



Cambridge Technicals IT

Unit 1: Science Fundamentals

Level 3 Cambridge Technical in Laboratory Skills

Mark Scheme for June 2017

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All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Question		Answer	Marks	Guidance
1	a	2,6;	1	DO NOT ALLOW 26 (without ,) unless clear separate values IGNORE [] ALLOW 1S ² and 2S ² and 2P ²
	b	8;	1	
	c	i	10;	
		ii	¹⁸ ₈ O;	ALLOW 18 , 8 OR 18 and 8 ALLOW ⁸ ₁₈ O
	d	i	2H ₂ + O ₂ → 2H ₂ O Formula; Balancing;	ALLOW for one mark: 2H + O → 2 H ₂ O DO NOT ALLOW O or O ² for formula ALLOW one error for reactants (if H ₂ O is product) eg. 2H ₂ + O = 1 mark max. ALLOW H ₂ + ½ O ₂ → H ₂ O = 2 marks ALLOW equal sign = →
		ii	Covalent; (Valence) electrons are shared;	IGNORE references to sharing one electron only ALLOW both non-metals = 1 mark
		iii	Neon/noble gases have 8 electrons in outer shell ; Oxygen also has (6+2=) 8 electrons in outer shell ;	ALLOW <i>both</i> have <i>full</i> outer shells (= 2 marks) ALLOW same number of electrons / 10 electrons each = 1 mark
	e	i	Atomic diameter decreases, as group number increase / along each row/left to right; Atomic diameter increases, as period increases / down column/top to bottom / down each group;	MUST refer to group number/period or columns/rows
		ii	Hydroxide/it, 220 pm diameter is more than the sum of H and O diameters/202 pm / further 18pm;; Weaker attraction between the nuclei and the electrons;	ALLOW diameter more/larger (hydroxide/it) ALLOW between positive charges/protons and negative charges/electrons
			Total	14

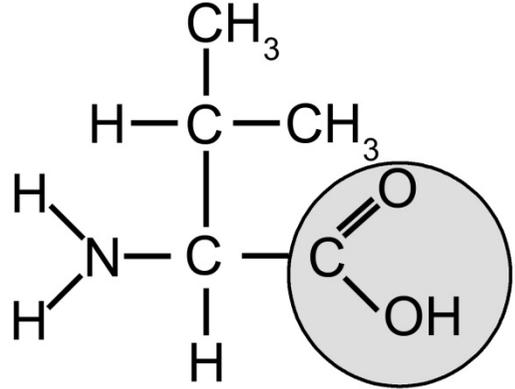
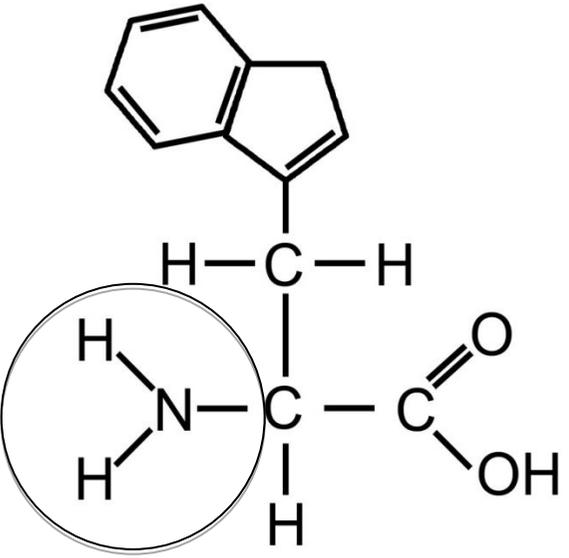
Question			Answer	Marks	Guidance
2	(a)	(i)	<p><i>Any four from:</i></p> <p>General feature Increased temperature – increased oil extraction / positive correlation;</p> <p>Without papain From 9 – 13 g (oil per g of alga);</p> <p>With papain Increases more markedly (or wtte) as temperature increases; From 14 – 27 g (oil per g of alga); Reaches a peak of 27 g / 60 °C; Reaches a peak before that of ‘without papain’; Mass of oil extracted per g of alga decreases above 60 °C; Decreases from 27 – 25g (at 60°C);</p>	4	<p>IGNORE references to reasons for increased oil extraction.</p> <p>MAX. 3 marks if no reference to oil extraction without the addition of papain.</p> <p>DO NOT ALLOW values without some units</p>
		(ii)	<p><i>Any four from:</i></p> <p>Increase in activity with increasing temperature; Up to approx. 60 °C; Molecules gain more energy (with increased temperature) / move faster / more excited; Increase in successful collisions (between enzyme/papain and substrate/protein); To form enzyme–substrate complex; Optimum activity reached at 60 °C; Decrease above 60 °C is the result of (increasing) denaturation of the enzyme; Resulting in change in shape of active site; The substrate/protein no longer fits the active site;</p>	4	<p>ALLOW oil extraction = BOD for indication of enzyme activity</p> <p>ALLOW best/ideal/peak = optimum DO NOT ALLOW enzymes broken down / killed</p>

