



COMBINED SCIENCE

0653/41

Paper 4 Extended Theory

May/June 2019

MARK SCHEME

Maximum Mark: 80

Published

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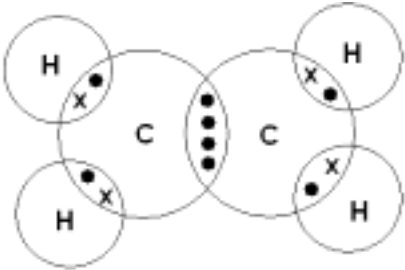
GENERIC MARKING PRINCIPLE 5:

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GENERIC MARKING PRINCIPLE 6:

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Question	Answer	Marks
1(a)(i)	$27.3 - 25.6 = 1.7$; $(1.7) / 25.6 \times 100 = 6.64(\%)$;	2
1(a)(ii)	high water potential outside and low water potential inside bag / higher water potential outside bag / water moves from high to low water potential ; <i>and one of</i> water moves in by osmosis ; use of the term diffusion ; water moves so as to try to equalise water potential ;	2
1(b)	protein ;	1
1(c)(i)	$6\text{H}_2\text{O} + 6\text{CO}_2 \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ 1 mark for formulae ; 1 mark for balancing dependent on formulae ;	2
1(c)(ii)	<i>any two of</i> (used) in respiration / release energy ; stored as starch ; avp ;	max 2

Question	Answer	Marks
2(a)	high temperature / high pressure / catalyst ;	1
2(b)(i)	A, B and E ;	1
2(b)(ii)	A, B and E ;	1
2(b)(iii)	A, B, C, D and E / all of them ;	1
2(c)	 two bonding pairs between carbon atoms ; all else correct ;	2
2(d)	family of compounds with a general formula ; similar chemical properties ;	2

Question	Answer	Marks
3(a)(i)	14 000 (N) ;	1
3(a)(ii)	1400 (kg) ;	1
3(b)(i)	(speed =) distance / time or 5400 / 3600 ; = 1.5 (m/s) ;	2

Question	Answer	Marks
3(b)(ii)	(work done =) force $\times$ distance / $W = F \times d = 500 \times 2000$; $= 1\,000\,000$ (J) ;	2
3(b)(iii)	(KE =) $\frac{1}{2} mv^2$; $= \frac{1}{2} \times 1400 \times (1.5)^2 = 1575$ (J) ;	2
3(c)(i)	speed of sound in liquid / water faster than in gas / air ;	1
3(c)(ii)	range of human hearing = 20 to 20 000Hz ; so beluga can produce sound that lies within the range of human hearing ; beluga sounds very high-pitched (to humans) ;	max 2

Question	Answer	Marks
4(a)	A – enzymes ; B – flagellum ;	2
4(b)(i)	oviduct ;	1
4(b)(ii)	jelly coating changes form after fertilisation (to prevent further entry of sperm) ;	1
4(c)(i)	A umbilical cord ; B amniotic sac / amnion ;	2
4(c)(ii)	glucose ; amino acids ;	2

Question	Answer	Marks
5(a)(i)	sodium atom loses one electron ; oxygen atom gains two electrons / oxygen atom achieves filled outer shell by gaining electrons ;	2
5(a)(ii)	Na ₂ O ; explanation in terms of balanced charges / implication that charges need to balance ;	2
5(b)	opposite / unlike charges (attract) ;	1
5(c)	NaOH (aq) + HCl (aq) → NaCl (aq) + H ₂ O (l) all formulae correct ; balanced and at least three correct state symbols ;	2
5(d)(i)	in the range 25 °C to 55 °C (inclusive) ;	1
5(d)(ii)	melting point decreases down Group 1 ;	1
5(d)(iii)	metals are above carbon in reactivity series ;	1

Question	Answer	Marks
6(a)(i)	($E =$) $IVt = 0.5 \times 2000 \times 0.1$; $= 100$ (J) ;	2
6(a)(ii)	($Q =$) $It = 0.5 \times 0.1$; $= 0.05$; coulomb(s) / C ;	3
6(b)	$v = f\lambda$ or $f = v/\lambda$ or $f = 3.0 \times 10^8 / 184 \times 10^{-9}$; $= 1.6(3) \times 10^{15}$ (Hz) ;	2

Question	Answer	Marks
6(c)	to protect humans from touching the high voltage wires / owtte ;	1

