



Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

COMBINED SCIENCE

0653/41

Paper 4 Extended Theory

May/June 2017

MARK SCHEME

Maximum Mark: 80

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

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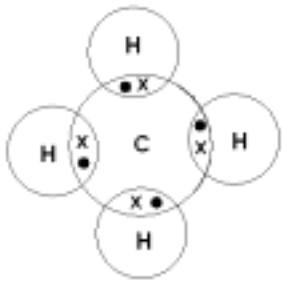
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Question	Answer	Marks
1(a)	lines drawn from Flowering plants to produce haploid pollen ; use auxins to respond to light ; have root hair cells which increase water uptake ;	3
1(b)(i)	(anthers) hang outside the flower so pollen is easily picked up by wind ; (stigmas) feathery / large surface area to collect pollen ;	2
1(b)(ii)	to increase the chances of pollination between plants ;	1
1(c)(i)	the idea that fossil fuels contain sulfur / sulfur compounds ; sulfur dioxide produced ; dissolves in water in the air ;	Max 2
1(c)(ii)	reduces activity / denatures <u>enzymes</u> present in the plants ;	1

Question	Answer	Marks
2(a)(i)	covalent ;	1
2(a)(ii)	 four shared pairs between C and four H atoms ; all symbols correctly shown ;	2
2(b)(i)	carbon dioxide ; water ;	2
2(b)(ii)	releases <u>heat</u> / <u>thermal</u> energy when it reacts / burns / is used ;	1
2(c)(i)	<u>natural gas</u> ;	1
2(c)(ii)	coal and petroleum ;	1

Question	Answer	Marks
3(a)(i)	D C	1
3(a)(ii)	(Force C is 1200 N) no mark no vertical motion / forces (A and C) are balanced ;	1
3(b)	line starts along the speed = 2 m / s horizontal, levelling off at speed = 4.5 m / s and 10 mins ; any curved line between these points, then level after (10,4.5) ;	2
3(c)(i)	$KE = \frac{1}{2} m v^2 / \frac{1}{2} \times 120 \times 3 \times 3 ;$ $= 540 \text{ (J)} ;$	2
3(c)(ii)	(90 kJ =) 90 000 J (= work done = energy transferred) ; distance moved = $3 \text{ (m / s)} \times 50 \text{ (s)} = 150 \text{ m} ;$ force = work done $\div$ distance / $90\,000 \div 150 = 600 \text{ (N)} ;$	3

Question	Answer	Marks
4(a)(i)	contain chlorophyll ; trap light (energy) ; converts (light) into chemical energy ; the idea that chemical energy is contained in glucose / starch / carbohydrate ;	3
4(a)(ii)	flagellum ; the idea that the flagellum is for movement ;	2
4(b)(i)	food chain containing the following organisms phytoplankton→zooplankton→mussel→crab→seagull ; four arrows in correct direction in the chain ;	2
4(b)(ii)	fewer steps / stages / organisms in chain containing mussels / ora ; use of the term <u>trophic level</u> ; energy is lost at each stage ; by heat / movement / avp ;	3

Question	Answer	Marks
5(a)(i)	increases ; neutralisation / salt-making;	2
5(a)(ii)	CuSO_4 ; CO_2 and H_2O ;	2
5(b)	filter (to remove excess solid / copper carbonate) ; heat the solution / filtrate / mixture ; reference to evaporation ; cool / leave (to allow crystals to form) ;	2
5(c)	the idea that the gradient decreases ; the idea that the rate decreases ; the idea that the rate becomes zero ;	2
5(d)(i)	less steep initial line ; levels off at a lower volume;	2
5(d)(ii)	(decreases rate of reaction) because particles collide less frequently / owtte ;	1

Question	Answer	Marks							
6(a)(i)	infra-red / radiation ; poorly absorbed / mainly reflected by white ;	2							
6(a)(ii)	the idea that feet lose heat / thermal energy ; the idea that heat / thermal energy is lost to the water ; because the water is colder ;	2							
6(a)(iii)	(line 1) more energetic/faster and (line 3) energy / speed ; (line 4) temperature ;	2							
6(b)	ray from X refracts correctly at surface ; unbroken rays drawn with a ruler to the eye with at least one arrow on a ray ;	2							
6(c)(i)	<table border="1"><tr><td>gamma rays</td><td></td><td></td><td>Visible light</td><td></td><td>micro-waves ;</td><td>radio waves</td></tr></table>	gamma rays			Visible light		micro-waves ;	radio waves	1
gamma rays			Visible light		micro-waves ;	radio waves			
6(c)(ii)	$v = f \lambda / f = 3 \times 10^8 \div 0.12 ;$ $= 2.5 \times 10^9 \text{(Hz)} ;$	2							