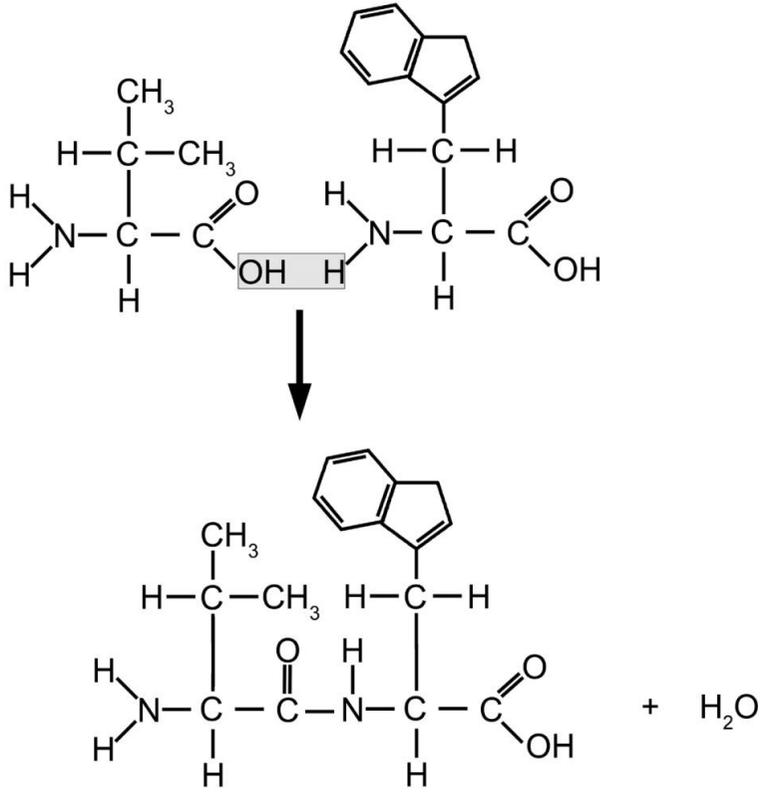
	(b)	(i)	Addition (reaction); <i>Any two from:</i> Involving 2H/two hydrogen atoms (gained); To carbon atoms 13 and 14; Double bond removed / molecule becomes saturated;	3	ALLOW reduction as an alternative to addition. ALLOW hydrogenation.
		(ii)	Reduction (reaction): Addition of H/hydrogen atoms / COOH reduced; One mark for correct equation but must show 4H; $\text{CH}_3(\text{CH}_2)_{20}\text{COOH} \xrightarrow{[4\text{H}]} \text{CH}_3(\text{CH}_2)_{20}\text{CH}_2\text{OH}$ behenic acid behenyl alcohol	3	ALLOW oxidation and reduction for first mark; ALLOW answers related to specific reducing agent. ALLOW $2\text{H}_2 = 4\text{H}$ ALLOW location of 2H_2 on left side of arrow ALLOW equal sign = \rightarrow
		(iii)	Displacement (reaction);	1	
			Total	15	

Question			Answer	Marks	Guidance
3	(a)	(i)	Bone/compact bone	1	
		(ii)	<p><i>Any four from:</i></p> <p>Bone becomes calcified/ossified; For strength/support/protection; Contains living cells / is a living tissue/organ; Bone tissue can grow; Bone cells/osteocytes/osteoblasts in layers;</p> <p>Mature bone cells/osteocytes confined to spaces (called lacunae); Osteocytes/bone cells arranged in concentric rings called lamellae; Osteocytes/bone cells connect by cytoplasmic extensions; Osteocytes/bone cells deposit calcium (into the matrix); Immature osteocytes/osteoblasts can reproduce to enable bones to grow; Central Haversian canal contains blood vessels to provide nutrients/oxygen; Canaliculi/small channels/Volkmann's canals radiate from Haversian system to connect cells/deliver blood/nutrients/oxygen;</p>	4	<p>IGNORE references to gross anatomy of bones. ALLOW Bone is compacted = ossified</p> <p>ALLOW correct reference to blood cell production</p>
		(iii)	<p>A – Rough endoplasmic reticulum /RER / ribosomes; B – Cytoplasm/nucleus; C – Mitochondrion/crista;</p>	3	<p>DO NOT ALLOW plasma = B ALLOW mitochondria = C</p>
		(iv)	A	4	

