



COMBINED SCIENCE

0653/41

Paper 4 Extended Theory

October/November 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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Question	Answer	Marks
1(a)	red blood cells ; pulmonary vein ; aorta ; capillaries ;	4
1(b)	thick (wall) ; to resist bursting / withstand high blood pressure ;	2
1(c)	A trachea ; B bronchiole ;	2
1(d)	(nicotine) causes addiction / increases blood pressure / leads to heart disease ; (tar) increases mucus / (tar) builds up in lungs / paralyses / destroys cilia / can cause cancer / avp ;	2

Question	Answer	Marks
2(a)(i)	(negative) cathode and (positive) anode ;	1
2(a)(ii)	(negative) potassium / K ; (positive) bromine / Br ₂ ;	2
2(a)(iii)	ions must be able to move / be mobile ;	1
2(b)(i)	(K ₂ CO ₃ (s) + 2) ... HCl (aq) ... → 2 KCl (aq) + ... CO₂ (g) ... + ... H₂O (l) ... HCl ; RHS ; all three states ;	3
2(b)(ii)	(test) (acidified) silver nitrate (solution) ; (observation) white precipitate / solid ;	2

Question	Answer	Marks
2(b)(iii)	filter (to remove excess solid / potassium carbonate) ; and then one from heat / boil the solution / filtrate / mixture / diagram showing this process ; reference to evaporation / removal of water ; cool / leave (to allow crystals to form) ;	max 2

Question	Answer	Marks
3(a)(i)	80 cycles / vibrations / oscillations per second ;	1
3(a)(ii)	first note louder than second note ;	1
3(a)(iii)	yes (no mark) frequency range lies within frequency range of normal human hearing ;	1
3(b)	radio / electromagnetic waves travel (much) faster than sound waves / ora ;	1
3(c)	 both rays shown as continuous straight lines, being reflected from and touching the mirror ; angles of incidence and reflection the same by inspection and at least one arrow in the correct direction ;	2
3(d)(i)	extension / deformation is proportional to the load / cause / force = a constant $\times$ extension / $F = kx$;	1

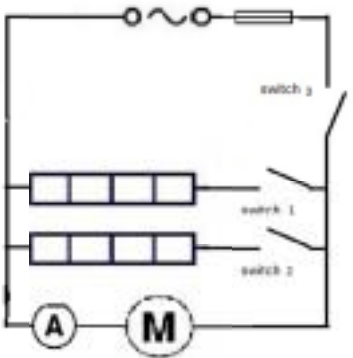
Question	Answer	Marks
3(d)(ii)	tension in the range 80 to 84 N ;	1

Question	Answer	Marks
4(a)	length of cell on diagram is 25 mm ; divided by 0.001 = 25 000 ;	2
4(b)(i)	reduces rate – no mark enzymes made inactive / denatured by acid / no longer at optimum pH ;	1
4(b)(ii)	44°C is optimum temperature ; above 44°C enzymes denatured by heat ; additional detail describing denaturation ;	max 2
4(c)(i)	(an organism) that gets energy from / feeds on dead / waste organic matter ;	1
4(c)(ii)	they decompose / break down / get rid of dead bodies / waste ; allow carbon to be recycled / release carbon dioxide (into the air) ; the idea that plants make use of carbon dioxide / carbon (during photosynthesis) ;	max 2

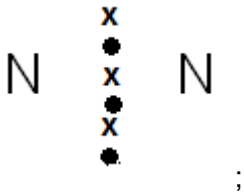
Question	Answer	Marks
5(a)(i)	<u>fractional distillation</u> ;	1
5(a)(ii)	greater lower greater ;	1
5(b)	cracking ;	1