Question	Answer	Marks
7(a)	energy = $37 \times 11 + 17 + 13 \times 17$ (= 645) ; $\times 2 = 1290$ (kJ) ;	2
7(b)	eggs (no mark) contains the most fat ;	1
7(c)(i)	6CO_2 and $6\text{H}_2\text{O}$;	1
7(c)(ii)	in red (blood) cells ; by haemoglobin ; red cells carried in plasma ;	Max 2
7(d)	chemical digestion:- mouth, and stomach and small intestine / duodenum / ileum ; absorption:- small intestine / duodenum / ileum ;	2

Question	Answer	Marks
8(a)	2,8,3 ;	1
8(b)(i)	oxygen (gas) ;	1
8(b)(ii)	aluminium ions gain electrons ; gain 3 electrons / ions are discharged / become aluminium atoms ;	2
8(c)(i)	carbon / C / carbon monoxide / CO ;	1
8(c)(ii)	aluminium / Al is more reactive than carbon / C ;	1
8(d)(i)	Al is less reactive than Mg ;	1
8(d)(ii)	Al is more reactive than Cu ;	1

Question	Answer	Marks
9(a)	any two from one or two metals <i>or</i> alloys (<i>other than copper</i>) graphite / carbon	1
9(b)	$= 2 / 0.5 = 4$; ohms / Ω ;	2
9(c)(i)	(2 A) sum of currents in parallel branches = current from source ;	1
9(c)(ii)	P and Q have different resistances / thicknesses ; P less resistance than Q / P is thicker than Q ;	2



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Question	Answer	Marks
1(a)	three lines from 'Enzymes' to are biological catalysts ; work best in a narrow pH range ; are made from amino acids ;	3
1(b)	(correct) 46 °C is optimum temperature / rate decreases above and below 46 °C ; correct reference to denaturation ;	2
1(c)(i)	glucose / sugar / simple sugar ;	1
1(c)(ii)	glycogen ;	1
1(c)(iii)	<u>nitrogen</u> ;	1

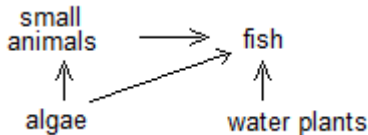
Question	Answer	Marks
2(a)(i)	A potassium / K B lithium / Li C sodium / Na 1 or 2 correct, 1 mark all 3 correct, 2 marks	2
2(a)(ii)	exothermic ; <u>chemical</u> (potential) ; two from thermal (allow heat) / light / sound / kinetic ;	3
2(a)(iii)	in the range 1 to 14 (seconds) inclusive ;	1
2(b)	(too) dangerous / (risk of) explosion ;	1
2(c)(i)	resists corrosion / does not rust ;	1
2(c)(ii)	stronger / more difficult to damage ;	1

Question	Answer	Marks
3(a)(i)	C B	1
3(a)(ii)	(D is 500 000 N) the idea that height remains constant / forces (B and D) are balanced / equal and opposite / the resultant force in the vertical direction is zero ;	1
3(a)(iii)	(decreases) the <u>weight</u> decreases ;	1
3(b)(i)	acceleration = increase in speed ÷ time / (160 – 100) ÷ 30 ; = 2 m / s ² ;	2
3(b)(ii)	potential energy change = mgh or mgΔh / 50 000 × 10 × 2000 ; = 1 × 10 ⁹ (J) ;	2

Question	Answer	Marks
4(a)(i)	valve A closes and valve B opens ;	1
4(a)(ii)	high(er) pressure required to send blood around the body / travel a long distance / ora ; high(er) pressure in aorta and low(er) pressure in pulmonary artery ; low pressure in pulmonary artery prevents damaging capillaries in lungs ;	Max 2
4(b)(i)	reduces blood flow in <u>coronary artery</u> / <u>arteries</u> ; by presence of cholesterol / fatty deposits / plaque ;	2
4(b)(ii)	less fatty diet / reduced stress / reduced smoking / more exercise ;	1
4(c)(i)	any valid fight or flight situation described ;	1
4(c)(ii)	destroyed by the <u>liver</u> ;	1
4(d)	reference to <u>auxins</u> ; greater concentration on dark side (of stem) ; cause greater (cell) elongation / growth (on that side) ;	3

