



Cambridge IGCSE™

COMBINED SCIENCE

0653/41

Paper 4 Extended Theory

October/November 2020

MARK SCHEME

Maximum Mark: 80

Published

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GENERIC MARKING PRINCIPLE 1:

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- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

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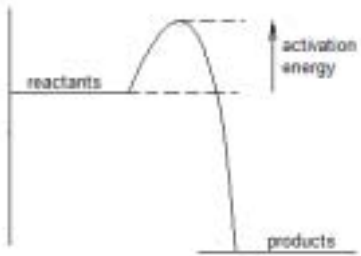
Question	Answer	Marks
1(a)(i)	<i>any two from:</i> oxygen moves into the blood; carbon dioxide moves into the, air / lungs / alveoli; by diffusion ;	2
1(a)(ii)	alveoli ;	1
1(a)(iii)	<i>any two from:</i> thin / one, layer of cells ; good blood supply ; large surface area ; well ventilated ;	2
1(b)(i)	(contains blood vessels for) taking substances / correct named substances, to (and from) the placenta / fetus ;	1
1(b)(ii)	protects the fetus from mechanical shock ;	1
1(b)(iii)	amino acids circled ; glucose circled ;	2

Question	Answer	Marks
2(a)	<i>trend:</i> boiling point increases ; <i>explanation:</i> molecules are larger ; stronger (intermolecular) forces ;	3
2(b)(i)	(family of compounds with) the same general formula ; similar chemical properties ;	2
2(b)(ii)	two double bonds shown ; all else correct including chemical symbols ;	2

Question	Answer	Marks
2(b)(iii)	$(C_7H_{16}) + 11 O_2 \rightarrow 7 (CO_2) + 8 H_2O$ all formulae correct ; balanced correctly dependent on correct formulae ;	2
2(c)	global warming / <u>enhanced</u> greenhouse effect / climate change / consequence of climate change ;	1

Question	Answer	Marks
3(a)(i)	use of area under graph OR distance = speed $\times$ time ; correct area identified / 1.5×5.0 ; 7.5 (m) ;	3
3(a)(ii)	25 (s) ;	1
3(a)(iii)	X anywhere on curved section between 25 s and 35 s ;	1
3(b)(i)	$\Delta G.P.E = mg\Delta h$ / $\Delta G.P.E = W\Delta h$ / 600×9.0 ; 5 400 (J) ;	2
3(b)(ii)	conversion of 48 kW to 48 000 W; energy = power $\times$ time / $48\,000 \times 20$; 960 000 (J) ;	3
3(b)(iii)	<i>any two from:</i> work is done moving the woman forward horizontally / KE of woman ; work is done moving the escalator / KE of escalator ; work is done against friction / thermal energy produced / heat produced ;	2

Question	Answer	Marks
4(a)	coronary artery correctly labelled ;	1
4(b)	haemoglobin ;	1
4(c)	<i>any three from:</i> so more oxygen / glucose, taken to the muscles ; so more energy can be released ; correct reference to respiration ; so more carbon dioxide can be removed (from the muscles) ;	3
4(d)(i)	a chemical substance produced by a <u>gland</u> , carried by blood ; which alters the <u>activity</u> of one or more specific target organs ;	2
4(d)(ii)	adrenaline ;	1

Question	Answer	Marks
5(a)(i)	 reactants and products labelled ; activation energy labelled ;	2
5(a)(ii)	(sodium) particles gain (sufficient) energy ; to (overcome the attractive forces and) break the bonds between particles ;	2
5(a)(iii)	8–14 AND sodium hydroxide is a base ;	1
5(a)(iv)	Na^+ AND OH^- ;	1

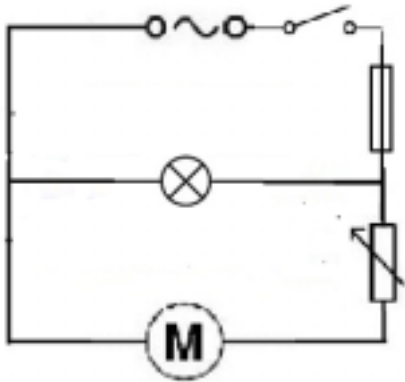
Question	Answer	Marks
5(b)	too reactive / very reactive / explosive ;	1
5(c)	chlorine ;	1
5(d)	as number of (outer shell) electrons increases the element becomes more non-metallic / ora ;	1

