Answer Sheet YR 11
PHYSICS HOMEWORK

Q1 — mm in 650 nm

1nm = 10^{-9} m

However we are asked for the number of mm not the number of metres

∴ $650 \times 10^{-9}\,\text{m} \times 10^{3}\,\frac{\text{mm}}{\text{m}}$

∴ 650×10^{-6} mm

$6.50 \times 10^{2} \times 10^{-6}$

$= 6.50 \times 10^{-4}$ mm — ANSWER (D)

Q2 Significant figures in 0.01060

∴ $\overline{0.01060}$

α β γ δ

∴ First & second zeros (α & β) — not significant

The third zero (γ) - significant

Last zero (δ) may or may not be — generally considered significant however

∴ As shown by bar — 4 significant figures, although 3 would not be incorrect provided you explained what you are doing

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Q3. Order of magnitude of 0.0009

Convert to scientific notation

∴ 0.0009 — 9×10^{-4}

This suggests an order of magnitude of 10^{-4} or 10^{-3}. To choose we immediately recognise that this is very close to 10×10^{-4} which is 1×10^{-3} ∴ order of magnitude is 10^{-3}

The rule for judging this is not directly related to our normal rules of rounding ie 0 → 4.99... rounded down 5 → 9.99... rounded up. The rule relies on converting the number to a power of 10 - ie, a logarithm ∴ if the number converts to a power of 10 such as $10^{3.6}$ then this is rounded up to 10^4. Numbers such as $10^{3.4}$ round down ie 10^3.

Note that we need to look at the decimal part of the logarithm. For example $10^{2.5}$, this would be rounded up. What is $10^{2.5}$ as a real number. That is what is $10^{2.5}$ in scientific notation — 3.162×10^2; Thus numbers between 1 → 3.16 (approx 3.2) round down and numbers > 3.16 (approx 3.2) round up

See the following example

Number	10^x	Order of magnitude
4×10^2	2.6	3
2.6×10^3	3.41	3
3×10^4	4.48	4

Q4) D - False - "random" errors by their very nature have no definable cause - if an error has a definable cause it must be a systematic error.

Q5) Which of the following is the shortest distance.
To do this convert all measurements to the same units - eg metres

a) $1.5 \cancel{mm} \times 10^{-3} \frac{m}{\cancel{mm}} = 1.5 \times 10^{-3} m$

b) $0.01 m \longrightarrow 1 \times 10^{-2} m$

c) $0.0001 \cancel{km} \times 1000 \frac{m}{\cancel{km}} \rightarrow 1 \times 10^{-1} m$

d) $100 \cancel{nm} \times \frac{10^{-9} m}{\cancel{nm}} \rightarrow 100 \times 10^{-9} \rightarrow 1 \times 10^{-7} m$

∴ the shortest distance is (d)

Q6) Seconds in a day

$$60 \frac{\text{seconds}}{\cancel{min}} \times 60 \frac{\cancel{min}}{\cancel{hr}} \times \frac{24 \cancel{hr}}{d}$$

$$= 60 \times 60 \times 24 \frac{\text{seconds}}{\text{day}}$$
$$= 6 \times 10^1 \times 6 \times 10^1 \times 2.4 \times 10^1$$
$$= 86.4 \times 10^3$$
$$= 8.64 \times 10^4 \longrightarrow 10^5 \text{ (A)}$$

Q7) Absolute error in the measurement
∴ measurement is 1400
∴ Limit of reading is 0.01
Half limit of reading is 0.05
∴ Absolute error = 0.05 m
0.05 m → 5 cm (C)

Q8) Limit of reading is 1 mm. Absolute error is half limit of reading
∴ 1 mm → 0.5 mm
0.5 mm — 0.0005 m (B)

Q9) Volume of a cube = 5 × 5 × 5
∴ With multiplication you must add percentage errors
∴ 3% + 3% + 3% → 9%

Q10) Measured time is 13.1 ± 0.2 seconds

∴ Relative error $= \frac{0.2}{13.1}$

$= 0.015267$

$\doteq 0.02$ (B)

Note that percentage error is just the relative error $\times \frac{100}{1}$

Q11) Non SI units → Year + Yard

Two fundamental quantities:

The seven fundamental quantities are listed below

Length — metre

Time — second

mass — kilogram

{Electric current — ampère

Temperature — kelvin

{Amount of Substance — mole.

{Luminous Intensity — candela.

