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.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2012 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.
Section A

1 (a) force is proportional to the product of the masses and inversely proportional to the square of the separation either point masses or separation >> size of masses

(b) (i) gravitational force provides the centripetal force
\[ m \frac{v^2}{r} = GMm/r^2 \text{ and } E_K = \frac{1}{2}mv^2 \]
hence \( E_K = GMm/2r \)

(ii) 1. \[ \Delta E_K = \frac{1}{2} \times 4.00 \times 10^{14} \times 620 \times ((7.30 \times 10^6)^{-1} - (7.34 \times 10^6)^{-1}) \]
\[ = 9.26 \times 10^7 \text{ J (ignore any sign in answer)} \]
(allow \( 1.0 \times 10^8 \) J if evidence that \( E_K \) evaluated separately for each \( r \))

2. \[ \Delta E_P = 4.00 \times 10^{14} \times 620 \times ((7.30 \times 10^6)^{-1} - (7.34 \times 10^6)^{-1}) \]
\[ = 1.85 \times 10^8 \text{ J (ignore any sign in answer)} \]
(allow \( 1.8 \) or \( 1.9 \times 10^8 \) J)

(iii) either \((7.30 \times 10^6)^{-1} - (7.34 \times 10^6)^{-1}\) or \(\Delta E_K\) is positive/\(E_K\) increased speed has increased

2 (a) (i) sum of potential energy and kinetic energy of atoms/molecules/particles reference to random

(ii) no intermolecular forces no potential energy internal energy is kinetic energy (of random motion) of molecules (reference to random motion here then allow back credit to (i) if M1 scored)

(b) kinetic energy \( \propto \) thermodynamic temperature
either temperature in Celsius, not kelvin so incorrect or temperature in kelvin is not doubled

3 (a) temperature of the spheres is the same no (net) transfer of energy between the spheres

(b) (i) power = \( m \times c \times \Delta \theta \) where \( m \) is mass per second
\[ 3800 = m \times 4.2 \times (42 - 18) \]
\[ m = 38 \text{ g s}^{-1} \]

(ii) some thermal energy is lost to the surroundings so rate is an overestimate

4 (a) straight line through origin shows acceleration proportional to displacement negative gradient shows acceleration and displacement in opposite directions
(b) (i) 2.8 cm  

(ii) either gradient = $\omega^2$ and $\omega = 2\pi f$ or $a = -\omega^2 x$ and $\omega = 2\pi f$

gradient = $13.5/(2.8 \times 10^{-2}) = 482$

$\omega = 22$ rad s$^{-1}$

frequency = $(22/2\pi) = 3.5$ Hz

(c) e.g. lower spring may not be extended

e.g. upper spring may exceed limit of proportionality/elastic limit

(any sensible suggestion)

5 (a) (i) ratio of charge and potential (difference)/voltage

(ratio must be clear)

(ii) capacitor has equal magnitudes of (+)ve and (-)ve charge

total charge on capacitor is zero (so does not store charge)

(+)-ve and (-)-ve charges to be separated

work done to achieve this so stores energy

(b) (i) capacitance of Y and Z together is 24 $\mu$F

$1/C = 1/24 + 1/12$

$C = 8.0 \mu F$ (allow 1 s.f.)

(ii) some discussion as to why all charge of one sign on one plate of X

$Q = (CV =) 8.0 \times 10^{-6} \times 9.0$

$= 72 \mu C$

(iii) 1. $V = (72 \times 10^{-6})/(12 \times 10^{-6})$

$= 6.0$ V (allow 1 s.f.) (allow 72/12)

2. either $Q = 12 \times 10^{-6} \times 3.0$ or charge is shared between Y and Z

charge = $36 \mu C$

Must have correct voltage in (iii)1 if just quote of 36$\mu C$ in (iii)2.

6 (a) (i) particle must be moving

with component of velocity normal to magnetic field

(ii) $F = Bqv \sin \theta$

$q$, $v$ and $\theta$ explained

(b) (i) face BCGF shaded

(ii) between face BCGF and face ADHE

(c) potential difference gives rise to an electric field

either $F_E = qE$ (no need to explain symbols)

or electric field gives rise to force (on an electron)
7 (a) induced e.m.f./current produces effects/acts in such a direction/tends to oppose the change causing it M1 A1 [2]

(b) (i) 1. to reduce flux losses/increase flux linkage/easily magnetised and demagnetised B1 [1]
2. to reduce energy/heat losses (do not allow 'to prevent energy losses') caused by eddy currents M1 A1 [2]
(allow 1 mark for 'reduce eddy currents')

(ii) alternating current/voltage gives rise to (changing) flux in core B1 flux links the secondary coil M1 (by Faraday’s law) changing flux induces e.m.f. (in secondary coil) A1 [4]

8 (a) discrete quantity/packet/quantum of energy of electromagnetic radiation B1 energy of photon = Planck constant × frequency B1 [2]

(b) threshold frequency rate of emission is proportional to intensity max. kinetic energy of electron dependent on frequency max. kinetic energy independent of intensity (any three, 1 each, max 3) B3 [3]

(c) either \( E = \frac{hc}{\lambda} \) or \( \frac{hc}{\lambda} = eV \) C1
\( \lambda = 450 \text{ nm} \) to give work function of 3.5 eV energy = \( 4.4 \times 10^{-19} \) or 2.8 eV to give \( \lambda = 355 \text{ nm} \) M1
2.8 eV < 3.5 eV so no emission 355 nm < 450 nm so no A1 [3]

or work function = 3.5 eV threshold frequency = \( 8.45 \times 10^{14} \text{ Hz} \) C1
450 nm = \( 6.67 \times 10^{14} \text{ Hz} \) M1
\( 6.67 \times 10^{14} \text{ Hz} < 8.45 \times 10^{14} \text{ Hz} \) A1
Section B

9 (a) e.g. zero output impedance/resistance
infinite input impedance/resistance
infinite (open loop) gain
infinite bandwidth
infinite slew rate
1 each, max. 3

10 X-ray images taken from different angles/X-rays directed from different angles
of one section/slice (1)
al images in the same plane (1)
images combined to give image of section/slice B1
images of successive sections/slices combined B1
image formed using a computer B1
image formed is 3D image (1)
that can be rotated/viewed from different angles (1)
(four B-marks plus any two additional marks) B2 [6]

11 (a) e.g. noise can be eliminated/filtered/signal can be regenerated
extra bits can be added to check for errors
multiplexing possible
digital circuits are more reliable/cheaper
data can be encrypted for security
any sensible advantages, 1 each, max. 3 B3 [3]

12 (a) (i) signal in one wire (pair) is picked up by a neighbouring wire (pair) B1 [1]

(ii) outer of coaxial cable is earthed
outer shields the core from noise/external signals B1 [2]
(b) attenuation per unit length = \( \frac{1}{L} \times 10 \log_{10}(P_2/P_1) \)

signal power at receiver = \( 10^{2.5} \times 3.8 \times 10^{-8} \)

= 1.2 \times 10^{-5} \text{W} \quad \text{C1}

attenuation in wire pair = \( 10 \log_{10}\left(\frac{3.0 \times 10^{-3}}{1.2 \times 10^{-5}}\right) \)

= 24 dB \quad \text{C1}

attenuation per unit length = 24 / 1.4

= 17 \text{ dB km}^{-1} \quad \text{A1 [4]}

(\textit{other correct methods of calculation are possible})