Question	Answer	Marks
5(a)(i)	<u>fractional distillation</u> ;	1
5(a)(ii)	larger molecules / hydrocarbons have larger inter-molecular forces / ora ;	1
5(a)(iii)	larger inter-molecular forces means higher boiling point / ora ;	1
5(b)(i)	(D) alkane / saturated ; (E) alkene / unsaturated ;	2
5(b)(ii)	<u>bromine</u> (water / solution) ; (D) no change and (E) decolourises ;	2
5(b)(iii)	<u>cracking</u> ;	1
5(c)	$(C_7H_{16}) + \dots 11 \dots (O_2) \rightarrow \dots 7 \dots (CO_2) + \dots 8 \dots (H_2O) ; ;$	2

Question	Answer	Marks
6(a)(i)	conduction ;	1
6(a)(ii)	(kinetic) energy of air molecules inside transferred to molecules in aircraft wall (fuselage) ; (kinetic) energy transferred between molecules in aircraft wall (fuselage) ; (kinetic) energy transferred from aircraft wall (fuselage) to air molecules outside ; the idea that energy is transferred via vibrating/colliding molecules/particles ;	Max 2
6(b)(i)	(Z) molecules shown not touching / apart ;	1
6(b)(ii)	molecules in jet engine moving faster ; because they are at a higher temperature / have greater kinetic energy ; or molecules in water moving more slowly ; because they are at a lower temperature / have smaller kinetic energy ; or the idea that molecules from the jet exhaust are able to move more freely ; because they are separated / far apart ; or the idea that molecules in water have more restricted movement ; because molecules are close together / touching ;	2
6(c)(i)	total distance = speed $\times$ time / $3 \times 10^5 \times 0.0002$; = 60 (km) ; so distance aircraft to transmitter = $\frac{1}{2} \times 60 / 30$ (km) ;	3
6(c)(ii)	(long wavelength end) it is in the microwave part of spectrum / it is a microwave / it is at the low frequency end ; lower frequency waves have longer wavelength / ref. to inverse proportionality / reference to the formula $v = f \times \lambda$;	2

Question	Answer	Marks
7(a)	an area where the organisms interact with each other ; and (interact with) their environment ;	2
7(b)	 all organisms written only once ; feeding relationships shown using arrows ;	2
7(c)(i)	no light ; for photosynthesis ;	2
7(c)(ii)	bacteria take in / use the oxygen ; for their respiration ;	2

Question	Answer	Marks
8(a)(i)	6 ;	1
8(a)(ii)	non-metal together with one from electrical / thermal insulator / low melting / boiling point ovp ;	1
8(b)(i)	(2), 8, 7 ;	1
8(b)(ii)	one shared pair and six non-bonding electrons on each Cl ;	1
8(c)(i)	ionic ;	1
8(c)(ii)	sodium loses one (electron) ; chlorine gains one (electron) ;	2

Question	Answer	Marks
8(d)	reference to full outer shell ;	1

Question	Answer	Marks
9(a)(i)	correct symbols for ammeter and lamp ; only the shown components connected in series ;	2
9(a)(ii)	voltmeter connected in parallel with lamp ; correct symbol for voltmeter ;	2
9(b)	$P = V \times I = 1.5 \times 0.6 = 0.9 \text{ (W)} ;$	1
9(c)(i)	total resistance more, (so current decreases / so dimmer lamps) ;	1
9(c)(ii)	the idea that (compared to one bulb) the (total) potential difference (across two bulbs) is the same but the current is lower (V the same I lower) ; (if V is the same, but I is less) then less power (dissipated) / less total energy transformed per unit time ; or the relation $P = V \times I / E = V \times I \times t$ therefore shows that the power / energy per unit time is lower (when two bulbs are used) ;	2



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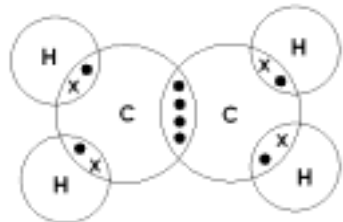
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1(a)	three lines drawn to increases the concentration of carbon monoxide in the blood ; damages the cilia in the airway ; causes more mucus to be produced in the lungs ;	3
1(b)(i)	arrow drawn from <u>plasma</u> to alveolar sac ;	1
1(b)(ii)	large surface area ; thin wall ; reference to good blood supply ;	2
1(c)	carried by haemoglobin ; in red blood cells ; enters left atrium / through the pulmonary vein ; red cells carried in plasma ;	max 3
1(d)(i)	more glucose available to be broken down by cells / for oxidation / chemical (energy) converted to thermal / heat (energy)	1
1(d)(ii)	faster delivery of oxygen / glucose to cells ;	1

