Practice Question Set For A-Level
Subject : Physics
Paper-1 Topic: Waves

Name of the Student:____
Max. Marks : 21 Marks **Time : 21 Minutes**

Mark Schemes

Q1.

(a) peak (to peak) voltage = 6.3(0) (V) ✔

accept any answer that rounds to 6.3 V
do not allow power of ten errors, eg 0.0063 V

1

(b) period = 8 divisions

(= $8 \times 0.5 \times 10^{-3}$ (s))

= 4 ms $_1$ ✔

$$\left(f = \frac{1}{T} = \frac{1}{0.004}\right)$$

= 250 (Hz) $_2$ ✔

award both marks if 250 Hz seen
accept 4.0(0) ms for $_1$ ✔ but reject 4.05, 3.95 etc
ecf$_2$ ✔ for wrong period

2

(c) any valid approach leading to *RC* in range

2.1×10^{-4} to 3.4×10^{-4} or 3×10^{-4} (s)

OR

their *T* in 02.2 × 0.069 ± 10 % $_{12}$ ✔ ✔

1 mark can be awarded for use of any valid approach in which *RC* is seen with substitutions or with rearranged equations, eg

$$0.5 = 6.3e^{\frac{-6\times10^{-3}}{RC}} \text{ or } RC = \frac{-t}{\ln\left(\frac{V}{V_0}\right)} \text{ or}$$

$$RC = \frac{t}{\ln\left(\frac{V_0}{V}\right)}$$

OR

$1.75 \times 10^{-4} = RC \times \ln 2$

OR

$$RC = \frac{t_{0.5}}{\ln(2)}$$

valid approaches;
reads off t when C starts to discharge and t at a lower value of V:
rearranges $V = V_0 e^{\frac{-\Delta t}{RC}}$ *to calculate RC*
for ecf $_2$ ✔ *Δt used must correspond to interpretation of time base used in determining the frequency in (b); there is no ecf for misinterpretation of the voltage scale*
OR
reads off t when C starts to charge and t at a higher value of V:
rearranges $V = V_0\left(1 - e^{\frac{-\Delta t}{RC}}\right)$ *to calculate RC etc*
OR
determines half-life $t_{0.5}$ *and finds RC from* $\frac{t_{0.5}}{\ln(2)}$
for ecf $_2$ ✔ $t_{0.5}$ *used must correspond to etc*
OR
uses idea that during discharge V falls to $0.37V_0$ *in one time constant: determines suitable V and reads off RC directly*
for ecf $_2$ ✔ *time interval used must correspond to etc*
OR
uses idea that during charging V rises to $0.63V_0$ *in one time constant: determines suitable V and reads off RC directly*
reject idea that V falls to zero in 5RC

2

(d) qualitative comment

idea that the waveform will stretch horizontally $_1$ ✔

quantitative comment

by a factor of $\left(\frac{0.5}{0.2} = \right) 2.5$ $_2$ ✔

OR

half a cycle now covers 10 (horizontal) divisions on the screen $_2$ ✔
(and also earns $_1$ ✔)

(so the) <u>resolution</u> of the time axis has <u>increased</u> $_3$ ✔ (and also earns $_1$

✔)

measuring larger distance / across more divisions from the screen reduces (percentage) uncertainty in reading the time (constant / interval / half life) $_4$ ✔

for $_1$ ✔ look for reference to time axis or direction waveform is re-scaled

accept 'graph is longer/stretched' or 'will not see whole cycle' or 'fewer cycles shown' or 'period takes more space' or 'distance being measured is larger' or 'time per division is less' or 'larger in x direction' or 'time is stretched'

reject 'waveform becomes larger' or 'may not see whole cycle' or 'measuring larger time'

for $_2$ ✔ there needs to be valid quantitative detail

award $_{12}$ ✔ ✔ for 'half a cycle now fills the screen' or 'half a cycle is displayed' as these clearly recognise the stretching is along the time axis and 'half' is quantitative

accept 'new distance (on screen corresponding to half life or time constant) is 2.5 × answer shown in working for (c)'

the candidate who realises that half a wave now covers the complete width of the screen cannot claim this is a disadvantage; they would still be able to bring either half cycle into view by using the X-shift and find RC for $_3$ ✔ uses technical language correctly

ignore (but do not penalise) 'times are more precise' or 'more accurate'

reject 'smaller resolution' or 'lower resolution'

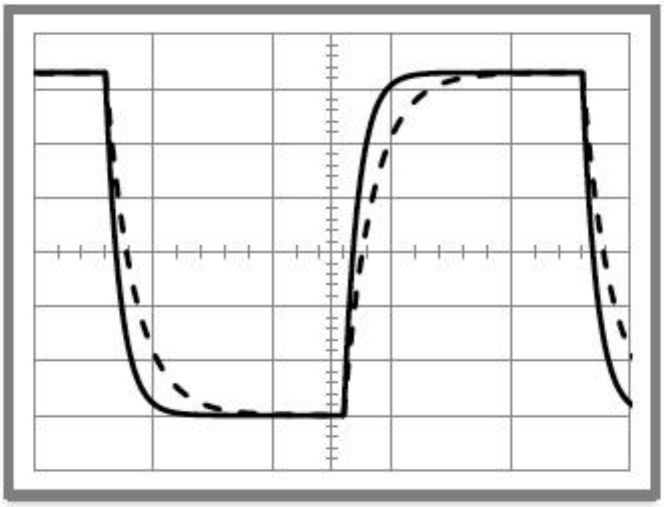
for 4 ✔ there needs to be a qualifying explanation for the comment about uncertainty

reject 'advantage because the (time) scale is easier to read'

