



COMBINED SCIENCE

0653/41

Paper 4 Extended Theory

May/June 2018

MARK SCHEME

Maximum Mark: 80

Published

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This document consists of **11** printed pages.



Cambridge Assessment
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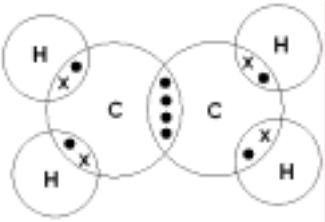
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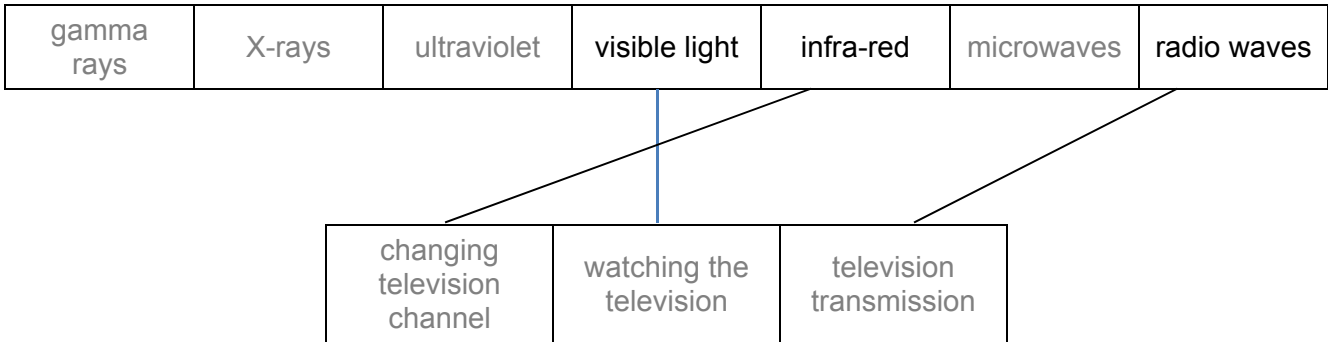
Question	Answer	Marks																													
1(a)	<table><tr><th rowspan="2">substance in food</th><th colspan="4">element</th></tr><tr><th>carbon</th><th>hydrogen</th><th>nitrogen</th><th>oxygen</th></tr><tr><td>carbohydrate</td><td>✓</td><td>✓</td><td></td><td>✓</td></tr><tr><td>fat</td><td>✓</td><td>✓</td><td></td><td>✓</td></tr><tr><td>protein</td><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr><tr><td>water</td><td></td><td>✓</td><td></td><td>✓</td></tr></table> one mark for each correct row ;;;;	substance in food	element				carbon	hydrogen	nitrogen	oxygen	carbohydrate	✓	✓		✓	fat	✓	✓		✓	protein	✓	✓	✓	✓	water		✓		✓	4
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fat	✓	✓		✓																											
protein	✓	✓	✓	✓																											
water		✓		✓																											
1(b)	include more fibre / roughage / fruit / vegetables ; (fibre) helps to move food through digestive system ;	2																													
1(c)	fatty ; (first space) smoking ; stress ;	3																													
1(d)(i)	(increases blood flow) (because the artery is) wider / the idea of more space (for blood to pass through) ;	1																													
1(d)(ii)	increases supply of glucose / oxygen (reaching the heart muscle) ; for respiration (in heart muscle cells) / to release energy (in muscle cells) / for contraction / action (of heart muscle) ;	2																													

Question	Answer	Marks
2(a)(i)	No reaction expected / will take place / experiment has to compare different metals ;	1
2(a)(ii)	aluminium / Al zinc / Zn tin / Sn lead / Pb ; aluminium and lead correctly located = 1 all correct = 2	2
2(b)(i)	magnesium chloride ;	1
2(b)(ii)	$\text{Mg(s)} + 2\text{HCl(aq)} \rightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$ all formulae and balanced (dependent on formulae) ; 3 or 4 correct state symbols (dependent on correct species) ;	2
2(b)(iii)	feasible method of collection ; timing device listed or shown in diagram ;	2
2(c)(i)	(Number of) protons + neutrons (in an atom) ;	1
2(c)(ii)	13 electrons shown ; arranged 2, 8, 3 ;	2

