(allow 28 –30);
anaerobic glycolysis releases energy next/energy release peaks at 10 seconds/ceases by 40 seconds;
only releases about half as much energy as creatine phosphate/correct ref to figures;
aerobic oxidative phosphorylation releases energy continuously;
increases release gradually/reaches a plateau at 70 seconds/peak rate of release less than the other mechanisms/correct ref to figures;
max 4

(b) (i) creatine phosphate accumulated from ATP /ATP + creatine → ADP + creatine phosphate;
during rest;
(at the start of contraction) stored creatine phosphate reacts with ADP to yield ATP; **max 2**

(ii) (anaerobic) glycolysis yields ATP and lactic acid;
from oxidation of glucose/glycogen;
ATP produced directly, not via respiratory chain/electron transport chain/coenzymes;
when 1,3-diphosphoglyceric acid forms 3-phosphoglyceric acid;
only yields a net gain of 2ATP per glucose molecule; **max 3**

(iii) oxidative phosphorylation is coupled to the respiratory chain/electron transport chain;
which is fed by reduced coenzymes from glycolysis/Krebs cycle;
coenzymes are reoxidised for reuse using oxygen;
at this stage energy is conserved/trapped in ATP;
glycolysis uses glucose/glycogen as substrate/Krebs cycle uses acetyl-coenzyme A produced by (aerobic) glycolysis;
max 3

(c) ref to long diffusion gradient for oxygen into muscle/syncytial structure of muscle fibre results in long diffusion gradient;
(thus) in continuous/severe exercise muscle cannot get oxygen quickly enough to maintain the respiratory/electron transport chain;
thus only glycolysis can continue, but anaerobically;
resulting in the production of much lactic acid;
this can make the pH of the fibre too acid to allow further metabolism/work/contraction/causes fatigue/pain;
oxygen debt is the volume of oxygen deficient/volume required to allow oxidation of lactic acid; **max 4**

TOTAL 16

QUESTIONSHEET 9

(a) true;
creatine phosphate will all have been changed to creatine, yielding ATP; **2**

(b) true;
lactic acid is produced in muscle during anaerobic glycolysis/oxygen debt;
some lactic acid leaks out of the muscle into blood thus increasing blood acidity; **3**

(c) false;
it would reach a plateau and result in an oxygen debt ; **2**

(d) false;
glycogen cannot be transported, but liver glycogen may yield glucose which could be used (in the muscle); **2**

(e) true;
(HCO_3^-) chemoreceptors in carotid/aortic bodies/medulla sense that HCO_3^- tension is still raised/high;
(thus) continue to stimulate ventilation/heart until levels return to norm/mean/resting values;
max 3

TOTAL 12

QUESTIONSHEET 10

acetylcholine; calcium; sarcoplasmic; acetylcholine esterase;
actin; myosin; (either way round)
troponin; tropomyosin; (either way round)
ratchet; myosin; actin; actin; myosin; ATP;

TOTAL 14

QUESTIONSHEET 11

(a) (i) to be weight bearing/able to support the weight of the body; **1**

(ii) a humerus (in human) does not normally carry the weight of the body whereas the femur does; **1**

(iii) readings from graph, men = 5.2 arbitary units (accept 5.18 - 5.22)
women = 3.95 arbitary units (accept 3.93 - 3.97)
$\frac{3.95 \times 100}{5.2}$; = 75.96 %; (accept 75.9%) **2**

(b) (i) men rise to a higher peak than women in first 20 - 30 years;
women's peak starts to fall around 45 - 50 years whereas men's remains high until around 70 years;
women's curve fluctuates during years 20 - 30 whereas men's curve stays smooth;
overall men's femurs are stronger than those of women; **4**

(ii) collagen fibres/fibres of Sharpey;
calcium phosphate/hydroxyapatite crystals; **2**

(iii) 1. calcium salts may be withdrawn from mother's bones into the baby's bones during pregnancy;
bone calcium may be used to contribute to milk calcium during lactation/breast feeding; **2**

2. oestrogen stimulates the activity of osteoblasts which produce bone during normal tissue replacement;
women of age 45 to 55 years suffer from the menopause in which they become oestrogen deficient (and thus have less bone replacement); **2**

(iv) osteoporosis; **1**

TOTAL 15

QUESTIONSHEET 12

(a) (i) oxygen carried by haemoglobin/red blood cells;
volume of oxygen carried could be reduced by anaemia/reduced red cell counts;
volume of oxygen carried could be reduced by acidosis/ref Bohr shift of haemoglobin dissociation curve to the right/acidosis due to lactic acid build up;
volume of oxygen carried could be increased by raised red blood cell counts/raised haemoglobin content;
ref effect of altitude/increased erythropoietin raising red cell counts;
renal disease causing reduced erythropoietin resulting in anaemia; **max 4**

(ii) cardiac output in litres per minute/$dm^3\ min^{-1}$;
= pulse rate in beats per minute multiplied by stroke volume in cm^3 per beat;
increased cardiac output pumps more blood to lungs for oxygenation/more blood to tissues to supply oxygen;
regular exercise/training will increase (the upper limit of) cardiac output (allowing more oxygen to be carried to the tissues per minute);
well trained athletes can achieve higher cardiac outputs than sedentary individuals; **max 4**

(iii) the larger the mass of exercising muscle the greater the (possible) use of oxygen;
ref to regular exercise causing an increased mass of active skeletal muscle;
ref to different muscle fibre types/type 1 or slow twitch type/type 2 or fast twitch type;
slow twitch fibres have many mitochondria/oxidative enzymes/associated capillaries and extract much oxygen from blood (for aerobic respiration);
fast twitch fibres are more adapted for ATP synthesis by anaerobic glycolysis (and so use less oxygen);
(give credit to answers which also distinguish the different types of fast twtch fibres) **max 4**

(b) (i) women generally have less muscle mass than men and so consume less oxygen;
women have lower mean red blood cell counts than men and so their blood transports less oxygen; **2**

(ii) athlete will develop a greater (working) muscle mass than a non-exercising man and so will consume more oxygen;
blood supply to athlete's muscles will be more developed/more efficient/have more capillaries;
2

TOTAL 16