Question	Answer	Marks
7(a)(i)	haemoglobin ;	1
7(a)(ii)	any two of not enough red blood cells / haemoglobin ; not enough oxygen taken to body / cells / muscles ; less (energy released by) respiration ;	max 2
7(b)(i)	fruit / vegetable / named example ; to add vitamins / minerals / fibre ;	2
7(b)(ii)	energy taken in by body exceeds energy needed by body ; excess (energy) is stored as fat ;	2
7(c)(i)	coronary arteries ; become blocked / narrowed ;	2
7(c)(ii)	too much fat (contained in the food) ;	1

Question	Answer	Marks
8(a)	20 electrons ; 2,8,8,2 ;	2
8(b)(i)	(carbon dioxide) gas released from the apparatus ;	1
8(b)(ii)	particles have more energy/kinetic energy / move faster ; more successful collisions / collisions with enough energy ; greater frequency of collisions ;	max 2
8(b)(iii)	curved portion steeper ; horizontal line at same mass ;	2
8(c)	calcium oxide / calcium hydroxide / calcium hydrogencarbonate / calcium ;	1

Question	Answer	Marks
9(a)	100 °C ;	1
9(b)	fuse symbol ; switch symbol + completed circuit ;	2
9(c)(i)	transfer from powder to metal tube by molecular vibrations ; transfer through metal by mobile electrons ; transfer of molecular vibrations from metal tube to vibration / movement of water molecules ; reference to the transfer of energy through the water for example by particle collisions / or by convection ;	max 2

Question	Answer	Marks
9(c)(ii)	magnesium oxide or aluminium oxide ; the idea that these materials are poor electrical conductors and good thermal conductors / owtte ;	2
9(c)(iii)	(less) resistance inversely proportional (to cross-sectional area) / the greater the cross section the lower the resistance ;	1



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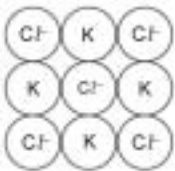
Question	Answer	Marks
1(a)(i)	A (untreated so the) enzyme caused the brown substance to be produced (in air) ; C (the boiling water) <u>denatured</u> the enzymes ;	2
1(a)(ii)	active site / enzyme damaged / destroyed / shape changed ; substrate will no longer fit into it ;	2
1(b)(i)	kills bacteria / pathogens / (harmful) microorganisms ; gives an acid pH for enzymes / owtte ;	2
1(b)(ii)	hydrochloric acid is a strong acid ; hydrochloric acid can damage mouth, etc. when swallowed ;	max 1
1(c)(i)	glycogen ;	1
1(c)(ii)	amino acids ;	1
1(c)(iii)	carbon, hydrogen, oxygen, nitrogen	1

Question	Answer	Marks
2(a)	molecule / compound containing carbon and hydrogen atoms only ;	1
2(b)(i)	high temperature / high pressure ;	1
2(b)(ii)	thermal energy is changed into chemical energy ; so thermal energy is absorbed / removed from surroundings / temperature (of surroundings) decreases ;	2
2(b)(iii)	aqueous bromine remains orange / not decolourised by saturated hydrocarbons ; aqueous bromine is decolourised by unsaturated hydrocarbons ;	2

Question	Answer	Marks
2(c)(i)	$ \begin{array}{ccccc} & \text{H} & & \text{H} & & \text{H} \\ & & & & & \\ \text{H} & - \text{C} & - & \text{C} & = & \text{C} \\ & & & & & \\ & \text{H} & & & & \text{H} \end{array} $ 3 carbon atoms in chain ; only one carbon-carbon double bond ; all else correct ;	3
2(c)(ii)	$2\text{C}_3\text{H}_6 + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$ all formulae correct ; balancing (dependent on correct formulae) ;	2

Question	Answer	Marks
3(a)	P ;	1
3(b)	weight of box = $500 \times 10 = 5000 \text{ (N)}$; work done = force $\times$ distance moved / $F \times d$; = $5000 \times 3 = 15\,000 \text{ (J)}$;	3
3(c)(i)	decelerating / slowing down to a stop ; deceleration changing / not constant ;	2
3(c)(ii)	distance = area under graph or $0.5 \times 20 \times 5 + (50 - 20) \times 5 (+40)$ or $(0.5 \times (50 + (50 - 20)) \times 5)(+40)$; = 240 (m) ;	2
3(c)(iii)	$\text{KE} = \frac{1}{2}mv^2$ or $\text{KE} = 0.5 \times 1500 \times 5^2$; = 18 750 J	2