Question	Answer	Marks
2(a)(i)	C_8H_{18} ; allow $H_{18}C_8$	1
2(a)(ii)	(higher up) lower boiling point ; smaller molecules ; lower intermolecular forces ;	3
2(b)	cracking ;	1
2(c)	(ethene) alkene / unsaturated ; both (ethane) and (octane) alkane / saturated ;	2
2(d)	 2 pairs between carbon ; 1 pair between each H and C ; (whether dots or crosses does not affect marks)	2

Question	Answer	Marks
3(a)(i)	C A	1
3(a)(ii)	(Force B is 1000 N) no vertical motion / forces (A and B) are balanced ;	1
3(b)	1 km at 15 km / h $\rightarrow 1 / 15$ h / 0.067 h ; $1 / 15$ h = $3\,600 \times 1 / 15 = 240$ (s) ;	2
3(c)	KE = $\frac{1}{2} mv^2$ = $\frac{1}{2} \times 100 \times 4 \times 4 = 800$ (J) ;	2
3(d)(i)	energy input = $120 \times 250 = 30\,000$ (J) ;	1
3(d)(ii)	work done = force $\times$ distance (moved) / $F \times d$; = $25 \times 1\,000 = 25\,000$ (J) ;	2
3(d)(iii)	efficiency (%) = (work got out $\div$ work put in) $\times 100$ / (equivalent wording) ; = $(25\,000 / 30\,000) \times 100 = 83.3$ (%) ;	2

Question	Answer	Marks
4(a)	geotropism / gravitropism ;	1
4(b)(i)	drawing with shoot bending upwards ; root bending downwards ;	2
4(b)(ii)	auxins become more concentrated on lower surface ; cause more growth / cell elongation ;	2
4(c)(i)	sulfur dioxide ; dissolves in rain water ;	2
4(c)(ii)	denatures the enzymes / makes the enzymes less active ;	1

Question	Answer	Marks
5(a)	8 electrons 2 nd shell ; 2 electrons 3 rd shell ;	2
5(b)(i)	gas / H ₂ produced / lost ; reaction ends / over ;	2
5(b)(ii)	(Mg) + 2HCl → H ₂ + (MgCl ₂) 2HCl ; H ₂ ;	2
5(c)(i)	increases ; particles collide more often / forcefully / energetically / successfully ;	2
5(c)(ii)	increases / changes ; no change ;	2

Question	Answer	Marks							
6(a)(i)	conduction ;	1							
6(a)(ii)	air is a good insulator / poor conductor (of heat) ;	1							
6(b)(i)	(Z – no mark) at 800 °C / such a high temperature water is formed as a gas ;	1							
6(b)(ii)	ice (crystals) ; water vapour / steam from engines freezes in contact with air at a temperature well below freezing point of water ;	2							
6(c)(i)	microwaves ;	1							
6(c)(ii)	<table border="1"><tr><td></td><td>X-rays</td><td></td><td>visible light</td><td></td><td>micro-waves ;</td><td></td></tr></table>		X-rays		visible light		micro-waves ;		1
	X-rays		visible light		micro-waves ;				
6(d)(i)	speed of radio waves / electromagnetic waves (much) faster than speed of sound ;	1							
6(d)(ii)	vibrations produced by engines / owtte ; create series of compressions and rarefactions through air to man / vibrations passed through air from particle to particle / longitudinal (sound) waves are passed through the air ;	2							

Question	Answer	Marks
7(a)	$C_6H_{12}O_6$ and $6O_2$;	1
7(b)(i)	line drawn through stoma to cell Z ;	1
7(b)(ii)	xylem correctly labelled ;	1
7(c)(i)	by evaporation ; from the surfaces of the mesophyll cells / cells inside the leaf ;	2
7(c)(ii)	(greater in A) air around A is less humid than around B / ora ; transpiration happens more slowly if the air is humid / ora ;	2

Question	Answer	Marks
8(a)	(rubidium) in the range 25 to 50 (°C) inclusive ;	1
8(b)(i)	C A B D C and D correct ; A and B correct ;	2
8(b)(ii)	chemical (energy) decreases ; thermal / heat (energy) increases ;	2
8(c)(i)	cathode ;	1
8(c)(ii)	chlorine / Cl ₂ ;	1
8(c)(iii)	(so that) ions move ;	1

Question	Answer	Marks
9(a)(i)	(4.5 A) idea that current in main circuit = sum of currents in branches ;	1
9(a)(ii)	(because) same p.d. across both resistors ; (so) R_2 and R_3 must have different values ; R_2 greater than R_3 ;	max2
9(b)(i)	3 A	1
9(b)(ii)	voltage across $R_1 = 12 - 3 = 9\text{V}$; $R_1 = V / I = 9 / 3 = 3\ \Omega$;	2