Question	Answer	Marks
3(a)(i)	arrow vertically upwards acting from the load ;	1
3(a)(ii)	(moving at) constant speed ;	1
3(b)(i)	constant acceleration constant speed changing acceleration ;	1
3(b)(ii)	Distance (= area under graph) = $\frac{1}{2} \times 4 \times 25 + 4 \times (65 - 25)$; = 210 (m) ;	2
3(c)	volume of cube = $2.0 \times 2.0 \times 2.0 = 8.0 \text{ m}^3$; density = mass / volume or $d = m / V$ or $m = V \times d = 8.0 \times 7000$; = 56 000 (kg) ;	3

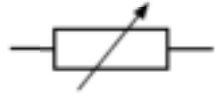
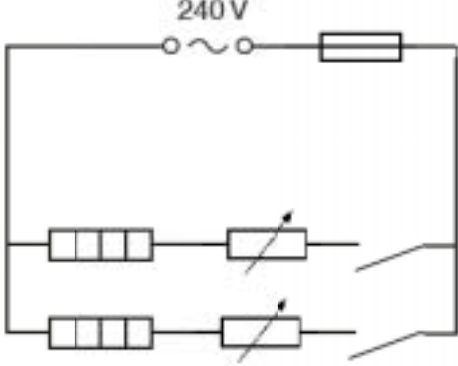
Question	Answer	Marks
4(a)(i)	(leaf P) it contains most chlorophyll ;	1
4(a)(ii)	converted to chemical energy ; used to make glucose / carbohydrate ;	2
4(b)(i)	$\text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$ correct formulae ; correctly balanced depending on correct formulae ;	2
4(b)(ii)	from leaves ; (transport) through the phloem ;	2

Question	Answer	Marks
5(a)(i)	(compound / substance) containing hydrogen and carbon (atoms) ; (carbon and hydrogen) only ;	2
5(a)(ii)	 (circles not essential) four electrons shown between carbon atoms ; four H atoms drawn with single pair of electrons between each and a C atom ;	2
5(a)(iii)	(test) (addition of) bromine ; (ethane) no change owtte and (ethene) decolourises ;	2
5(b)(i)	global warming / any valid effect of global warming ;	1
5(b)(ii)	thermal /heat energy released (by chemical reaction) / (chemical reaction causes) temperature increase ; chemical energy converted (to thermal / heat energy) ;	2

Question	Answer	Marks
6(a)	 3 correctly named parts of the electromagnetic spectrum ; these named parts correctly located ; 2 correct links between action and part of the electromagnetic spectrum ;	3
6(b)(i)	convection ;	1
6(b)(ii)	the density of hot gases is lower (than air in balloon) ; hot gases / lower density gases rise / or ;	2
6(b)(iii)	molecules move faster / have greater kinetic energy ; (attractive) forces become weaker / less significant ; the separation between molecules increases ;	3

Question	Answer	Marks
7(a)(i)	green plants → caterpillars → small birds → hawk or green plants → mice → cats → hawk correct organisms from the diagram in order ; arrows in correct sense ;	2
7(a)(ii)	cat ; hawk ;	2
7(b)(i)	(the hawk's) energy lost in respiration / heat / movement / growth ; (the hawk's) energy lost in waste products e.g. faeces, urine ; not all of the cat eaten by the hawk ;	max 2
7(b)(ii)	very little energy remains after 4 transfers / the idea that there is insufficient energy to sustain further levels ;	1

Question	Answer	Marks
8(a)(i)	melt / make it molten / convert it into a liquid form ;	1
8(a)(ii)	ions not mobile / the idea that ions need to (be able to) move ;	1
8(b)(i)	<u>blast furnace</u> ;	1
8(b)(ii)	carbon is more reactive than iron ; group II metals / calcium are more reactive than carbon ;	2
8(c)(i)	transition (elements / metals) ;	1
8(c)(ii)	noble (gases) / Group VIII ;	1

Question	Answer	Marks
9(a)(i)	fuse  switch  variable resistor  3 correct for 2 marks Any 1 correct for 1 mark	2
9(a)(ii)	parallel ;	1
9(a)(iii)	 two hotplates connected in parallel ; each hotplate branch contains a variable resistor in series ; each hotplate branch contains a switch in series ; fuse in main circuit ;	4

Question	Answer	Marks
9(b)	$P = V \times I$; EITHER larger hotplate: $I = 1500 / 240 = 6.25 \text{ A}$ smaller hotplate: $I = 1000 / 240 = 4.17 \text{ A}$; total current = 10(.4 A), (safely less than 13 A) ; or total power = 1.5 (kW) + 1.0 (kW) = 2.5 (kW) ; $P = V \times I$ or $I = P / V$ or total current = 2500 / 240 ; = 10(.4 A) (safely less than 13 A) ;	3