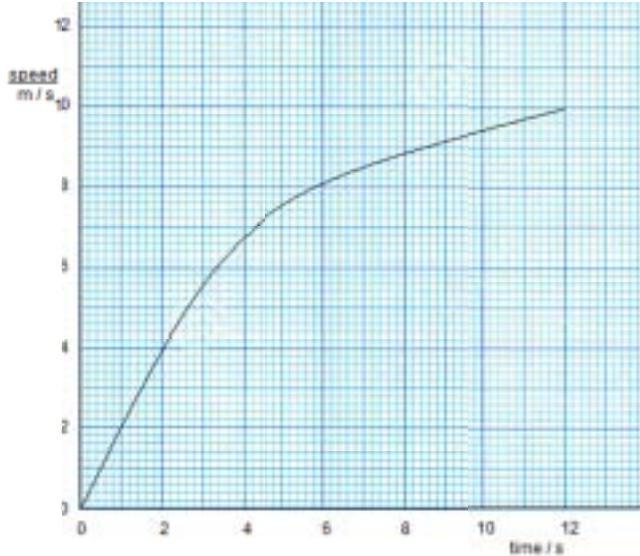
Question	Answer	Marks
5(c)(i)	(test) bromine (water) ; (observation A) no change and (observation B) decolourises / turns (brown to) colourless ;	2
5(c)(ii)	ethene ;	1
5(d)(i)	reference to use of (fossil) fuel / named fuel / industrialisation / deforestation ;	1
5(d)(ii)	global warming / consequences of global warming ;	1

Question	Answer	Marks
6(a)	(both) switch 1 and switch 3 ;	1
6(b)(i)	$P = V \times I$ (or rearranged) / 1100 / 240 ; = 4.58 or 4.6 A ;	2
6(b)(ii)	(if everything switched on) then 9.4 A / 2250 W / 0.21 A seen in calculation ; correct comparison of total current with fuse rating ;	2

Question	Answer	Marks
6(c)	 correct symbol for ammeter ; ammeter in fan motor branch, all circuit connections complete ;	2

Question	Answer	Marks
7(a)	plants produce carbon dioxide ; during respiration ;	2
7(b)	large surface area / elongated shape ; increases rate / efficiency of uptake ; by diffusion ;	max 2
7(c)(i)	any time between 10.00 and 13.00 ; maximum rate of oxygen production / steepest gradient ;	2
7(c)(ii)	line drawn with reduced gradient after 10.00 ; (rate of) photosynthesis (oxygen production) dependent on (amount of) light ;	2

Question	Answer	Marks
8(a)(i)	15 ; 16 ;	2
8(a)(ii)	2, 8, 5 ;	1
8(b)(i)	covalent / triple ;	1
8(b)(ii)		1
8(c)	(helium) balloons / avp ;	1
8(d)	(Group I metals are) more reactive than carbon ;	1
8(e)	solid and 165–310 (actual 302) ;	1

Question	Answer	Marks
9(a)(i)	weight / gravitational force ;	1
9(a)(ii)	 curved line, convex upwards ; from (0,0) and arriving at 10 m / s at 12 s ;	2
9(b)(i)	$\text{efficiency} = \{\text{energy out} / \text{energy in}\} \times 100$; $\text{energy in} = 100 \times \text{energy out} / \text{efficiency} = 200\,000\,000 \text{ (J)}$	2
9(b)(ii)	any two from hydroelectric / tidal / waves / geothermal / wind ;;	2
9(c)(i)	{thermal} expansion (of bridge structure) ; <i>owtte</i>	1
9(c)(ii)	buckle / twist / bend / deform etc. ;	1
9(c)(iii)	evaporates ; faster ;	2
9(c)(iv)	line drawn between the two bottom boxes ;	1



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Question	Answer	Marks
1(a)	red blood cells ; placenta ; umbilical cord ;	3
1(b)	sperm cell / egg cell ; zygote / body cell ;	2
1(c)	for identical twins genetic material is similar and for non-identical the genetic material is different ; (identical twins) genetic material has come from one egg / one fertilised egg / one sperm / one zygote ; (non-identical twins) genetic material has come from two eggs / two fertilised eggs / two sperms / two zygotes ; all eggs / sperms are genetically different / owtte ;	max 3
1(d)(i)	C label line to any part of the cell membrane ; R label line to any part of the cytoplasm ;	2
1(d)(ii)	$C_6H_{12}O_6$ and H_2O ; 6 before O_2 , CO_2 , H_2O ;	2

Question	Answer	Marks
2(a)(i)	D (most reactive) A C B ; (least reactive)	1
2(a)(ii)	D (most readily) B ; (least readily)	1
2(a)(iii)	initially / at the start / (the idea of during the first) two minutes ;	1
2(a)(iv)	increases ; particles collide more often / more successful collisions ;	2
2(b)	(iron(II) ions) green ppt / solid ; (iron(III) ions) brown ppt / solid ;	2

Question	Answer	Marks
2(c)(i)	R ;	1
2(c)(ii)	(alloys are) harder / more resistant to wear / more resistant to corrosion / avp ;	1

