

MARK SCHEME for the October/November 2013 series

0653 COMBINED SCIENCE

0653/31

Paper 3 (Extended Theory), maximum raw mark 80

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- 1 (a) (i) reference to reactivity of elements / compound is more stable ;
- (ii) compound has elements in fixed proportions / has a formula ;
mixture has no fixed proportions ;
- compound has new chemical properties ;
mixture retains the properties of the constituents ;
- compound has all constituents chemically bonded ;
mixture does not have chemical bonds between all constituents ;
- a mixture can be separated by physical means ;
a compound cannot / can only be separated by chemical means ;
- a compound is formed by chemical reaction
a mixture is not formed by chemical reaction ; [max 2]
- (b) (i) potassium and calcium (both required) / Ca^{2+} and K^+ ; [1]
- (ii) reference to charge balance / correct electron transfer shown ;
 CaF_2 ; [2]
- (c) (i) cathode is negative ;
reference to attraction between opposite charges ; [2]
- (ii) ions gain electrons ;
each ion gains two (electrons) / is discharged ; [2]
- [Total: 10]
- 2 (a) (i) arrow going downwards ; [1]
- (ii) cooler air / gas contracts / particles closer together / particles are moving more slowly /
particles have less kinetic energy ;
cold air is denser (therefore moves down) ; [2]
- (b) (mass =) density $\times$ volume / 1.26×0.15 ;
 $= 1.26 \times 0.15 = 0.19 \text{ kg} / 0.189 \text{ kg} / 189 \text{ g}$; [2]
- (c) (i) solid – all particles touching, regular arrangement particles of similar size ;
liquid – most particles touching, irregular arrangement particles of similar size ; [2]

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(ii)

Description	S, L or G
It cannot flow.	S
It cannot transfer heat by convection.	S
It contains particles which are widely separated.	G
It expands the most when heated.	G
It fills a closed container.	G
It has a fixed volume but not a fixed shape.	L

1 mark for every three correct answers ; ;

[2]

(d) refrigerator **D** (no mark)

white/light surfaces are worst absorbers / reflect most radiation ; radiation ;

shiny surfaces are worst absorbers / reflect most radiation ;

[2]

3 (a) increased then decreased ;

increased more rapidly than it decreased ;

maximum 6.6 units / peak reached after 40 minutes ;

quote figures, e.g. returned to normal / 2 units by 100 minutes ;

[max 3]

(b) starch digested / broken down to, sugar / glucose ;

by enzymes / amylase ;

sugar / glucose, absorbed into the blood in the small intestine (causing increase) ;

sugar / glucose, used in respiration (causing decrease)

[max 3]

(c) (i) (blood glucose concentration) did not rise as high ;

maximum 4 units rather than 6.6 units ;

rose more slowly ;

fell more slowly ;

took longer to return to normal / does not return to normal by end / at end it

is 0.2 units higher than at the start ;

[max 3]

(ii) reduces, constipation / bowel cancer ;

[1]

[Total: 10]

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- 4 (a) silicon ;
in Group 4 (and third period) / (atoms has) four outer electrons ;
- (b) (i) Group 1 ;
reference to at least one of the proton numbers plotted on graph / all proton numbers match those of group 1 elements ; [2]
- (ii) allow anywhere in range 34–20 °C ;
at proton number 55 ; [2]
- (c) (i) carbon monoxide ; [1]
- (ii) redox / reduction ;
oxygen removed from iron oxide ; [2]
- (iii) iron oxide + carbon monoxide $\longrightarrow$ iron + carbon dioxide ; [1]

[Total: 10]

- 5 (a) (i) area under graph/working/ $\frac{1}{2} \times 1000 \times 30 + 3000 \times 30$;
105,000 m ; [2]
- (ii) (acceleration =) gradient or $30 / 1000$;
 $= 0.03 \text{ m/s}^2$; [2]
- (b) (i) 10% ; [1]
- (ii) $1,000,000 \times 0.10$;
 $\times 0.70 = 70,000 \text{ J}$; [2]