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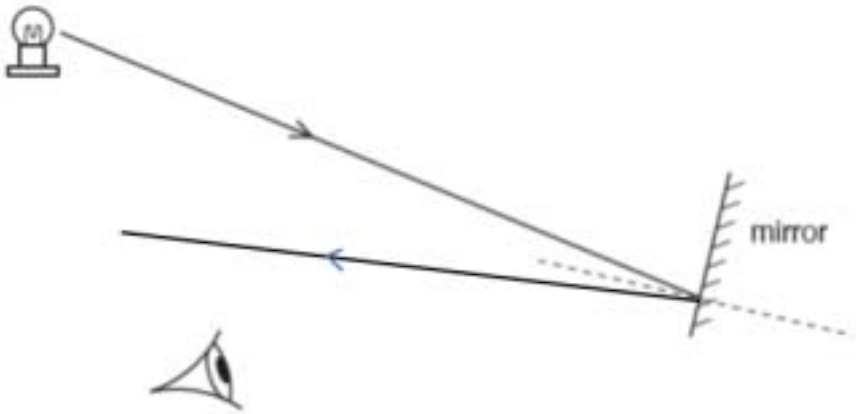
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Question	Answer	Marks
1(a)(i)	geotropism ;	1
1(a)(ii)	auxin moves to lower surface ; causes more elongation / growth ;	2
1(a)(iii)	causes retardation of elongation / growth (on lower surface) ;	1
1(b)(i)	has large projection / is long / large surface area ; the idea of increased rate of water uptake / of diffusion ;	2
1(b)(ii)	higher concentration of water / water potential in soil / ora / there is a concentration gradient between the soil water and the cell water ; water moves from high to low concentration (of water) / down the concentration gradient ;	2
1(c)	xylem ;	1

Question	Answer	Marks
2(a)(i)	anhydrous / blue cobalt chloride ; turns (blue to) pink ; OR anhydrous / white copper sulfate ; turns (white to) blue ;	2
2(a)(ii)	$\text{Ca(OH)}_2(\text{aq}) + \text{CO}_2(\text{g}) \rightarrow \text{CaCO}_3(\text{g}) + \text{H}_2\text{O}(\text{l})$ correct species both sides ; 3 or 4 correct states ;	2

Question	Answer	Marks
2(b)(i)	(circles not essential) 4 electrons between two C atoms ; 2 electrons between each of 4 pairs of C and H atoms ;	2
2(b)(ii)	covalent ;	1
2(c)	2, 4 ;	1

Question	Answer	Marks
3(a)	fuse ; (the idea that 240 V could produce a) high current ; one from (a high current could) cause damage / overheating ; (fuse) protects circuit / breaks circuit / melts ;	3
3(b)(i)	$(R = V / I) = 3 / 0.2 ;$ $= 15 (\Omega) ;$	2
3(b)(ii)	total power supply required = $100 + 20 = 120 \text{ W} ;$ $P = I \times V$ or total current = $120 / 240 ;$ $= 0.5 \text{ A} ;$	3

Question	Answer	Marks
3(c)	 reflected ray shown at approx. correct angle missing the eye ;	1

Question	Answer	Marks
4(a)	trachea, bronchus, bronchiole ;	1
4(b)	<i>effect on mucus</i> mucus production increases ; <i>effect on cilia</i> cilia become paralysed / damaged ; cannot remove mucus from airway / away from lungs ;	3
4(c)	(rate of gas exchange reduced) reduced area (for gas exchange in alveoli) ;	1
4(d)(i)	narrowing / blockage of <u>coronary arteries</u> ; due to fatty deposits / plaque ;	2
4(d)(ii)	high fat diet ; stress ;	2

Question	Answer	Marks
5(a)(i)	(decrease) gas produced / released (by the reaction) ; to the surroundings / substance leaves the flask / apparatus ;	2
5(a)(ii)	(increase) particles move faster / gain (kinetic) energy ; particles collide more often ; the idea that more of the collisions are successful ;	max 2
5(a)(iii)	increase ; calcium is more reactive (than magnesium) ;	2
5(b)(i)	cathode ;	1
5(b)(ii)	(each ion) loses (one) electron ;	1
5(b)(iii)	MgCl_2 ;	1
5(b)(iv)	reduction ;	1

