Name of the Student:_____

Max. Marks : 27 Marks **Time : 27 Minutes**

Mark Schemes

Q1.

Question Number	Acceptable Answer	Additional Guidance	Mark
(a)(i)	• Use of $V = \pi r^2 t$ (1) • Use of half resolution to calculate % uncertainty in d (1) • % uncertainty in area = 2 × (% uncertainty in d) (1) • Calculation of % uncertainty in t (1) • % uncertainty in t added to % uncertainty in area (1) • $V = 5.94 \times 10^{-7}\text{m}^3$ (1) • $\%\ U = 0.4\ \%$ (1)	Allow MP4 for use of full resolution if MP2 was withheld for not using half resolution Example of calculation $V = \pi\left(\frac{22.16 \times 10^{-3}\text{m}}{2}\right)^2 \times 1.54 \times 10^{-3}\text{m}$ $\therefore V = 5.94 \times 10^{-7}\text{m}^3$ $\%\ U = \left(2 \times \frac{0.005\ \text{mm}}{22.16\ \text{mm}} + \frac{0.005\ \text{mm}}{1.54\ \text{mm}}\right) \times 100\%$ $\%\ U = 0.36\ \%$	7

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(a)(ii)	**EITHER** • Use of $\rho = \frac{m}{v}$ (allow use of V from (i)) **(1)** • Calculation of % U in ρ **(1)** • Max density = 1.9×10^4 kg m^{-3} (ecf from (a)(i)) • 1.9×10^4 kg m^{-3} < 1.93×10^4 kg m^{-3} so coin not pure gold **(1)** **Or** comparison of calculated value of max density with density of gold and consistent conclusion **(1)** **OR** • Use of $\rho = \frac{m}{v}$ to calculate volume of a pure gold coin with mass 11.2g • Mass of pure gold coin = 11.5 g (ecf from (a)(i)) **(1)** • Use of half resolution to calculate max mass of coin being tested **(1)**	For MP2, allow use of resolution if use of half resolution has already been penalised in (a)(i) Allow a conclusion that states the values are similar so it might be gold MP4, allow "density of pure gold" for 1.93×10^4 kg m^{-3} For MP3, allow use of resolution if use of half resolution has already been penalised in (a)(i) MP4: allow "density of pure gold" for 1.93×10^4 kg m^{-3} Example of calculation $\rho = \frac{m}{V} = \frac{11.2 \times 10^{-3}\text{kg}}{5.94 \times 10^{-7}\text{m}^3}$ $= 1.89 \times 10^4$ kg m^{-3} $\%\ U = \frac{0.05\ g}{11.2\ g} \times 100\% + 0.36\%$ $= 0.81\ \%$ $\therefore$ range $= \pm 1.89 \times 10^4$ kg $\times 0.008$ $= \pm 152$ kg m^{-3} $\therefore$ max density $= 18900 + 150$ $= 19050$ kg m^{-3}	**4**

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• 11.25 g < 11.5 g, so coin is not pure gold **Or** comparison of maximum value of mass of coin with mass pure gold coin and consistent conclusion. **(1)** **OR** • Use of $\rho = \frac{m}{v}$ to calculate volume of a pure gold coin with mass 11.2g **(1)** • Use of half resolution to calculate % U in mass (0.05/11.2 × 100% = 0.44 %), and hence calculated volume **(1)** • Find the *smallest* volume possible within uncertainty from part (i) **(1)** • $5.83 \times 10^{-7}\ m^3 < 5.91 \times 10^{-7}\ m^3$, so coin not pure gold **Or** comparison of minimum value of volume of coin from part i with maximum volume of pure gold coin and consistent conclusion. **(1)**	

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Question Number	Acceptable Answer		Additional Guidance	Mark
(b)	**MAX 4** • Measure thickness of a stack of coins **Or** measure the mass of a stack of coins • (Uncertainty remains the same, so) % U is reduced [MP2 dependent on MP1 • Determine diameter/mass/thickness by repeating measurement and calculating a mean • This reduces the effect of random errors • Check and correct for zero error on calipers or balance • This reduced the effect of systematic error	(1) (1) (1) (1) (1)	MP1 accept measuring a number of coins side by side MP1 accept using a balance with a higher resolution MP2 as this would reduce the uncertainty MP4 dependent on MP3 MP6 dependent on MP5	4

Q2.

Question Number	Acceptable Answer		Additional Guidance	Mark
(a)(i)	• Use of $P = VI$ • $P = 1900$ W (1.9 kW)	(1) (1)	Example of calculation $P = 230\text{ V} \times 8.20\text{ A} = 1890\text{ W}$	2
(a)(ii)	• Use of $\Delta E = mc\Delta\vartheta$ • Use of $P = \frac{\Delta E}{\Delta t}$ • $\Delta t = 112$ s or 113 s [106 s or 107 s if show that value used] ECF from (a)(i)	(1) (1) (1)	Example of calculation $\Delta E = 0.655\text{ kg} \times 4190\text{ J kg}^{-1}\text{K}^{-1} \times (100 - 22.5)\text{K}$ $\Delta E = 2.13 \times 10^5\text{ J}$ $\Delta t = \frac{2.13 \times 10^5\text{J}}{1890\text{ W}} = 112.5\text{ s}$	3

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Question Number	Acceptable Answer	Additional Guidance	Mark
(b)(i)	• After a short time of boiling in the flask, all the apparatus would be at 100 °C. **Or** so energy is not being used to heat up the flask **Or** so steam won't condense in the flask (1)		1
(b)(ii)	• Use of $\Delta E = mL$ (1) • Use of $P = \frac{\Delta E}{\Delta t}$ (1) • 1720 W (1.72 kW) (1)	Example of calculation $\frac{\Delta m}{\Delta t} = \frac{95 \times 10^{-3}\ \text{kg}}{125\ s}$ $= 7.6 \times 10^{-4}\ \text{kg s}^{-1}$ $\frac{\Delta E}{\Delta t} = 7.6 \times 10^{-4}\ \text{kg s}^{-1}$ $\times 2.26$ $\times 10^{6}\ \text{J kg}^{-1}$ $P = 1720\ \text{J s}^{-1}$	3
(b)(iii)	• Comparison of answer to (a)(i) with answer to (b)(ii) (1) • Not all of the energy from the heater is used to turn water from liquid state into vapour (1) **Or** energy is being used to heat the heat exchanger (1) **Or** not all the steam condenses in the heat exchanger • Some energy is transferred to the surroundings	e.g. rate at which thermal energy is supplied to the water in the flask is greater than rate at which thermal energy is removed from the water in the heat exchanger. If answer for (b)(ii) is bigger than 2 kW,1 mark for correct comparison can be scored.	3

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