[Total: 7]

- 6 (a) (i) increases pressure / reference to high pressure ;
pushes blood out into the aorta / out of the heart ; [2]
- (ii) closes it ; [1]
- (b) (i) use energy for contraction ;
energy obtained by respiration ;
respiration uses oxygen ; [max 2]
- (ii) most of area below the label line and to the left of the septum shaded ; [1]
- (iii) eating too much fat / high fat diet / eating fatty food ;
not enough exercise ;
stress / overwork ;
smoking ; [max 3]

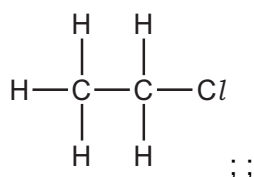
[Total: 9]

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7 (a) (i) orange / yellow to colourless ;

(ii) addition ;

(iii)



all single bonds ;
all else correct ;

[2]

(b) $\text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3 \text{H}_2$; ; ;
(LHS formulae ; RHS formulae: balanced – one mark)

[3]

[Total: 7]

8 (a) 2.0 A
14 A ; both required for the mark

[1]

(b) $1/R = 1/R_1 + 1/R_2 + 1/R_3 + 1/R_4$;
 $= 4 / 24 = 1 / 6$;
 $R = 6 \Omega$;
or
 $R = V/I$;
 $= 12/2$;
 $= 6 \Omega$;

[3]

[Total: 4]

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- 9 (a) (i) palisade (mesophyll) ;
- (ii) photosynthesis takes place in chloroplasts ;
 chloroplasts contain chlorophyll ;
 chlorophyll absorbs, sunlight / energy from sunlight ;
 starch grain stores products of photosynthesis ;
 cell membrane allows water and carbon dioxide to enter the cell ;
 detail, e.g. chloroplasts near edge of cell to obtain more sunlight ;
- [max 3]

- (b) less photosynthesis ;
 so less carbon dioxide removed from the atmosphere ;
- burning / trees produces carbon dioxide ;
- rotting trees produce carbon dioxide ;
- carbon dioxide traps long wave / infra-red radiation / heat / thermal energy ;
 reduces rate of loss of heat from the Earth's surface ;
- [max 3]

[Total: 7]

- 10 (a) (i) infrared ;
- (ii) microwaves ;
- (b) $3 \times 10^8 \text{ m/s}$;
- (c) 100 m ;
 1.5 m ;
- [1]
- [1]
- [1]
- [2]

[Total: 5]

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- 1 (a) **P** decane covalent molecules only / no ions present ;
Q solid copper chloride ions are not mobile ;
R aqueous copper chloride ions are mobile ;
(may refer to ions as charge carriers)
(max 2 if suggested that immobile ions exist in decane) [3]
- (b) (i) chlorine ; [1]
- (ii) copper is / copper atoms are forming / copper ions are being attracted ;
copper ions are gaining electrons ;
copper ions are being discharged / (gaining) two (electrons) each ; [3]
- (c) sodium and chloride ions have opposite (electrical) charge ;
reference to force of attraction (between opposite charges) ; [max 2]
- [Total: 9]
- 2 (a) (i) reflection ;
total internal ;
when angle (of incidence) is greater than critical angle ; [3]
- (ii) time = distance/speed ;
0.03 s ; [2]
- (iii) distance is less (for optical fibre) ; [1]
- (b) sound waves need a medium ;
as the air is sucked out there is less of a medium to convey the sound wave ;
no air means sound waves cannot pass through ; [max 2]
- [Total: 8]