Question		Answer	Marks	Guidance		
		<p><i>Any two from:</i> Involved in protein synthesis; Processing/packaging/storage of protein; Transport of proteins; Forms vesicles to create Golgi apparatus/body;</p> <p>B If cytoplasm <i>Any two from:</i> Site of (cellular) reactions; Site of named reaction; Provide cell shape; Transport of materials (to and from organelles); Supports/holds/contains organelles; Cytoskeleton; Storage of materials/molecules;</p> <p>If nucleus <i>Any two from:</i> Contains DNA/genes/genome/chromosomes; Site of DNA replication; Controls protein synthesis</p>		<p>ALLOW proteins made = protein synthesis</p> <p>ALLOW keeps cell contents together / cell movement = cytoskeleton</p>		
	(b)	(i)		<p><i>Any one from:</i> (Many/packed with) RER/ribosomes;</p>	1	

Question			Answer	Marks	Guidance
			Nucleus is large/prominent; Cell wrapped around (a bundle of) collagen; (Many) mitochondria;		
		(ii)	<p><i>Any two from:</i></p> Contains fibres/collagen; Strength/support of connective tissue; Holds organs in position / bone to bone / bone to muscle; Contains elastin / elastic fibres; Flexible/stretches/elastic; Immature fibrocytes (fibroblasts) divide rapidly Grows/repairs/heals/wtte;	2	<p>ALLOW holds tissues in place</p> <p>DO NOT ALLOW soft = flexible</p> <p>DO NOT ALLOW cells unqualified</p>
			Total	15	

Question			Answer	Marks	Guidance
4	(a)	(i)	 <p>The diagram shows the structural formula of valine. It consists of a central alpha-carbon atom bonded to a hydrogen atom (H) on the left, a methyl group (CH₃) above, another methyl group (CH₃) to the right, and a nitrogen atom (N) below. The nitrogen atom is bonded to two hydrogen atoms (H). The alpha-carbon is also bonded to a carboxyl group (COOH) to the right, which is circled in grey. The carboxyl group consists of a carbon atom double-bonded to an oxygen atom (O) above and single-bonded to a hydroxyl group (OH) below.</p>	1	The circle MUST be drawn on valine .
		(ii)	 <p>The diagram shows the structural formula of tryptophan. It features an indole ring system (a benzene ring fused to a pyrrole ring) at the top. Below the ring system is a methylene group (CH₂) bonded to an alpha-carbon atom. This alpha-carbon atom is bonded to a hydrogen atom (H) on the left, another hydrogen atom (H) on the right, and a nitrogen atom (N) below. The nitrogen atom is bonded to two hydrogen atoms (H), and this entire amino group is circled. The alpha-carbon is also bonded to a carboxyl group (COOH) to the right, which consists of a carbon atom double-bonded to an oxygen atom (O) above and single-bonded to a hydroxyl group (OH) below.</p>	1	The circle MUST be drawn on tryptophan .

Question	Answer	Marks	Guidance
(b)	 <p>The diagram illustrates the condensation reaction between alanine and phenylalanine. Alanine (left) has a methyl group (CH₃) on its alpha carbon and a hydroxyl group (OH) on its carboxyl group. Phenylalanine (right) has a benzyl group (a benzene ring attached to a CH₂ group) on its alpha carbon and a hydrogen atom on its amino group. A grey box highlights the OH from alanine and the H from phenylalanine's amino group. An arrow points down to the products: a dipeptide (Ala-Phe) and a water molecule (H₂O). The dipeptide has a peptide bond (C=O from alanine linked to N-H of phenylalanine) and a free carboxyl group on the phenylalanine end.</p>	3	<p>Two correct reactants = 1 mark</p> <p>ALLOW correct dipeptide only = 2 marks if reactants not drawn</p> <p>ALLOW inclusion of H₂O = 1 mark</p>
(c)	Peptide (bond);	1	ALLOW covalent
(d) (i)	Alanine, leucine, phenylalanine;	1	All three required for 1 mark. If >3 amino acids named = 0 marks
(ii)	Leucine;	1	
(iii)	Phenylalanine;	1	
(iv)	Serine;	1	
(v)	Glycine;	1	