Question	Answer	Marks
3(a)	force arrow vertically upward labelled 'uplift' ; force arrow vertically downward labelled weight / gravitational force / gravity ; the two vertical force arrows in contact with helicopter / or the vertical arrows of approximately equal length by inspection ;	3
3(b)	chemical ; gravitational / potential ;	2
3(c)(i)	acceleration = (change of speed / time = 50 / 20) = 2.5 ; m / s ² ;	2
3(c)(ii)	$\frac{1}{2} \times 50 \times 20 / 500$ (m) / $50 \times (50 - 20) / 1500$ (m) seen ; = 2000 (m) ; (also by using the formula for the area of the trapezium, $\frac{1}{2} (30 + 50) \times 50$)	2
3(c)(iii)	non-constant deceleration / acceleration <i>owtte</i> ;	1

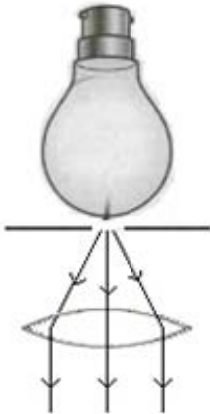
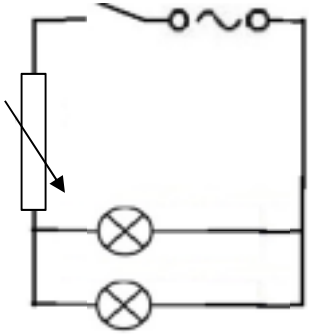
Question	Answer	Marks
4(a)	results show starch present (around A and / or B) ; reference to inactive / denatured enzymes ; because A was boiled / heated ; because B was placed in acid / pH3 / low pH ;	max 3
4(b)	traps light energy ; converts it to chemical energy / enable carbohydrates / sugar to be formed ;	2

Question	Answer	Marks
5(a)	reference to use of (fossil) fuel / named fuel / industrialisation / deforestation ; global warming / any named effect of global warming ;	2
5(b)	C_2H_5OH / C_2H_6O ;	1
5(c)(i)	(octane has higher boiling point / ora) (octane has) larger molecules / ora ; (octane has) greater intermolecular forces (of attraction) / ora ;	2
5(c)(ii)	$(2C_8H_{18}) + 25...(O_2) \rightarrow ...16 CO_2 + ...18 H_2O$ correct species ; balanced (dependent on correct species) ;	2
5(d)(i)	cracking ;	1
5(d)(ii)	(ethene) alkene / unsaturated and (ethane) alkane / saturated ;	1

Question	Answer	Marks
6(a)	atoms / molecules (in contact with water) vibrate (more) ; the idea that energy / vibrations passed on through collisions / from particle to particle (owtte) ;	2
6(b)(i)	arrows show rise (to ceiling), progress across (ceiling), downward progress (to floor) ; (past people) return to radiator ;	2
6(b)(ii)	warm air is less dense / ora ; so warm air rises / ora ;	2
6(c)	radio (waves) ;	1
6(d)	TV signal travels at speed of e / m waves ; e / m waves travel (much) faster than sound (waves) ;	2

Question	Answer	Marks
7(a)(i)	arrow drawn on Fig. 3.1 from red blood cell to any tissue cell ;	1
7(a)(ii)	lower concentration in tissue cells than in the red blood cells / blood ;	1
7(b)(i)	elongated shape / large surface area ; for increased rate / efficiency of uptake (of water) ;	max 2
7(b)(ii)	diffusion rate would slow down / stop ; because the water / solution concentrations have become similar to / the same as each other ; or water diffuses from cells into the soil (water) ; because the concentration of water is now higher inside the cell / concentration of salt is now higher outside the cell ;	max 2
7(c)	bacteria feed on dead organisms / bacteria population increases ; bacteria respire ; bacteria / respiration use up oxygen ; no oxygen left for fish ;	max 3

Question	Answer	Marks
8(a)(i)	add water / make into a solution / aqueous ; (so that) ions are mobile / can move ;	2
8(a)(ii)	electrons arranged 2,8,7 ;	1
8(a)(iii)	two electrons shown between Cl atoms ; six unshared electrons around each Cl atom ;	2
8(b)(i)	thermal / heat (energy) → chemical (energy) ;	1
8(b)(ii)	reduction ;	1
8(b)(iii)	reactive metals / high in the reactivity series extracted by electrolysis ; less reactive metals / low in the reactivity series extracted by reaction with carbon ; reference to the relative reactivity of metal / named metal with carbon ;	max 2