Question	Answer	Marks
6(a)(i)	X-rays ;	1
6(a)(ii)	electromagnetic spectrum uses all three correct ;	1
6(b)	electromagnetic / infra-red waves can travel through a vacuum / do not need a medium to travel through ;	1
6(c)(i)	glass is a bad / poor conductor (of thermal energy) ;	1
6(c)(ii)	air / gas expands / volume increases ; molecules move faster / gain kinetic energy ; separation / distance between molecules increases ;	3

Question	Answer	Marks
7(a)(i)	the Sun ;	1
7(a)(ii)	death / egestion / excretion ;	1
7(a)(iii)	1, 2, 4	1
7(b)(i)	photosynthesis ;	1
7(b)(ii)	(concentration increases) less CO ₂ removed ; because photosynthesis reduced ; (CO ₂ continues to be) added to atmosphere by respiration / combustion ;	max 2
7(c)	dissolves in rainwater / owtte ; forms acid rain ; consequence of pollution by acid rain ; (e.g. harm to plants / animals / water courses damage to building materials)	3

Question	Answer	Marks
8(a)(i)	the idea that the number of outer electrons is the same as the group number ;	1
8(a)(ii)	more (outer-shell) electrons more non-metallic ; metallic elements have fewer (outer-shell) electrons ;	1
8(b)(i)	temperature in range 21–62 (°C) ;	1
8(b)(ii)	rubidium is more reactive ;	1
8(c)	kill / destroy bacteria / microbes / microorganisms ;	1
8(d)(i)	thermal / heat energy released (by chemical reaction) / (chemical reaction causes) temperature increase ; chemical energy converted (to thermal / heat energy) ;	2
8(d)(ii)	sodium hydroxide / NaOH / sodium carbonate / Na ₂ CO ₃ / sodium hydrogen carbonate / sodium bicarbonate / NaHCO ₃ ;	1

Question	Answer	Marks
9(a)(i)	two opposite vertical force arrows ; both arrows from the load ;	2
9(a)(ii)	weight / gravitational force ;	1
9(b)(i)	constant acceleration constant speed changing acceleration (in this order) ;	1
9(b)(ii)	selection of area under graph as method ; calculation of area: $\frac{1}{2} \times 50 \times 1 + (125 - 50) \times 1 = 100 \text{ m}$;	2
9(b)(iii)	$(P =) E/t$ or W/t or $(P =) 2\,000\,000 \div 150$; $= 13\,300 \text{ (W)} / 13\,000 \text{ (W)}$;	2
9(c)	density = mass / volume ; unit change noted: $5000 \text{ dm}^3 = 5 \text{ m}^3$; mass (= volume x density) = $5 \times 1025 = 5125 \text{ (kg)}$;	3



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Question	Answer	Marks
1(a)(i)	$6\text{CO}_2 + 6\text{H}_2\text{O} \longrightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$;;	2
1(a)(ii)	makes the leaf float ; good light absorption ;	2
1(b)(i)	more plants produced in B than A / greater increase in B than A ; use of supporting data e.g. increase of 5 in A and 19 in B ;	2
1(b)(ii)	nitrate ions causes population to increase more rapidly ;	1
1(c)(i)	becomes covered with duckweed / algae / plants ;	1
1(c)(ii)	(bacteria) decompose the dead plants ; bacteria use up oxygen / oxygen concentration in pond decreases ; due to <u>respiration</u> of the bacteria ; fish die / suffocate due to lack of oxygen ;	max 3

Question	Answer	Marks
2(a)(i)	(metal ion) any moving towards negative electrode and (non-metal ion) any moving towards positive electrode ; (electrolyte) solution ; (anode) positive electrode ;	3
2(a)(ii)	the idea that electron transfer occurs between ions and electrodes ; positive ions gain electrons and negative ion lose electrons ;	2
2(b)	electrolysis ; molten (sodium chloride) ; relevant additional detail e.g. high temperature needed / inert electrodes used ;	max 2
2(c)(i)	carbon / coke ;	1
2(c)(ii)	carbon monoxide / CO / carbon / C ;	1
3(a)(i)	upward vertical force arrow acting on the drone at any point ;	1

