MARK SCHEME for the May/June 2015 series

0654 CO-ORDINATED SCIENCES

0654/31 Paper 3 (Extended Theory), maximum raw mark 120

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1. (a) Use of (energy =) power × time;
   \[ = 24 \times 60 \times 60 \times 20000 = 1.73 \times 10^9 \text{ (J)} ; \] [2]

(b) (i) cancer / mutation / damage to DNA / damage to cells / sunburn ; [1]

   (ii) radiation and correct use ;
       [both required for mark] [1]

(c) (KE =) \( \frac{1}{2}mv^2 \);
   \[ = \frac{1}{2} \times 30 \times 0.8 \times 0.8 = 9.6 \text{ (J)} ; \] [2]

(d) friction ;
   transfer of electrons / charged particles ; [2]

(e) black surfaces emit more thermal energy / heat energy than white surfaces ; [1]

(f) light travels faster than sound, etc. ; [1]

[Total: 10]

2. (a) (i) exothermic ; [1]

   (ii) the idea that thermal energy given out until (one of) the reactants is used up / thermal energy is only released while reaction occurs ;
       the idea that when reactants used up / reaction stops, the mixture cools / starts to return to room temperature / energy leaves beaker / temperature increases until reactants used up ; [2]

   (iii) no temperature change ;
       because no reaction occurs ;
       because copper is less reactive than zinc ; [3]

(b) \( 4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3 \)
   all formulae ;
   and then look for balanced ; [2]
(c) (i) (G) no mark
  G/larger grains have smaller surface area ;
  smaller surface area causes lower speed of reaction/longer reaction
time/time to use up reactants ;
lower speed of reaction causes longer reaction time/time to use up
reactants ;
extra detail, e.g. correct collision theory ideas ; [max 3]

(ii) decreases ;
(chemical potential) energy is transferred (out of the mixture) as thermal
energy/heat ; [2]

[Total: 13]

3 (a) (i) arrows on Q and R, both pointing to the right ; [1]

(ii) less CO\textsubscript{2} leaving the apparatus ;
  more oxygen leaving the apparatus ;
  cooler ; [max 2]

(iii) A – no change ;
  B – goes cloudy/milky ; [2]

(iv) more CO\textsubscript{2} in expired air ; [1]

(b) faster change/more cloudy (in tube B) ;
because more respiration/more CO\textsubscript{2} in expired air ; [2]

[Total: 8]

4 (a) (i) H J and K/argon hydrogen oxygen ;
  only one type of atom/in Periodic Table/cannot be simplified ; [2]

(ii) it is a mixture/owtte ; [1]

(iii) measure the melting point ;
  compare the melting point/should be same as published value ;
  OR
  chromatography ;
  compare with pure sample ; [2]
(b) (i) total of 18 electrons; 
arranged 2,8,8; [2]
(ii) both (argon) atoms have 18/same number of protons; 
\(\text{Ar} - 36\) has 18 neutrons (per atom) and \(\text{Ar} - 40\) has 22 neutrons (per atom)/different numbers of neutrons (per atom); [2]

[Total: 9]

5 (a) (i) ray of light reflecting off mirror; 
at approx. correct angle; [2]
(ii) angle of incidence correctly labelled; [1]

(b) (i) correct series circuit; 
correct parallel circuit; 
switch in correct place and all symbols correct; [3]
(ii) \(1/R_T = 1/R_1 + 1/R_2\) (or \(R_T = R_1R_2 / R_1 + R_2\)) /relevant working; 
\(2.5\) (\(\Omega\)); [2]

[Total: 8]

6 (a) (i) needed for chlorophyll; [1]
(ii) chlorophyll needed for photosynthesis; 
(so) less photosynthesis; 
(so) less sugar/energy for growth; [max 2]

(b) (i) first 20 days: the same; [1] 
next 100 days: do not grow as high in Field B; 
grow slower in Field B; 
approx. straight line instead of curve; 
final (mean) difference of 35 cm; [max 2] [max 3]
(ii) supplies extra nitrate; 
for making protein; [2]

(c) washed (out of soil) into river/lake; 
eutrophication; 
increased growth of algae/surface plants; 
blocks light to plants (deeper down); 
algae/plants, die; 
bacteria feed on them/population increases; 
bacteria, etc. use oxygen; 
lack of oxygen kills fish; [max 3]

[Total: 11]
7 (a) (i) (C) no mark
A is natural gas ;
B is air ;
products of decomposition (of organic material) are CH₄/CO₂. [max 2]

(ii) carbon dioxide ;
water ; [2]