3 MAX

(e) valid sketch on **Figure 7** showing discharge time to 0 V reduced and charging time to peak voltage reduced (see below) $_1$ ✔

connecting resistor in parallel with R halves [reduces by 50%] circuit [total] resistance [time constant] $_2$ ✔



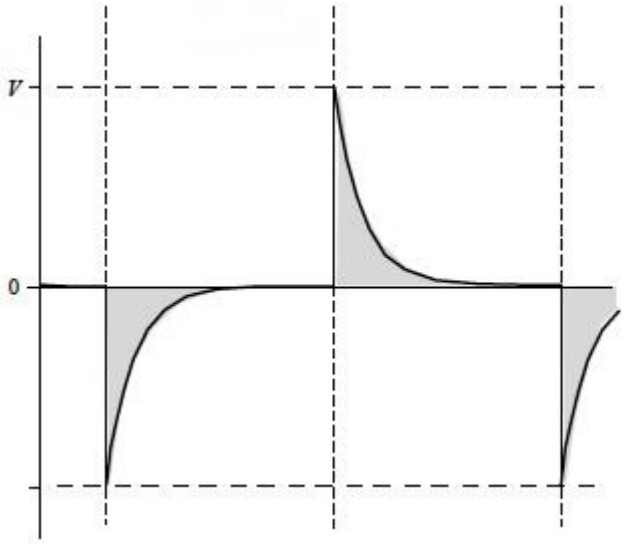
do not insist on seeing second discharge although if shown this must look correct

2

(f) amendment to **Figure 8** showing waveform across R with approximately the correct shape, amplitude ± *V* and the correct phase

correct waveform shown while signal generator output is low (0 V): only the complete negative half cycle needs to be shown but if second negative half cycle is included it must be correct $_1$ ✔

correct waveform shown while voltage across signal generator output is high; condone no signal or signal = 0 V before going to –V for the first time $_2$ ✔



don't insist on seeing vertical lines

2

(g) <u>reduce</u> the (sensitivity of) (Y-voltage)) <u>gain</u> $_1$ ✔

(change) to <u>2 V</u> division^{-1} $_2$ ✔ (and earns $_1$ ✔)

adjust the <u>Y</u> (vertical) <u>shift</u> $_3$ ✔

'make (Y-) gain smaller' or 'increase the volts per division' or 'reduce the Y-resolution' are acceptable substitutes for 'reduce the (Y-)gain'

<u>increase</u> the (Y-) gain to 2 V division^{-1} $_2$ ✔ not $_1$ ✔

<u>reduce</u> the (Y-) gain to 0.5 V division^{-1} $_1$ ✔ not $_2$ ✔

ignore any comment about time base or 'X-gain'

if all positive waveform is given for (f) allow sensible comment about triggering/stability control, eg

waveform may not be stable $_1$ ✔ ; adjust triggering $_2$ ✔

2 MAX

[14]

Q2.

(a) $\sin\theta_1 = \dfrac{XZ}{WX}$ and $\sin\theta_2 = \dfrac{YZ}{WY}$ or $\dfrac{\sin\theta_1}{\sin\theta_2} = \dfrac{(XZ)\div(WX)}{(YZ)\div(WY)}$ 1 ✔

(must see this step either separately or in substitution for $\dfrac{\sin\theta_1}{\sin\theta_2}$ or 0/2

condone *i* and *r* for *θ* etc.)

$$n = \frac{(XZ) \div (WX)}{(YZ) \div (WY)} = \frac{XZ}{WX} \times \frac{WY}{YZ}{}_2 \checkmark$$

$$\left(= \frac{(XZ) \times (WY)}{(WX) \times (YZ)} \right)$$

2

(b) idea implied that (XZ) × (WY) = n × (WX) × (YZ) is of form $y = mx$ (+ c);

plot (XZ) × (WY) against (WX) × (YZ) $\left[\frac{XZ}{WX}\right.$ against $\frac{YZ}{WY}$ etc] or 0/2 $_1$ ✔

calculate gradient to find n (false plot loses both marks) $_2$ ✔

[must mention XZ, WX, YZ and WY for full credit: bland 'plot sin θ_1 against sin θ_2 and calculate gradient to find n'= 1 MAX]

[alternative method is to plot XZ against WX to find G_1 and plot YZ against WY to find G_2 $_1$ ✔; evaluate $\frac{G_1}{G_2}$ to find n $_2$✔]

2

(c) upper limit of (XZ) range [largest value] is suitable $_1$ ✔

largest XZ value ≈ length of block (114)

[largest WX value ≈ diagonal distance (131) across block / used

(approximately) largest value of XZ [WX] available]$_2$✔

lower limit of (XZ or YZ) range [smallest value] is not suitable$_3$✔

smallest YZ [XZ] values have large percentage uncertainty / are unreliable] $_4$✔ (reject idea these values are too close to zero)

smallest WX value ≈ width of block (65)$_5$✔

[statement that range is suitable plus quantitative comment comparing length of block (114) with 98 (the range of XZ data) or covers more than 85% of available range] $_{12}$✔✔

equivalent statement regarding WX: compares available range (131 to 65 = 66) with 63 (the range of WX data) $_{12}$✔✔ = 2 MAX

statement that range is suitable plus simple qualitative comment relating range to the block, e.g. 'a large fraction / part of the available XZ [WX] range is covered' $_{12}$✔ = 1 MAX (bland 'range is large / wide' is not enough)]

MAX 3

[7]