Question	Answer	Marks
9(a)	two more rays from hole to lens with at least one additional arrow correctly shown ; all rays emerge from lens reasonably parallel ; 	2
9(b)(i)	correct symbol showing variable resistor ; 	1
9(b)(ii)	20 A ; because lamps in parallel / current is shared / current in main circuit = sum ;	2
9(b)(iii)	remains lit (no mark) still a complete circuit through that branch / reference to parallel circuit / <i>owtte</i> ;	1
9(c)(i)	$I = P / V = 3000 / 240 = 12.5 \text{ (A)} ;$	1
9(c)(ii)	the idea that the resistance in the dimmer must be decreased / turn control to minimum resistance ;	1



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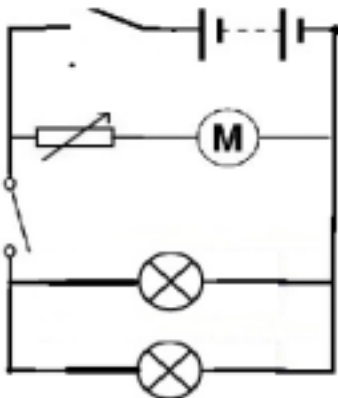
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Question	Answer	Marks
1(a)	right atrium ; right ventricle ; pulmonary artery ;	3
1(b)(i)	blood passes through heart twice, in each cycle / blood has two circulation paths (to the lungs and to the body) ;	1
1(b)(ii)	<i>(higher pressure on left side)</i> needed for blood going all round the body / blood travels further ; <i>(lower pressure on right side)</i> needed for blood going to the lungs / shorter distance / so the blood capillaries are not damaged ;	2
1(c)(i)	to take oxygen / glucose to the cells / muscles more quickly / to take more oxygen / more glucose to cells / muscles remove carbon dioxide from cells / muscles more quickly / remove more carbon dioxide from cells / muscles ; correct reference to respiration ;	max 2
1(c)(ii)	to take more oxygen (into blood) / remove carbon dioxide (from blood) more quickly ;	1
1(d)	<i>any two from</i> tar increases mucus / tar builds up in lungs / paralyses / destroys cilia / causes cancer ; or nicotine causes addiction / increases blood pressure / leads to heart disease ; or carbon monoxide reduces the concentration of oxygen carried by the blood / makes carboxyhaemoglobin ;	2

Question	Answer	Marks
2(a)	(a pure substance) A or D ; (a mixture) B or C ; (an alloy) C ; (a compound) D ; (1) for any two or three correct (2) for all four correct	2
2(b)(i)	(Ca(s)) + 2HCl(aq) → ... CaCl2 ...(aq) + ... H2 ...(g) ;; species RHS (1) state symbols (1) for species given	2
2(b)(ii)	(effect on rate) decreases ; (explanation) particles collide less often / less frequently / less chance of collisions ;	2
2(b)(iii)	silver nitrate solution ; <u>white</u> solid / precipitate ;	2
2(c)	Fe ₂ S ₃ ;	1

Question	Answer	Marks
3(a)	 variable resistor in motor branch, correct symbol ; switch for headlamps after motor branch, before first headlamp branch ;	2
3(b)	(decreasing resistance) increases current, (so faster motor) ;	1
3(c)	in parallel ; the same as ; less than ;	3
3(d)	$10 \text{ min} = 1/6 \text{ h} / 5/60 = 0.083 \text{ (km/min)} ;$ $\text{distance} = \text{speed} \times \text{time} = 5 \times 1/6 = 0.83 \text{ km} / \text{distance} = \text{speed} \times \text{time} = 0.083 \times 10 = 0.83 \text{ km} ;$	2

Question	Answer	Marks
4(a)	letter A label going to small intestine / ileum ;	1
4(b)(i)	stomach ; stomach has acidic conditions ; enzyme only worked in tube 1 / at pH 2 / in an acidic environment ;	3
4(b)(ii)	<i>any two from</i> enzyme will become denatured ; further detail of denaturation ; correct reference to (likely) optimum temperature ;	max2
4(b)(iii)	<i>any two from</i> large / insoluble molecules are broken down ; small / soluble molecules are produced ; by the action of an enzyme ;	max 2