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- 3 (a) (i) increased / numerical example ;
- (ii) colour change (blue) to red ;
effervescence / (gas) bubbles produced ; [2]
- (b) (i) colour change of cobalt chloride paper shows water and limewater reaction shows carbon dioxide ;
(test results are not required) [1]
- (ii) $2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O}$; ; [2]
(LHS RHS; and balanced;)
- (iii) sodium hydrogencarbonate provides barrier between paper and and air/oxygen ;(if paper does burn) sodium hydrogencarbonate decomposes / releases carbon dioxide / water ;
carbon dioxide / water inhibits burning / owtte ; [max 2]
- (iv) (endothermic)
heat energy supplied (to keep the reaction going) ;
heat is transferred to chemical energy ;
heat is used to decompose (the reactant) /to break bonds in the reactant ; [max 2]

[Total: 10]

- 4 (a) (i) more root hairs ;
shorter root hairs ; [2]
- (ii) increase in number in both types is, the same / 0.44 more root hairs per unit area /
percentage increase is different ;
decrease in length is much greater in type B plants ; [2]
- (iii) reduced surface area ;
less able to take up water ;
so less water available for photosynthesis ;
less able to take up, mineral ions / named ion ;
less able to take up nitrates to form proteins ;
plant may wilt ;
because water loss greater than water uptake ; [max 3]
- (b) ref. to eutrophication ;
nitrate leached into waterways ;
causes algal growth to increase ;
reduces photosynthesis / light available for submerged plants ;
submerged plants / algae die ;
bacteria feed on dead plants / algae ;
bacteria use oxygen (for respiration) ;
which causes animals to die because of lack of oxygen ; [max 4]

[Total: 11]

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- 5 (a) parallel ;
- (b) (i) $1/R_1 + 1/R_2 = 1/R$;
correct substitution ;
 $R = 10/3 = 3.3 \Omega$; [3]
- (ii) $I = V/R$;
 $9/10 = 0.9 \text{ A}$; [2]
- (c) density = mass/volume ;
 $= 9000/3000 = 3.0 \text{ g/cm}^3$; [2]
- [Total: 8]
- 6 (a) A to placenta ;
B to amniotic fluid ;
C to cervix ; [3]
- (b) oxygen comes from mother('s blood) ;
ref. red blood cells ;
ref. haemoglobin ;
diffusion across placenta ;
blood (vessels) in umbilical cord carry oxygen to foetus ; [max 3]
- [Total: 6]
- 7 (a) gaseous / a gas ;
reference to smaller / lighter molecules ;
reference to low attraction between molecules ; [max 2]
- (b) (i) covalent ;
non-metallic elements joined / it is a molecule ; [2]
- (ii) 7 ; [1]
- (iii) 8 ;
each halogen atom shares an electron (pair) with carbon ;
reference to the completion of the outer shell of the halogen ; [max 2]
- [Total: 7]

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- 8 (a) (i) driving force forwards and friction forces backwards ;
(ii) equal and opposite ;
(iii) constant speed ;
(iv) driving force is greater than friction force ;
- (b) (i) work done = $F \times D$;
 $= 10000 \times 1000 = 10000000 \text{ J}$;
(ii) power = work/time ;
 $10000000/100 = 100000$;
- (c) (i) infra-red ;
(ii) copper is a good conductor of heat ;
(convection off) large surface area ;
thin pipes means shorter distance for conduction ;

[Total: 11]

- 9 (a) (i) 1 carbon dioxide ;
2 oxygen ;
(ii) movement of molecules ;
from region of high concentration to low concentration / down a concentration gradient ;
reference to random movement (of molecules) ;
(max 1 if implication that a membrane is required)
(iii) thin / only one cell thick ;
reduces diffusion distance ;
- (b) (i) carbon monoxide
tar
particulates / smoke particles
nicotine ; ;
(any two for one mark)
(ii) mucus not swept upwards / away from lungs / details of the normal functioning of cilia
and the fact that this is impaired ;
mucus accumulates in, lungs / alveoli ;
bacteria breed / accumulate in mucus ;

[max 2]

[Total: 10]