Question	Answer	Marks
4(a)(i)	combustion / burning ;	1
4(a)(ii)	death / excretion / egestion ;	1
4(a)(iii)	(increases) less photosynthesis / fewer trees to photosynthesise ; so CO ₂ not taken in / fewer trees to take in carbon dioxide ;	2
4(b)	growth ; increased ; death ; decomposers ;	4

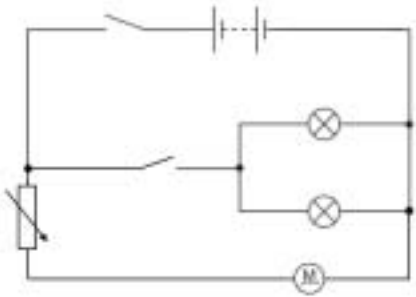
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5(a)(i)	any suggestion in the range 50–75°C (inclusive) ;	1
5(a)(ii)	rubidium is more reactive than potassium;	1
5(a)(iii)	hydrogen;	1
5(a)(iv)	the idea that attractive forces between particles have to be broken down / decreased / atoms gain speed / KE so they move further apart / owtte ;	1
5(b)(i)	outer shell / one electron lost from K atom; outer shell of chlorine gains one electron / outer shell of chlorine atom is filled / completed ;	2
5(b)(ii)	 alternating K⁺ and Cl⁻ ions ;	1
5(b)(iii)	opposite / unlike charges (attract) ;	1

Question	Answer	Marks
6(a)	hot gases less dense (than cooler gases) / owtte ; less dense / hotter gases rise (and cooler gases fall) / owtte ;	2
6(b)(i)	$(\text{time}) = \frac{\text{distance}}{\text{speed}} ;$ $= \frac{150\,000\,000\,000}{300\,000\,000} (= 500) \text{ s} ;$ $= \frac{500}{60} = 8.3 \text{ min} ;$	3
6(b)(ii)	$v = f\lambda$ or $f = \frac{v}{\lambda}$ or $f = 3.0 \times 10^8 / 7.4 \times 10^{-7}$; $= 4.1 \times 10^{14} \text{ (Hz)} ;$	2
6(c)	remote control / movement detector / intruder alarm / heat lamps / other correct use ;	1

Question	Answer	Marks
7(a)	<u>phototropism</u> ;	1
7(b)	auxin produced at tip ; more auxin in cells in dark side ; auxin causes (cell) elongation ; (cell) elongation greater on dark side ;	max 3
7(c)	any example of a fight or flight situation described ;	1
7(d)	(breathing rate) enables more oxygen to enter blood / be taken in (at lungs) ; (heart rate) increases rate of delivery of oxygen / glucose to cells ;	2

Question	Answer	Marks
7(e)	<i>any two from</i> muscle contraction protein synthesis growth maintenance of body temperature ;	2

Question	Answer	Marks
8(a)(i)	nickel ions and copper ions ;	1
8(a)(ii)	$(7 - 2) \div (10 - 2)$ or $5 \div 8$; = 0.6(25) ;	2
8(b)	transition metals / elements ;	1
8(c)(i)	chloride / Cl^- ; copper / Cu^{2+} ;	2
8(c)(ii)	CuCl_2 ;	1

Question	Answer	Marks
9(a)(i)	variable resistor ;	1
9(a)(ii)	 at least three symbols correct ; variable resistor and motor in series in same branch ; lamps in parallel with motor and each other ; only two switches and both correctly located ;	4
9(b)(i)	$P = V \times I / 36 \times 7.0 ;$ $= 252 / 250 ;$ watt(s) / W ;	3
9(b)(ii)	time / t ;	1



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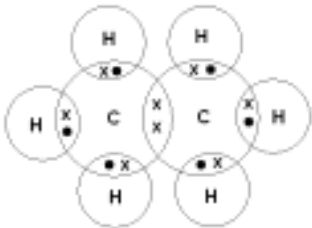
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1(a)	gas X oxygen (no mark) reduces in expired air (so oxygen used in respiration) ; gas Y carbon dioxide (no mark) increases in expired air (so carbon dioxide released in respiration) ;	2
1(b)	any two of large surface area ; thin walls ; good blood supply ; good ventilation with air ;	max 2
1(c)	goblet cells secrete mucus ; mucus traps pathogens and particles ; cilia sweep mucus out of the trachea ;	3
1(d)	chronic obstructive pulmonary disease / COPD ; lung cancer ; coronary heart disease ;	max 2