Question	Answer	Marks
6(a)	distances between molecules inside the tyre are smaller / molecules inside tyre are closer together / ora ;	1
6(b)	use of $P = F / A$; ($F = P \times A = 3 \times 10^5 \times 0.25 = 0.75 \times 10^5 / 75\,000$ (N) ;	2
6(c)(i)	<i>any two from:</i> holes help air flow (over the surface of the skin on her head) ; holes allow water to escape ; which increases rate of evaporation ;	2
6(c)(ii)	make, shiny / white / light in colour ; reflects (the Sun's radiation) ;	2
6(d)	$v = f \lambda$ in any form / $330 \div 1320$; 0.25 (m) ;	2

Question	Answer	Marks
7(a)	correct reference to, fusion / joining / combining ; of <u>nuclei</u> of pollen and ovule ;	2
7(b)(i)	(anthers) are long ; hang outside the flower ;	2

Question	Answer	Marks
7(b)(ii)	<i>any two from:</i> the reproductive organs / anther (and stigma), are inside the flower ; large petals ; the stigma is above the anther ;	2
7(c)	(they are) organisms that make (their own) nutrients ; using light energy / by photosynthesis ;	2
7(d)	<i>any two from:</i> energy is lost / wasted, throughout the food chain ; not enough energy to support many higher levels ; further detail, e.g. by respiration (heat), excretion, death ;	2

Question	Answer	Marks
8(a)	copper oxide / copper sulfide ;	1
8(b)(i)	solid (at RT) / high density / malleable / ductile / shiny / (good) conductor of, heat / electricity ;	1
8(b)(ii)	coloured (other than white) / reference to catalysis ;	1
8(c)	reduction and oxidation both occur (redox) ; copper <u>oxide</u> is reduced / carbon is oxidised ; copper <u>oxide</u> loses oxygen / carbon gains oxygen ;	3
8(d)	alloy AND mixture both circled ;	1

Question	Answer	Marks
9(a)	 switch and fuse symbols correct ; variable resistor symbol correct ; switch and fuse in main circuit ; variable resistor in motor branch ;	4
9(b)	$V = IR$ in any form / $230 \div 0.25$; 920 (Ω) ;	2



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1(a)	(vegetable noodles) contain (more) vitamin C ;	1
1(b)	(vegetable noodles) contain less energy ; excess energy would be stored as fat / owtte ;	2
1(c)	carbohydrate / fat / protein ;	1
1(d)	prevents constipation ;	1
1(e)(i)	by haemoglobin ; in red blood cells ;	2
1(e)(ii)	rate / depth of breathing increases ; (due to) increased carbon dioxide (concentration in the blood) ; (because), (rate of) respiration increases / CO ₂ is a product of respiration ;	3

Question	Answer	Marks
2(a)(i)	(compound containing only carbon and hydrogen and) only single (covalent) bonds (between carbon atoms) ;	1
2(a)(ii)	x = 4 ; y = 8 ;	2
2(b)(i)	double bond between carbon atoms; all else correct including chemical symbols ;	2
2(b)(ii)	orange to colourless ;	1
2(c)(i)	carbon dioxide / CO ₂ ; water / H ₂ O ;	2
2(c)(ii)	(bond breaking is) endothermic AND (bond forming is) exothermic ; more energy released during bond formation than energy required for bond breaking ;	2

Question	Answer	Marks
3(a)(i)	Q ;	1
3(a)(ii)	equal (magnitude) AND opposite (direction) ;	1
3(b)(i)	X drawn to show region between (0,0) and (3,0.4) ;	1
3(b)(ii)	Y drawn to show region between (10,0.2) and (14,0.3) ;	1
3(b)(iii)	acceleration = change of speed ÷ time / $-0.2 \div 3$; -0.07 ; m / s^2 ;	3
3(c)(i)	$\Delta \text{G.P.E.} = mg\Delta h$ in any form / $200 \times 10 \times 1.2$; 2400 J (= 2.4 kJ) ;	2
3(c)(ii)	any two from: thermal energy lost to surroundings / work done against friction ; man also has to gain PE going up onto the platform ; kinetic energy transferred / work also done in moving the man (and load) forward ;	2

Question	Answer	Marks
4(a)(i)	guard cell labelled with letter P ;	1
4(a)(ii)	contains, chloroplasts / chlorophyll ;	1
4(b)	any three from: water molecules have increased (kinetic) energy ; increased (rate of) <u>evaporation</u> (from surface of mesophyll cells) ; increased (rate of) <u>diffusion</u> , through stomata / out of leaves ;	3
4(c)(i)	leaves / trees → snails → thrushes → hawks organisms in correct order ; arrows in correct direction ;	2

Question	Answer	Marks
4(c)(ii)	snails ; herbivores / feed on producers / second trophic level ;	2
4(c)(iii)	<i>any two from:</i> respiration / heat / movement ; death ; excretion (of waste / urine) / loss of solid waste / faeces ; not all organisms in the chain, eaten / digested ;	2