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- 1 (a) (i) **A** to cell membrane ;
B to cell wall / large vacuole ;
- (ii) functions are uptake of water and mineral ions ;
partially permeable membrane allows (water to enter) by osmosis ;
has large surface area ;
increases (rate of) uptake (of water / mineral ions) ; [max 3]
- (b) (i) water moved up through the stem / stalk ;
through xylem vessels ;
reference to transpiration ;
description of transpiration ;
veins contain xylem vessels ; [max 2]
- (ii) slower rate of transpiration ;
water pulled up xylem / stem / stalk more slowly ;
ref. to decrease in rate of evaporation / diffusion, at lower temperature ;
particles / water molecules, have less kinetic energy / move more slowly ; [max 3]
- [Total: 10]
- 2 (a) two of oxygen sulfur fluorine ;
both elements are non-metals / implication of non-metallic character ; [2]
- (b) PH_3 ; / H_3P ;
hydrogen atoms have electron configuration of 1 ;
atoms share (pairs) of electrons ;
so that each has filled shells ;
(correct bonding diagram scores max2 of last three points) [max 3]
- (c) barium, magnesium, chloride, (allow hydrogen) ;;
(all 3 for 2 marks any 2 for 1 mark max 1 if sulfate suggested) [2]
- (d) **Q**
hydrogen
P ;
- Q** more reactive than **H** because able to remove oxygen from it / owtte ;
P less reactive than **H** since unable to separate oxygen from it / owtte ; [3]
- [Total: 10]

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- 3 (a) decreases ;
decreases ;
- (b) length ;
diameter ; [2]
- (c) (i) (power =) voltage x current ;
= $3 \times 0.6 = 1.8\text{W}$; [2]
- (ii) work = force x distance and power = work/time ;
= $40 \times 1.2/36$;
1.33W ; [3]
- (iii) energy lost (as heat /sound) ; [1]
- (iv) efficiency = $1.33/1.8 \times 100$;
73.88% / 0.74 ; [2]

[Total: 11]

- 4 (a) (i) bacteria / Lactobacillus / Streptococcus ; [1]
- (ii) to speed up the production of yoghurt ;
microorganisms work faster / better (at higher temperature) ;
ref. to optimum temperature for enzymes ; [max 2]
- (b) (i) increased ;
use of data e.g. from 0.15% to 0.31% / by 0.16% ;
description of the variation in rate
e.g. rate of increase slowed after 6 hours ; [max 2]
- (ii) added sugar increases the amount of lactic acid / fermentation /
rate of reaction / use of data to illustrate this ;
(microorganisms) convert sugar to lactic acid ;
more sugar increases rate of production of lactic acid ; [max2]
- (c) area too small to support populations / reduction in biodiversity / extinction /
species become endangered / lack of opportunity to find new medicines ;
due to reduction of habitat ;
- flooding / leaching of minerals ;
due to rain falling directly on soil / lack of protection of tree canopy / increased runoff ;
- soil erosion ;
due to lack of tree roots ;
- drought ;
due to lack of transpiration by trees to form rain (leading to desertification) ;

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CO₂ levels in the atmosphere increase ;
 due to fewer trees to photosynthesise/ less photosynthesis to remove carbon dioxide ;
 also due to burning trees produce CO₂ / rotting trees produce CO₂ by respiration of microbes

carbon dioxide traps long-wave radiation / infra-red / heat / thermal energy /is a greenhouse gas ;

reduces rate of loss of heat from the Earth's surface / increases global warming ;

[Total: 11]

5 (a) pass gas into limewater ;
 goes cloudy / milky / precipitate forms ; [2]