All other quantities can be defined in terms of these seven base quantities

From the list given in the question only FORCE is NOT a fundamental quantity

Q12) Which is not the same mass as the others

a) $10 \cancel{mg} \times \frac{10^{-3} g}{\cancel{mg}} \rightarrow 10 \times 10^{-3} g = 1 \times 10^{-2} g$

b) $100 g \rightarrow 100 g = 1 \times 10^{+2} g$

c) 10^{-4} ~~megagram~~ $\times \frac{10^{+6} g}{\text{Megagram}} = 1 \times 10^{+2} g$

d) 10^{-1} ~~kilogram~~ $\times \frac{1000 g}{\cancel{kg}} \rightarrow 10^{-1} \times 10^{3} \rightarrow 1 \times 10^{+2}$

(A) is the correct answer

Q21) A systematic error was identified
It will apply equally to all measurements
∴ Subtract 1.34g from all readings

Q22) Results
15.3 & 15.6, 15.6, 15.2, 15.5
∴ Average = 15.4
Residual for each

15.4 − 15.3 → +0.1
15.4 − 15.6 → −0.2
15.4 − 15.4 → 0.0
15.4 − 15.2 → +0.2
15.4 − 15.5 → −0.1

Greatest deviation is 0.2. Limit of reading 0.05
∴ 0.2 > 0.05
Use the deviation as the error

∴ ANS → 15.4 ± 0.2

Q23) Hair 20cm × radius 0.03 mm = Find volume

$V_{CYLINDER} = \pi r^2 h$.
$= \pi \times (0.03 \times 0.03) \times 200 \quad mm^3$
$= 0.565486...$

∴ ANS must be expressed to ONE significant figure
∴ $0.6\ mm^3$

Q24) a) Reading on vernie → 4.36

b) Reading on micrometer → 5.785

Q18) Write the numbers correct to 3SF

a) 42857 → 4.29×10^4

b) 5261 → 5.26×10^3

c) 100.25 → 1.00×10^2

d) 0.0023357 → 2.36×10^{-3}

Q19) A rectangular cell — 2.73 cm x 3.2×10^{-2} cm

Calculate — perimeter and area :

∴ Perimeter = 2.73 + 2.73 + 0.032 + 0.032

When adding (or subtracting) the answer must be expressed to the same no of decimal places as the least accurate measurement → 2 decimal places are used

∴ 5.524 → 5.52 cm

Area = L × B

= $2.73 \times 3.2 \times 10^{-2}$

With multiplication and division the answer must have the same number of significant figures as the least accurate component

∴ $2.73 \times 3.2 \times 10^{-2}$ → 0.08736

To two (2) significant figs

0.08736 → 0.087

Q20) Scale is in cm + mm — measurement is 99.0 cm (990 mm)

a) Limit of reading 1mm (0.1 cm)

b) absolute error 0.5mm (0.05 cm)

c) relative error $\frac{0.05}{99}$ → 5.05×10^{-4} → 5×10^{-4}

d) % relative error → 0.05

Q14) Write in decimal form.

a) 3.0×10^4 → 30000 → 30000

b) 1.5×10^{-3} → 0.0015 → 0.0015

c) 0.4×10^2 → 0.40 → 40

d) 6.0×10^{-1} → 0.6 → 0.60

Q15) Estimate order of magnitude

a) $(6.2 \times 10^8) \times (3.0 \times 10^{-2})$

$\sim 18 \times 10^6$

$\sim 20 \times 10^6$

$\sim 10 \times 10^6$

$\sim 10^7$

b) $(60) \times (32 \times 10^6)$

$= 6 \times 10^1 \times 32 \times 10^6$

$\sim 180 \times 10^7$

$\sim 100 \times 10^7$

$\sim 10^2 \times 10^7$

$\sim 10^9$

c) $\frac{800000}{400} \rightarrow \frac{8 \times 10^5}{4 \times 10^2} \rightarrow 2 \times 10^3 \rightarrow 10^3$

Q16) % error when a race of 10.4 seconds is timed at 10.5 seconds

Error is 0.1 seconds

$\therefore$ % error $= \frac{0.1}{10.4} \times \frac{100}{1}$

$= 0.96\%$

$\doteq 1\%$

Q17) Give no. of significant figures in each of the following

a) 4.02 → 3

b) 0.008 → 1

c) 8600 → 2

d) 1049 → 4

e) 0.0002 → 1

f) 52.07 → 4

g) 0.60* → 1 (2?)

You could argue how that if this zero is recorded then it is probably significant