Practice Question Set For A-Level
Subject : Physics
Paper-2 Topic: Fields And Their Consequences (Capacitance)

Merit Minds
www.merit-minds.com
Exam Preparation and Free Resources

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

Mark Schemes

Q1.

(a) (Dielectric constant is) $\frac{\text{permittivity of medium}}{\text{permittivity of free space}}$ and is equal to 6 ✔
OR
The permittivity of the dielectric is 6 times the permittivity of free space

Allow: $\frac{C \text{ with dielectric (between plates)}}{C \text{ in a vacuum}} = 6.$

Its not enough to quote relative permittivity = 6

1

(b) (Electric field exists between plates)

Polar molecules align with their positive side facing the negative plate (owtte) ✔$_1$

✔$_1$ or vice versa.

producing a counter electric field/reducing the field between the plates ✔$_2$

The pd V reduces between the capacitor plates but charge Q remains the same so capacitance Q/V increases. ✔$_3$

✔$_3$ This mark may be approached from the idea that more charge would be required to maintain pd hence C increases by referencing $C = Q/V$

3

(c) Q remains the same ✔$_1$

New C is 6 × previous C ✔$_2$

✔$_2$ May be seen in the substitution in the energy difference calculation

Energy difference = 3.8×10^{-9} J ✔$_3$

✔$_3$ Calculates change in energy using $E = \frac{1}{2}Q^2\left(\frac{1}{c_2} - \frac{1}{c_1}\right) = 4.58 \times 10^{-9} - 7.64 \times 10^{-10}$

Where $Q = 7.6 \times 10^{-10}$ C : $c_1 = 63 \times 10^{-12}$ F

and $c_2 = 6 \times 63 \times 10^{-12}$ $E = 378 \times 10^{-12}$ J

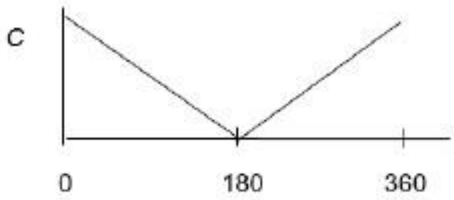
Condone a negative final answer

If no marks given award single mark for the initial energy stored = 4.58×10^{-9} J

3

(d) showing a linear decrease and increase ✔

points correct at 0, 180 and 360 degrees ✔



Ignore graph beyond 360 degrees

2

(e) Insert dielectric between plates/attach dielectric to one plate
OR reduce air gap explained ✔

Dielectric has $\varepsilon_r = 4$ ✔

air gap reduced to ¼ ✔

1st mark for <u>quantitative</u> answer for air gap or dielectric or both.

(Allow: more plates when explained)

*2nd and 3rd marks for numerical analysis for air gap **and** dielectric change. Do not allow incorrect physics.*

3

[12]

Q2.

(a) $V_{rms}\left(=\frac{V_{peak}}{\sqrt{2}}=\frac{15}{\sqrt{2}}\right)=10.6\text{ (V)}$ ✓

{allow 11 V to 2 sig figs}

1

(b) (Peak voltage 3 divisions corresponding to 15 V)

y-voltage gain = 5 (V div^{-1}) ✔

1

(c) A horizontal line drawn at 10.6 V ✔

Tolerance – must be between 10 and 11 up from the centre

Allow ecf from (a)

1

(d) (Period T = corresponds to 8 divisions
$T = 8 \times 5.0 \times 10^{-4}$ s = 0.0040 s
Frequency = $1/T$ = 1/0.0040) = 250 (Hz) ✔

Answer only gains the mark.

1

(e) Time constant = 4×10^{-4} (s) ✔$_1$ {only needs 1 sig fig}

The second and third mark can come from the following alternatives.
Note the mark is for the method so allow arithmetic slips and imprecise measurements.

To use a number of small divisions rather than grid divisions is not an arithmetic error. This error comes from not knowing how the oscilloscope is used.
Full marks can be awarded from consideration of the charging part of the cycle.

The equation can be presented in a number of variations using RC or τ for example.

Make use of the equation $V_t = V_0 e^{-\frac{t}{\text{time constant}}}$ ✓$_{2a}$
Substitute values for V_t and V_0 (confirmed by the graph) and calculate the (unknown) time constant. ✔$_{3a}$

Typical calculation might be:

$\frac{V_t}{V_0} = \frac{1}{12}$ *in 2 time divisions. Substitution into the equation will give τ*

V_t and V_o both need to be defined in relation to the graph

OR

Ln2 (= 0.69) $= \frac{t_{\frac{1}{2}}}{\text{time constant}}$ ✓$_{2b}$
Substitute time for V to decrease to half its value (confirmed by the graph) and calculate the time constant ✔$_{3b}$

OR
V halves its value in 0.5 time divisions.

Substituting gives τ

$t_{\frac{1}{2}}$ *needs to be defined in relation to the graph*

OR
The voltage falls to 1/*e* or 37% in a time constant ✔$_{2c}$ {owtte}
Find the time that corresponds to this fall in voltage confirmed by the graph (normally the start of the discharge This gives the τ directly) ✔$_{3c}$

OR
37% of 3 divisions is 1.1 divisions which occurs in time ¾ time divisions giving τ

3

(f) Reduce the time-base setting ✔$_{1a}$

Uncertainty is due to the smallness of the divisions and this action means the waveform/trace stretched horizontally/in x-direction. ✔$_{2a}$ {owtte}

OR

Increase the y-gain ✔$_{1b}$

Uncertainty is due to the smallness of the divisions and this action means the waveform/trace stretched vertically/in y-direction. (The trace will need to be moved vertically to fit on the screen) ✔$_{2b}$ {owtte}

$_1$ Stated answer must be a practicable change

$_2$ Explanation must refer to both the trace and its relation to uncertainty and follow a correct change.

2

[9]