Question	Answer	Marks
3(a)(ii)	falls to ground ; accelerates ;	2
3(a)(iii)	(moves / accelerates due to) unbalanced forces / weight / gravitational force ;	1
3(b)(i)	PE gained = $mgh = 5 \times 10 \times 50$; = 2500 ; joules / J ;	3
3(b)(ii)	chemical > electrical > kinetic > (grav PE) ;; all 3 correct for 2 marks; any 2 correct for 1	2
3(c)(i)	electromagnetic waves ;	1
3(c)(ii)	$v = f\lambda$ OR rearranged / $\lambda = 3.0 \times 10^8 / 35 \times 10^6$; = 8.6 m ;	2

Question	Answer	Marks
4(a)	A stigma ; feathery structure / large area to trap pollen ; B anther ; hangs outside the flower to (allow the wind) disperse pollen ;	4
4(b)	no need to attract insects ;	1
4(c)	haploid nuclei fuse / join ; to form a diploid zygote ; genetically dissimilar offspring ;	max 2

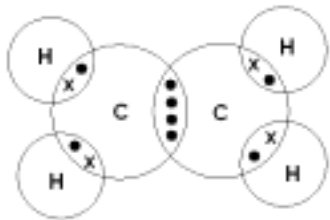
Question	Answer	Marks
5(a)(i)	(13) 13 electrons so 13 protons / same no. electrons and protons ;	1
5(a)(ii)	aluminium ;	1
5(b)(i)	(mass no.) 37 ; (neutron no.) 20 ;	2
5(b)(ii)	2, 8, 8 shown on a diagram with concentric shells ;	1
5(b)(iii)	(chlorine is an element but) sodium chloride is a compound / not an element ;	1
5(c)	(test) silver nitrate / aqueous/solution (acidic conditions) ; (result) white precipitate ;	2

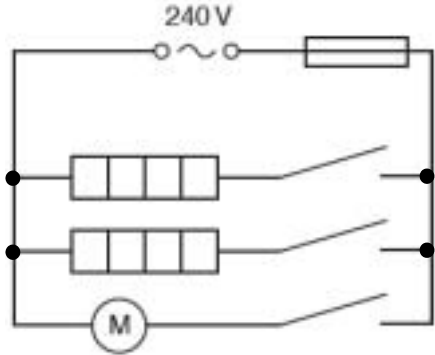
Question	Answer	Marks
6(a)	line starts from -5° ; line rises to meet cooling line ; curves meet at or after 200 seconds ; line matches cooling line and follows it as temp rises again at end ;	Max 3
6(b)(i)	convection ;	1
6(b)(ii)	cold water denser than warm (so sinks to bottom, displacing warmer water back to top) ;	1

Question	Answer	Marks
7(a)(i)	larynx correctly labelled ;	1
7(a)(ii)	<i>any bronchiole correctly labelled ;</i>	1
7(b)(i)	thin wall / short diffusion distance ; good blood supply ;	2

Question	Answer	Marks
7(b)(ii)	down concentration gradient owtte ;	1
7(c)	<i>mucus</i> traps pathogens / dust ; <i>cilia</i> (beat upwards to) remove the mucus ;	2
7(d)	(blood leaving left ventricle) has to go all round the body ; blood leaving right ventricle only has to go to lungs / high pressure in lung capillaries would damage them ;	2

Question	Answer	Marks
8(a)(i)	coal and natural gas ;	1
8(a)(ii)	<u>fractional distillation</u> ;	1
8(b)(i)	$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ all formulae correct ; correct balancing (dependant on correct formulae) ;	2
8(b)(ii)	C_6H_{14} ;	1
8(b)(iii)	(B / C_6H_{14} / hexane) (B) larger molecule / surface area ; (B) greater intermolecular (attractive) forces / more energy needed to separate molecules ;	2
8(c)(i)	cracking ;	1

Question	Answer	Marks
8(c)(ii)	 (circles not essential) double bond between carbon atoms ; four H atoms drawn with single pair between each and a C atom ;	2

Question	Answer	Marks
9(a)	 fuse in main circuit ; heating elements in parallel with each other and supply ; motor in parallel with heating elements (and supply) ; switches in series with both heaters and motor ;	4
9(b)	total power supply required = $1200 \times 2 + 100 = 2500 \text{ W}$; use of $P = I \times V$ e.g. current through one heater = 5 A / total current = $2500 \div 240$; = 10.4 A (which is above fuse rating) ;	3

Question	Answer	Marks
9(c)	value within range 10–15 kHz ; top end of normal range is 20 kHz / older residents can hear up to 15 kHz ;	2