Question	Answer	Marks	Guidance
(e)	<p><i>Any two from (transcription):</i> DNA in nucleus; DNA unzipped; by enzyme (DNA helicase); RNA polymerase also involved; DNA/gene code/used/template for synthesis mRNA; DNA contains, adenine, thymine, guanine and cytosine; RNA contains uracil instead of thymine; RNA single-stranded / DNA double-stranded/double helix; By transcription; mRNA synthesised in nucleus; mRNA moves, into cytoplasm / to ribosomes / to RER; mRNA attaches to ribosome;</p> <p><i>Any two from (translation):</i> Protein synthesis at ribosomes/RER; Ribosomal RNA / rRNA codes for synthesis of ribosomes; Codons on mRNA carry information on the sequence of amino acids to be assembled; Amino acid peptide bonds formed (on ribosome); Process is called translation; Amino acid ferried to ribosome by transfer RNA/tRNA; Process begun by initiation codon; Second amino acid is ferried to/binds to ribosome by next transfer RNA molecule/tRNA; Succession of amino acids/tRNAs brought in according the base sequence of mRNA / tRNA involved in decoding; tRNA released to ferry in further amino acids. Protein synthesis terminated by termination/stop codon;</p>	4	Reference to exons and introns, and pre-mRNA is not required. ALLOW information = code
	Total	15	

Question		Answer	Marks	Guidance
5	(a)	<p><i>Any five from:</i> salt; water; iron(II) sulphate; calcium carbonate; calcium sulphate; calcium phosphate; ammonium sulphate;</p>	2	<p>4 or 5 correct responses = 2 marks 2 or 3 correct responses = 1 mark 0 or 1 correct response = 0 marks</p> <p>If 6 or more responses - deduct 1 mark for each incorrect, additional response</p> <p>MARK as a list (remaining responses not considered)</p>
	(b)	(i)	2	<p>ALLOW component of mitochondria.</p> <p>IGNORE unqualified reference to body</p>

		<p>(ii) <i>Any three from:</i> Stored in endoplasmic/sarcoplasmic reticulum; (Calcium ions) flow/floods/diffuses into cytoplasm/sarcoplasm; Dislodges/removes barrier between actin and myosin/ binds with molecule/complex; Allowing actin and myosin to slide over each other / sliding filament theory; Muscle cells shorten; (Calcium ions) pumped back into endoplasmic/cytoplasmic reticulum;</p> <p>Involved in generation of muscle action potential; Myosin-binding sites on actin blocked by tropomyosin; Calcium ions bind to troponin-tropomyosin causing conformational change; Myosin can now interact with actin to cause actin-myosin cross-bridging/muscle contraction; Calcium channels close as action potential passes;</p>	3	
		<p>(iii) <i>Any two from:</i> Structural support (of plants/stems/roots/tissues/adjacent cells); Gives strength (within plants/stems//roots/tissues); Involved in plant defence mechanisms; Structural roles in cell wall and cell membrane/calcium pectate holds adjoining cells together/maintenance of cell membranes; Cell signalling/signal transduction; Regulator of biochemical and physiological processes;</p>	2	<p>ACCEPT inhibition/regulation of mould/fungus growth = defence mechanism</p> <p>ALLOW role in photosynthesis (details not needed)</p>

	(c)	<p>[Level 0] Candidate response includes no valid points. (0 marks)</p> <p>[Level 1] Candidate shows a basic understanding of the biological functions of iron in carriage of oxygen in haemoglobin OR in myoglobin OR as a component of cytochromes in electron transport chain with little or no explanation. (1 – 2 marks)</p> <p>[Level 2] Candidate shows an understanding of the biological functions of iron in carriage of oxygen in haemoglobin AND in EITHER myoglobin OR as a component of cytochromes in electron transport chain with little explanation. (3 – 4 marks)</p> <p>[Level 3] Candidate shows a good understanding of the biological functions of iron in carriage of oxygen in haemoglobin AND in myoglobin AND as a component of cytochromes in electron transport chain with an appropriate explanation. (5 – 6 marks)</p>	6	<p>Valid points:</p> <p>Carriage of oxygen in haemoglobin</p> <ul style="list-style-type: none"> • Involved with oxygen transport • (Iron is) located in haemoglobin • Involved in red blood cell formation/maturation • Haemoglobin found in red blood cells (in blood plasma). • Haemoglobin transports oxygen (in the blood). • Forms oxyhaemoglobin. • Oxygen becomes bound to the haemoglobin • (Oxygen/ferrous iron binding) is reversible ; • (Oxygen) binds to the iron-containing porphyrin ring. <p>Carriage of oxygen in myoglobin</p> <ul style="list-style-type: none"> • (Iron is) located in myoglobin • Myoglobin found in muscles / muscle cells/fibres. • Myoglobin stores/exchanges oxygen in muscle. • Myoglobin receives oxygen from oxyhaemoglobin; • Myoglobin has greater affinity/attraction for oxygen. <p>Component of cytochromes in electron transport chain</p> <ul style="list-style-type: none"> • Iron is a component of cytochrome • Cytochrome part of electron transport/transfer chain • (Involved with) ATP synthesis • Located inside mitochondrion • Iron(II) (ferrous, Fe²⁺) and iron(III), (ferric, Fe³⁺) reversibly oxidised/reduced.
		Total	15	