Question	Answer	Marks
2(a)(i)	arrow from reactant energy level to the top of the curve ;	1
2(a)(ii)	reactants have less chemical energy than products ;	1
2(a)(iii)	high temperature / high pressure / catalyst ;	1
2(b)	family of compounds with a general formula ; similar chemical properties ;	2

Question	Answer	Marks
2(c)	 six hydrogen atoms, three attached to each carbon ; one bonding pair between carbon atoms ; single bonding pairs between each carbon and hydrogen ;	3
2(d)	global warming / enhanced greenhouse effect / climate change / named consequence of climate change ;	1
2(e)	$\text{C}_2\text{H}_4 + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O}$ all formulae correct ; balanced (dependent on correct formulae) ;	2

Question	Answer	Marks
3(a)(i)	arrow pointing from right to left ;	1
3(a)(ii)	has to be an (equal and) opposite upward force / owtte ;	1
3(b)(i)	acceleration ; constant ;	2
3(b)(ii)	water friction / resistance (much higher than air resistance) ;	1
3(b)(iii)	working mark from one or more of : speed at 20 s = 0.88 m/s $(\text{KE} =) \frac{1}{2}mv^2$ $(\text{KE} =) \frac{1}{2} \times 60 \times 0.88^2$; = 23.2(3) (J) ;	2

Question	Answer	Marks
3(b)(iv)	(average speed =) distance $\div$ time or $25 \div 30$; = 0.83 (m/s) ;	2

Question	Answer	Marks
4(a)(i)	to make <u>chlorophyll</u> ;	1
4(a)(ii)	leaves turn yellow ;	1
4(b)	growth ; producers ; increase ; decrease ;	4
4(c)(i)	faster rate of transpiration / water loss from lower surface / cell surfaces ; more stomata on lower surface ;	2
4(c)(ii)	transpiration rate increases / increased evaporation from stomata / mesophyll cell surfaces ; water molecules have more kinetic energy due to higher temperature ; correct reference to diffusion of water molecules / vapour from air spaces in the leaf ;	max 2

Question	Answer	Marks
5(a)(i)	number of protons = 12 and number of neutrons = 12 ;	1
5(a)(ii)	12 electrons shown ; 2,8,2 configuration shown ;	2
5(b)(i)	(thermal) energy absorbed which decreases inter-particle forces / allows particles to separate / move around freely ;	1
5(b)(ii)	<u>cathode</u> ;	1
5(b)(iii)	gain electrons ; (gain) two (electrons) ;	2

Question	Answer	Marks
5(c)(i)	magnesium chloride ;	1
5(c)(ii)	limewater ; goes cloudy / milky ;	2

Question	Answer	Marks
6(a)(i)	forces decrease ; distances increase ;	2
6(a)(ii)	(average) speed (of molecules) decreases ;	1
6(b)	the higher the wind speed the higher the rate of evaporation / drying ; increased wind speed increases the rate at which molecules move away from suit / decreases the chances that escaped molecules return / owtte ; the higher the temperature the higher the rate of evaporation / drying ; increased temperature increases the energy / speed of molecules so they leave the surface at a higher rate / owtte ;	max 3
6(c)(i)	1 (m)	1
6(c)(ii)	$f = (1 \div \text{time between waves} = 1 \div 5) = 0.2 \text{ (Hz)} ;$	1
6(c)(iii)	$v = f \lambda$ or $\lambda = v / f$ or $\lambda = 3 / 0.2 ;$ $= 15 \text{ (m)} ;$	2

Question	Answer	Marks
7(a)	C ; shape of C is complementary to the active site ;	2
7(b)(i)	40 °C ;	1
7(b)(ii)	enzyme is <u>denatured</u> ; shape of active site changes ; substrate no longer fits the enzyme ;	3
7(c)	the breakdown of large / insoluble molecules ; into small / soluble molecules ;	2

Question	Answer	Marks
8(a)	electrons ; charges ;	2
8(b)(i)	1 hour = 3600 s / ($E =$) $50 \times 24 \times 3600$; 4 320 000 (J) ;	2
8(b)(ii)	($Q =$) $I \times t$ or ($Q =$) 25×60 ; = 1500 ; coulombs / C ;	3
8(c)	motor symbol with switch connected in parallel with lamps ;	1
9(a)(i)	in range 21 °C to 38 °C ;	1
9(a)(ii)	increases as group is descended ;	1
9(b)	metals are too reactive / more reactive than carbon ;	1
9(c)(i)	The group number is equal to the number of outer shell electrons ;	1
9(c)(ii)	metallic character decreases going from left to right ;	1