(b) (i) ref. to increasing the speed of a reaction ;
remaining unchanged itself ; [2]

(ii) air (taken into the engine) contains nitrogen and oxygen ;
nitrous oxide formed from (direct) combination/reaction of nitrogen and oxygen ;
(very) hot (and pressurised) in engine so (direct) combination/reaction possible ;
carbon monoxide from reaction between the fuel/hydrocarbons and oxygen ;
reference to incomplete combustion ; [max 4]

[Total: 10]

8 (a) contain starch/carbohydrate/oil/fat/contain chemical energy ;
stored there (by the plant) ;
for later development/until they can photosynthesise ; [max 2]

(b) (i) (animals disperse the seeds) when they eat (the outer part) of the apple ; [1]

(ii) stops animals eating/chewing the seeds ;
which would damage/kill the embryo/seed would not grow into plant ;
unchewed seeds can pass through intestines/in faeces/not digested ; [max 2]

(c) (i) wind ; [1]

(ii) colonising new areas ;
reduces overcrowding/competition ; [2]

[Total: 8]
9 (a) (i) particles gain thermal energy and vibrate faster/more; this vibration passes through the metal saucepan; [2]

(ii) (efficiency =) useful energy output/energy input; (or working) = 40 (%) ; [2]

(b) evaporation can occur at any temperature; boiling only happens at the boiling point; evaporation happens only at the surface; boiling occurs throughout the liquid; during boiling all/most molecules have enough energy to leave; evaporation lets only the molecules with the highest kinetic energy out; evaporation can occur using the internal energy of the system; boiling requires a(n external) source of heat; evaporation produces cooling; boiling does not produce cooling; evaporation is a slow process; boiling is a rapid process; [max 2]

(c) compressions are regions where the particles in air are close together; rarefactions are regions where the particles in air are spread out; compressions are regions with air at higher pressure than normal; rarefactions are regions with air at lower pressure than normal; [max 1]

(d) (B) no mark because particles are closely packed and randomly arranged; [1]

(e) (pressure =) force/area; = 20/0.03; (evidence of cm² to m² conversion) = 667/670 (N/m²); [3]

[Total: 11]

10 (a) V = lens; W = retina; [2]

(b) X

Y
(c)  

<table>
<thead>
<tr>
<th>Structure</th>
<th>Change when starting to focus on a near object</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciliary muscles</td>
<td>Contract</td>
</tr>
<tr>
<td>Suspensory ligaments</td>
<td>Less taut/AW; (accept: relax)</td>
</tr>
<tr>
<td>Lens – shape</td>
<td>Thicker/fatter</td>
</tr>
<tr>
<td>Lens – focal length</td>
<td>Decreased</td>
</tr>
</tbody>
</table>

(d) weaker ciliary muscles/AW; so cannot make lens thick enough;  

OR  

loss of lens elasticity; so cannot become thick enough;  

[Total: 9]

11 (a) (i) (B) no mark  

the idea that the electrolysis of copper chloride does not produce gas at the cathode/R/negative/does not produce two gases/produces gas only at the anode/S/positive/produces copper (a solid) and chlorine (a gas);  

(ii) oxygen;  
oxygen is evolved from the anode/positive electrode (when dilute sulfuric acid is electrolysed);  

(iii) hydrogen;  

(b) (i) mass of copper deposited = 178.38 − 177.42 = 0.96(g);  
moles of copper = 0.96 ÷ 64 = 0.015;  

(ii) anode mass decreases;  
anode dissolves/atoms break away as ions/  
Cu → Cu^{2+} + 2e⁻;  

[Total: 8]
12 (a) coal/petroleum/natural gas ;

(b) cannot be replaced once used ;

(c) (one named) alternative energy sources ;
   insulation ;
   low-energy appliances/equipment ;
   more public transport/less use of cars ;
   less use of/recycling of plastics ;
   AVP ;

[Total: 4]

13 (a) (i) \( \text{time} = \frac{\text{distance}}{\text{speed}} ; \)
\[
= \frac{240}{1500} = 0.16 \text{(s)} ;
\]

(ii) \( \text{wavelength} = \frac{\text{velocity}}{\text{frequency}} ; \)
\[
= \frac{1500}{45000} = 0.033 \text{(m)} ;
\]

(iii) 20 Hz to 20 000 Hz ;

(iv) ultrasound waves have a frequency above 20 000 Hz ;

(b) (i) float moves up and down ;
   makes magnet move in coil ;
   magnetic field in coil is changing/cut ;
   induces emf ;

(ii) stronger magnet ;
   more turns ;

[Total: 11]