Question	Answer	Marks
5(a)	iron oxide ;	1
5(b)	<i>any one from:</i> forms coloured <u>compounds</u> ; has high melting point ; has high density ; reference to use as a catalyst ;	1
5(c)(i)	ions must be mobile ;	1
5(c)(ii)	Al_2O_3 ;	1
5(c)(iii)	(type of bonding) aluminium oxide is ionic AND methane is covalent ; stronger forces of attraction (between oppositely charged ions) in aluminium oxide / weaker forces of attraction (between molecules) in methane ; so more energy needed to separate particles / overcome attraction (hence higher melting point) / ora ;	3
5(d)	as number of (outer shell) electrons increases, element changes from metallic to non-metallic ;	1

Question	Answer	Marks
6(a)(i)	forces decrease / weaken ; distances increase ; move, (more) freely / away from surface (of liquid water) ;	3
6(a)(ii)	black is a good absorber (of radiation) ; warm base of pool transfers thermal energy to water / increase in temperature of water (increases rate of evaporation) ;	2
6(a)(iii)	more-energetic molecules escape ; remaining molecules are less energetic (so lower temperature) ;	2
6(b)	radiation ;	1

Question	Answer	Marks
7(a)	<i>any two paired responses:</i> strong / thick wall, prevents bursting / withstands high pressure ; elastic fibres in wall, prevent bursting / stretch to accommodate high pressure of blood / enable wall to recoil and maintain pressure ; narrow lumen, maintains high pressure ;	2
7(b)	(capillaries have) thin walls ;	1
7(c)(i)	vena cava ;	1
7(c)(ii)	valve 1 opens AND valve 2 closes ;	1
7(d)	prevent backflow of blood / ensure that blood only travels in one direction ;	1

Question	Answer	Marks
8(a)	line with shallower gradient showing slower rate of reaction ; line starting and finishing at same mass ;	2
8(b)	<u>enhanced</u> greenhouse effect / global warming / example of a consequence of climate change ;	1
8(c)	measure distance to spot (from base line) ; measure distance to solvent front (from base line) ; show that $R_f = \text{distance to spot} \div \text{distance to solvent front} = 0.4$;	3
8(d)	idea of electrons gained by copper ions ; <u>two</u> electrons gained (per ion) / ions discharged ;	2

Question	Answer	Marks
9(a)(i)	$R = V \div I$ in any form / $6.0 \div 0.9$; (total resistance =) $6.7 \, (\Omega)$; so resistance of bell = total resistance – resistance of L1 / $6.7 - 4.0 (= 2.7 \, \Omega)$;	3
9(a)(ii)	use of parallel formula $R_{combined} = R_1 R_2 \div R_1 + R_2$ / $16 \div 8.0 (= 2.0 \, \Omega)$; (calculation of total resistance in circuit $R_{total} = 2.7 + 2.0 = 4.7 \, \Omega$; (current in bell = $V \div R_{total} = 6.0 \div 4.7 = 1.28 = 1.3 \, (A)$;	3
9(b)	any two from: if one lamp breaks, the other can still work ; the lamps can be used independently ; each bulb, gets the same voltage / has same brightness ;	2



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1(a)(i)	<i>any one from:</i> biconcave disc / large surface area (to volume ratio) for maximum oxygen absorption ; no nucleus so more space for oxygen transport ; contains haemoglobin ;	1
1(a)(ii)	produce antibodies ; phagocytosis ;	2
1(b)(i)	there is a circulation to the lungs and a circulation to the body (tissues) ;	1
1(b)(ii)	<i>any two from:</i> enables blood to go to the body tissues at high pressure ; enables blood to go the lungs at low pressure ; keeps oxygenated blood separate from deoxygenated blood ; enables faster blood flow ;	2
1(c)	(increase in breathing rate) enables more oxygen to, diffuse into / enter, the blood (at the lungs) ; (increase in heart rate) transports oxygenated blood faster ;	2
1(d)	coronary heart disease (CHD) ; COPD ;	2

Question	Answer	Marks
2(a)	(compound J) the molecule of J, has the formula C_2H_4 / is unsaturated ;	1
2(b)(i)	breaking of large hydrocarbon molecules into smaller molecules ;	1
2(b)(ii)	heat / use of a catalyst ;	1
2(c)	2 electrons shared in single bond between carbon atoms ; all else correct including the symbols ;	2

Question	Answer	Marks
2(d)	$\text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3\text{H}_2$ all formulae correct ; balanced ;	2
2(e)	carbon dioxide ; water ;	2