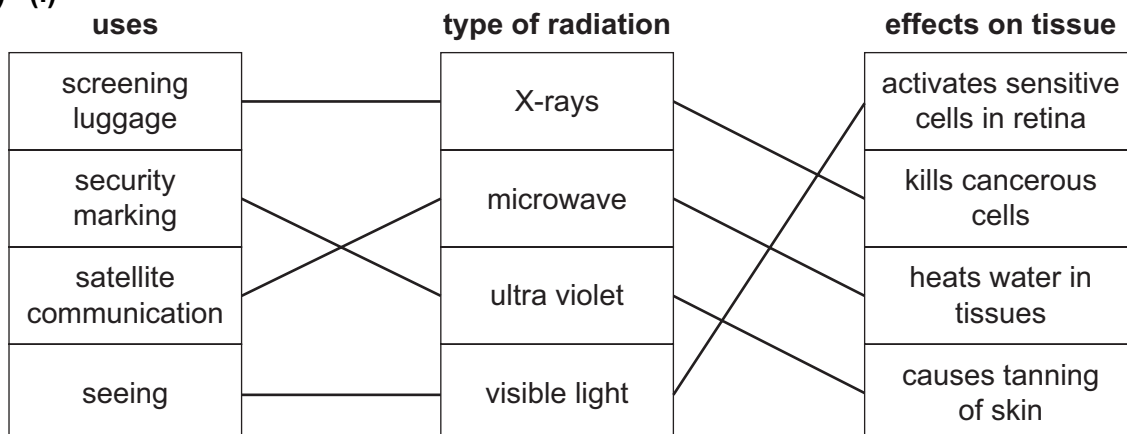
(b) (i) the greater the acid concentration the higher the rate ;
 ref. to direct proportionality ; [2]

(ii) ref. to reaction occurring as the result of particle collisions /
 ref. to the identity of colliding particles ;
 higher concentration means higher frequency of collision ; [2]

(iii) temperature affects rate of reaction ;
 so control needed so rate investigation data is valid / ref. to fair test ;
 additional collision theory detail related to rate ; [max 2]

[Total: 8]

6 (a) (i)



[4]

(ii) wave speed ; [1]

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(b) waves are reflected along fibre ;
reference to total internal (reflection) ;
angle (of incidence) is greater than critical angle ;
no light escapes ; [max 2]

(c) (i) two rays reflected at the mirror entering the eye with angles
correct by inspection ; [1]

(ii) two construction lines drawn back from the mirror locating **X** ;
X labelled in correct position by inspection ; [2]

[Total: 10]

7 (a) (i) **A** trachea ;
B lung ; [2]

(b) (i) (net) movement of molecules ;
from region of high concentration to low concentration /
down a concentration gradient ; [2]

(ii) more energy used / more muscle contraction ;
reference to (more / faster) respiration ;
so more carbon dioxide produced (in cells) ;
so greater diffusion gradient (from cells to blood) ; [max 3]

[Total: 7]

8 (a) (i) C_8H_{18} ; [1]

(ii) it is a hydrocarbon containing only single bonds / a saturated hydrocarbon
/ it conforms to the general formula C_nH_{2n+2} ; [1]

(b) molecules in gasoline (on average) are smaller / lighter ;
so attractive forces between molecules in gasoline are lower ;
so less energy needed to separate molecules (in gasoline) ;
so are less entangled (than in diesel) ; [max 2]

(c) (i) orange solution becomes colourless ; [1]

(ii) addition ; [1]

(iii) $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$;;; [3]
(LHS formulae; RHS formulae; then balanced)

[Total: 9]

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9 (a) (i) $KE = \frac{1}{2} mv^2$;
 $= \frac{1}{2} \times 400 \times 5 \times 5 = 5000J$;

(ii) not moving ;

[1]

(b) heat transferred from hands / body to sweat / heat absorbed by sweat from golfer's hands / body/heat energy in hands / body reduced by sweating ;

kinetic energy of water molecules increases / water molecules move faster ;

faster moving / more energetic (water) molecules escape / leave the surface / water (sweat) molecules turn to gas/vapour ;

ref. to break bonds /break forces of attraction between molecules ;

(KE) / energy of (remaining) water molecules (in sweat) decreases ;

[max 2]