Question	Answer	Marks
5(a)	(trend) increase (in boiling point) ; (explanation) bigger molecules ; greater intermolecular forces ;	3
5(b)(i)	cracking ;	1
5(b)(ii)	ethene ; allow ethylene	1
5(b)(iii)	alkene / unsaturated ;	1
5(b)(iv)	(from) orange / brown (to) colourless / decolourises ;	1
5(c)	chemical (energy) to thermal / heat (energy) ; <i>and one from</i> temperature increases ; thermal energy (heat) released ;	max 2

Question	Answer	Marks
6(a)(i)	atoms / molecules / particles vibrate (faster) and / transfer this vibration / energy to neighbouring particles owtte ;	1
6(a)(ii)	gas molecules far apart, no vibration ;	1
6(b)	radiation ;	1
6(c)(i)	$P = IV$; (or alternative expression) / $I = 80 / 240$; = 0.33 (A) ;	2
6(c)(ii)	$E = P \times t$ / $E = V \times I \times t$ / $E = 80 \times 3600$; = 288 000 (J) ;	2

Question	Answer	Marks
7(a)	transpiration ;	1
7(b)	decomposers ; break down dead organisms (or their leaves) ;	2
7(c)	rainfall reduced because less water is being transpired / evaporated from trees ;	1
7(d)	soil will be eroded ; no trees / tree roots to stabilise the soil ;	2
7(e)	carbon dioxide increases (no mark) less taken in during photosynthesis ; oxygen decreases (no mark) less given out by photosynthesis ;	2

Question	Answer	Marks												
8(a)(i)	2 electrons in 1st shell and 6 electrons in 2nd shell ;	1												
8(a)(ii)	 2 bonding pairs ; 2 lone pairs and no extra electrons anywhere ;	2												
8(b)(i)	II / 2 / two ;	1												
8(b)(ii)	<u>2+</u> ; loses two electrons ;	2												
8(c)	<table border="1" data-bbox="340 715 1554 1088"> <thead> <tr> <th><i>order of reactivity</i></th><th><i>metal</i></th><th><i>method of extraction</i></th></tr> </thead> <tbody> <tr> <td> <i>most reactive</i> ↓ <i>least reactive</i> </td><td>potassium / K</td><td>electrolysis ;</td></tr> <tr> <td></td><td>iron / Fe</td><td>blast furnace / reduction by C / CO ;</td></tr> <tr> <td></td><td>copper / Cu ;</td><td>carbon reduction / heat with carbon ;</td></tr> </tbody> </table> order of reactivity ; electrolysis linked to potassium ; carbon reduction owtte for both Fe and Cu ;	<i>order of reactivity</i>	<i>metal</i>	<i>method of extraction</i>	<i>most reactive</i> ↓ <i>least reactive</i>	potassium / K	electrolysis ;		iron / Fe	blast furnace / reduction by C / CO ;		copper / Cu ;	carbon reduction / heat with carbon ;	3
<i>order of reactivity</i>	<i>metal</i>	<i>method of extraction</i>												
<i>most reactive</i> ↓ <i>least reactive</i>	potassium / K	electrolysis ;												
	iron / Fe	blast furnace / reduction by C / CO ;												
	copper / Cu ;	carbon reduction / heat with carbon ;												

Question	Answer	Marks							
9(a)(i)	(Q =) friction / (water) resistance ;	1							
9(a)(ii)	(force Q cf force S) equal / balanced ;	1							
9(a)(iii)	$W = mg = 3\,000\,000 \times 10$; = 30 000 000 (N) ;	2							
9(b)	work done = force $\times$ distance / $F \times d = 100\,000 \times 50$; = 5 000 000 (J) ;	2							
9(c)(i)	$v = f \lambda$ and $\lambda = 3 \times 10^8 / 120 \times 10^6$; = 2.5 (m) ;	2							
9(c)(ii)	<table border="1"><tr><td>gamma</td><td></td><td></td><td>visible light</td><td></td><td>micro- waves</td><td>radio waves ;</td></tr></table>	gamma			visible light		micro- waves	radio waves ;	1
gamma			visible light		micro- waves	radio waves ;			
9(c)(iii)	<i>any two from</i> longitudinal (wave / vibration) / compressions and rarefactions ; (water) molecules / particles vibrate / oscillate ; pass on vibration / energy (through water) ;	max2							