Question	Answer	Marks
3(a)(i)	$(m = W \div g = 820 \div 10 =) 82 \text{ (kg)} ;$	1
3(a)(ii)	$\Delta \text{G.P.E.} = mg\Delta h / \Delta \text{G.P.E.} = w\Delta h / 82 \times 10 \times 12 ;$ 9840 (J) ;	2
3(b)(i)	use of acceleration = change in speed $\div$ time / $27 \div 3.0 ;$ 9.0 ; $\text{m} / \text{s}^2 ;$	3
3(b)(ii)	X marked at time = 3 s ;	1
3(b)(iii)	non-constant, deceleration / acceleration (until it comes to rest) ;	1
3(c)(i)	(extension = $40.84 - 40.00 =$) 0.84 (m) ;	1
3(c)(ii)	calculation of k OR $1/k$ for one test ; calculation of k OR $1/k$ for second test AND shown to be the same ;	2

Question	Answer	Marks
4(a)	<i>any two from:</i> for growth of bones (of the fetus) ; to, prevent soft bones / keep bones strong / prevent loss of calcium in mother's bones ; to assist calcium absorption ;	2
4(b)(i)	tiredness / feeling dizzy / pale complexion / anaemia ;	1
4(b)(ii)	liver / red meat / green leafy vegetables ;	1
4(c)(i)	the energy (in the food) taken in exceeds the energy needs of the person ;	1
4(c)(ii)	country H ;	1
4(d)(i)	acidic conditions / low pH ;	1
4(d)(ii)	best pH for, pepsin / enzyme action in the stomach ;	1

Question	Answer	Marks
5(a)(i)	<i>neutrons:</i> 12 ; <i>protons:</i> 12 ;	2
5(a)(ii)	as the number of electrons increases the element becomes less metallic ;	1
5(b)	MgCl_2 ;	1
5(c)(i)	ions must be mobile / ions in a solid cannot move ; ions can move to the electrodes / for conduction of electricity	2
5(c)(ii)	gains electrons ; (gains) two electrons / is discharged ;	2
5(d)	energy is taken in for bond breaking / energy is released when bonds are formed / owtte ; (reaction is exothermic because) more energy released than taken in ;	2

Question	Answer							Marks
6(a)	gamma	X-rays	ultraviolet	visible light	infrared	microwaves	radio waves	2
			x				✓	
	<i>lowest frequency:</i> tick in correct place ; <i>causes sunburn:</i> cross in correct place ;							
6(b)(i)	(even at speed of light) it takes the gamma radiation a (very) long time to travel (billions of kilometres) ;							1
6(b)(ii)	$v = f \lambda$ in any form / $3.0 \times 10^8 \div 2.0 \times 10^{-14}$; 1.5×10^{22} (Hz) ;							2
6(c)(i)	infrared ;							1
6(c)(ii)	back / wings / head / darker areas, because black is a good absorber (of radiation) / ORA ;							1

Question	Answer	Marks
7(a)(i)	root(s) ;	1
7(a)(ii)	magnesium ;	1
7(a)(iii)	any three from: yellow leaves ; reference to chlorophyll transfers light energy to chemical energy ; chlorophyll is needed for photosynthesis / (lack of chlorophyll) reduces rate of photosynthesis reduced, carbohydrate / glucose / starch production ;	3
7(b)(i)	mistletoe / berries → thrush / (small)bird → cat → hawk OR mistletoe / berries → thrush / (small) bird → hawk organisms in correct order in food chain ; arrows pointing in the correct direction ;	2

Question	Answer	Marks
7(b)(ii)	hawks feed on thrushes which are primary consumers / at the second trophic level (so they are secondary consumers) ; hawks feed on cats which are secondary consumers / at the third trophic level (so they are tertiary consumers) ;	2

Question	Answer	Marks
8(a)	warm hydrochloric acid particles have more kinetic energy ; more successful collisions / more frequent collisions ;	2
8(b)	hard / dense / high melting point / acts as a catalyst / forms coloured compounds ;	1
8(c)(i)	bleaches (damp litmus paper) ;	1
8(c)(ii)	sterilises water / kills microbes / kills bacteria ;	1
8(d)	copper ions = 4.5 (cm) AND solvent front = 8 (cm) (from diagram) ; (4.5 ÷ 8.0 =) 0.56 ;	2

Question	Answer	Marks
9(a)	(gas compared to a liquid) distances between molecules are larger ; forces between molecules are smaller ; molecules are faster-moving / molecules have more KE / move more freely ;	3
9(b)	increases rate of evaporation ; water (vapour) molecules taken away from surface of bath (by moving air, preventing them returning to the bath water) ;	2
9(c)(i)	$P = IV$ in any form / $12 \div 0.080$; 150 (V) ;	2
9(c)(ii)	($I = P \div V = 18 \div 150 =$) 0.12 A ; (current in main circuit = 0.12 + 0.080 =) 0.20 A (so 0.5 A fuse gives suitable margin) ;	2