Name of the Student:_____
Max. Marks : 22 Marks **Time : 22 Minutes**

Mark Schemes

Q1.

(a) callipers may **reduce** the (reading of the) diameter ✔

treat 'change reading' / 'give incorrect reading' as neutral;
accept the idea that the callipers may 'distort' / 'deform' / 'push in' the putty, eg
'change the shape' / 'crush' / 'squash' / 'cut into' / 'squeeze'
reject implication that density could change, eg 'volume will change' / 'will compress';
reject 'putty will move' / 'not able to grip the putty hard enough'

1

(b) average d

OR

uncertainty in d $_1$✔

percentage uncertainty ≥ 3 sf $_2$✔

answers to >3sf rounding to 2.37(%) earns both marks
for $_1$✔ either average = 33.8(0) (mm) OR
uncertainty from half range = 0.8(0) (mm);
allow 1/2 × (34.5−32.9) seen in working;
credit if seen in a percentage uncertainty calculation

1

percentage uncertainty 2.37(%) $_2$✔

for $_2$✔ percentage uncertainty to > 3 sf;
reject decimal answer or incorrect rounding to 2.36%;
reject answers if either 32.9 or 34.5 are (wrongly) rejected as anomalous (leading to 1.62% and 1.64% respectively)

1

(c) % uncertainty in length correct $_1$✔

for $_1$✔ minimum 2sf CAO; 2.8(2)%

1

calculates % uncertainty in volume $_2$✔

for $_2$✔ % uncertainty in V = 2 × their % uncertainty in d + their % uncertainty in L; allow 2.4% for % uncertainty in d

minimum 2 sf; expect 7.6 %

1

evidence for volume evaluated

OR

evidence for Δ volume evaluated $_3$✔

for $_3$✔ accept answers including:

*sub of **all data** in to* $V = \frac{\pi \times (\text{their} d)^2 \times L}{4}$

OR

*sub of **all data** in to*

$\Delta V = \frac{\pi \times (\text{their} d)^2 \times L}{4}$ *× their % uncertainty*

/ ΔV = their volume × their % uncertainty

OR

recognisable ΔV with POT error

1

Δ volume between 4.8 and 4.9 × 10^3 (mm^3) $_4$✔

answers that round to 4.8 or round to 4.9 are acceptable;

$_{34}$✔ for Δ volume in range and correct POT

1

(d) <u>ruled</u> line $_1$✔

for $_1$✔ line passing below 5th AND above 4th ie <u>no overlap between line and either +;</u>

line passing through or extrapolated to (0, 0) to half a minor grid square;

withhold this mark if line is poorly-marked (if doing so annotate clip to explain)

1

gradient calculated $_2$✔

for $_2$✔ gradient calculated from ΔR divided by ΔL^2;

minimum ΔL^2 = 25 (×10^{-3} m^2);

allow read-off errors in calculation / allow missing or incorrect POT

1

ρ in range 3.72 to 3.84 (× 10^{-2}) $_3$✔

for $_3$✔ accept 2 sf 3.8

1

POT and unit correct $_4$✔

for $_4$✔ treat 3.78 × 10^{-2} and 0.0378 Ω m as equally acceptable;

allow alternative valid answer, eg 37.8 Ω mm

1

[11]

Q2.

(a) The minima are caused when one star passes in front of the other. ✔

For mp2 it must be clear that dip size is related to temperature.

1

Deeper minima are caused by the cooler star passing in front of the hotter star. ✔

NB this is NOT related to the diameter of the star.

1

(b) The system is moving towards us AND mention of Doppler/red shift/effect ✔

OR

The system is moving so the light is blue shifted ✔

Condone 'star is, or stars are moving towards us'

1

(c) $\Delta\lambda = \frac{486.498 - 485.672}{2} = 0.413 \text{ nm}$ ✔

$z = \frac{\Delta\lambda}{\lambda} = \frac{0.413}{486.085\checkmark} = 8.50 \times 10^{-4}$

Alternative for mp1 use of average and one of the other values.

For mp2 must see evidence of correct use of average value (NB use of other wavelengths likely to give same answer to 3 sf).

2

$v = zc = 8.50 \times 10^{-4} \times 3.00 \times 10^{8} = 2.55 \times 10^{5} \text{ m s}^{-1} = 255 \text{ km s}^{-1}$ ✔

Average value (486.085)

Final answer must be seen to more than 2sf

For mp3 Allow ecf from mp1 and mp2 if answer is in range 250-260

1

(d) Identifies period (T) is 2.5 days ✔

$$v = \frac{2\pi R}{(their\ value\ of)\ T}$$

$R = \frac{v \times T}{2\pi} = \frac{2.55 \times 10^{5} \times 2.5 \times 24 \times 3600}{2\pi} = 8.76 \times 10^{9} \text{ m}$ ✔

Allow ecf from ***(c)***

1

Use of 250 km s^{-1} gives 8.59 × 10^{9} m ✔✔

1

(e) hydrogen and helium ✔

1

(f) Observable property of Neutron Star or White Dwarf ✔

Observable properties

Property of the other object

AND

coincident in space OR idea of how a property varies

WD – O or B class/ H-He absorption lines/ high temp AND not very bright abs mag.

NS – radio emissions/Pulsars

Variations include radio emissions from neutron star blocked by white dwarf ✔

Spectroscopic variation in white dwarf seen ✔

2

[11]