Question		Answer	Marks	Guidance
6	a	T is a specific temperature and pressure;	1	ALLOW the temperature of water at a certain pressure / the pressure of water at a certain temperature
	b	Solid, liquid and gas;	1	
	c	<p>[Level 0] Candidate includes no valid points. <i>(0 marks)</i></p> <p>[Level 1] Candidate shows a basic understanding of the stable phases and changes of state OR temperatures of fixed points. <i>(1 – 2 marks)</i></p> <p>[Level 2] Candidate shows an understanding of the stable phases and changes of state OR temperatures of fixed points. <i>(3 – 4 marks)</i></p> <p>[Level 3] Candidate shows a good level of understanding of the stable phases and changes of state AND temperatures of fixed points. <i>(5 - 6 marks)</i></p>	6	<p>Valid points:</p> <p>Stable phases and changes of state</p> <p><i>Solid</i></p> <ul style="list-style-type: none"> • Solid phase for water is ice • (This requires) lower temperatures • solid to gas is sublimation (at X) • gas to solid is deposition (at X) <p><i>Liquid</i></p> <ul style="list-style-type: none"> • (This requires) medium temperature AND medium pressure • solid to liquid is melting (at Y) • liquid to solid is freezing (at Y) <p><i>Gas</i></p> <ul style="list-style-type: none"> • Gas phase for water is steam • (This requires) high temperatures AND low pressure • liquid to gas is evaporation (at Z) • gas to liquid is condensation (at Z)

Question			Answer	Marks	Guidance
					Temperatures of fixed points: <ul style="list-style-type: none"> • $t_1 = 0\text{ }^\circ\text{C}/273\text{K}$ • $t_2 = 100\text{ }^\circ\text{C}/373\text{K}$ ALLOW additional, correct valid point e.g. intermolecular forces
			Total	8	

Question			Answer	Marks	Guidance
7	a	i	For MP 1 and 2 FIRST CHECK THE ANSWER. If answer is $R_1 = 171.4$ award 2 marks $(R=) V/I / V = IR / 12.0 \div 0.07;$ $(R_1=) 171.4;$ For MP3 $(12 \div 0.35)$ $(R_6=) 34.3;$	3	$R_1 = 117.4 = 2$ marks i.e. MP1 and MP2 ALLOW 171 or 171.43 / correct, unlimited decimal places (not limited via stem of question) ALLOW 34 or 34.29 / correct, unlimited decimal places (not limited via stem of question)
		(ii)	FIRST CHECK THE ANSWER. If answer is $R_{6T} = 28.6$ award 2 marks $\frac{1}{R_{6T}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5} + \frac{1}{R_6}$ OR $1 \div R_{6T} = 6 \div 171.4$ OR $R_{6T} = 171.4 \div 6;$ 28.6;	2	ALLOW $\frac{1}{R_2} = \frac{1}{R_1} + \frac{1}{R_1} \dots etc$ ALLOW ecf from answer to R_1 . ALLOW 28.57 / correct, unlimited decimal places (not limited via stem of question) ALLOW 28.5 only if 171 for R_1 in 7(a)(i)
		(iii)	Lamp resistance changes with temperature / the lamps are not ohmic resistors;	1	ALLOW heat = temperature

Question			Answer	Marks	Guidance
		(iv)	Use of calculation e.g 6 x current for one lamp / 3 x current for 2 lamps etc; Comparison with actual resistance / 0.35;	2	ALLOW theoretical current/ $I = V/R = 12/28.5 = 0.42A$ ALLOW correct reference to Ohm's Law / more resistance leads to reduced current = 1 max.
			Total	8	

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