AQA A-LEVEL PHYSICS · 7408

PHYSICS



MARK SCHEME

3.7.4 CAPACITANCE

SCORE	PERCENTAGE
/87	%

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Q1.

(a) (Refers to a capacitor that) stores/holds/changes by 370 μC of charge ✓

For every (1) volt/volt change (of pd across its plates) ✓

OR

Reference to charge to pd OR charge to voltage ratio ✓ includes units C or coulomb and V or volt ✓

"Unit of pd" is no substitute for using volt and "unit of charge" is no substitute for coulomb.

However the alternative marking could give a single mark for 370×10^{-6} units of charge per unit of pd.

An equation may contribute towards the first mark but only if the symbols are identified. A second mark can be given if the units are identified.

Ignore poor phrasing like 'per unit volt passing through'.

2

(b) (Using time constant = $R\,C$)

($R = 1.0 / 370 \times 10^{-6}$)

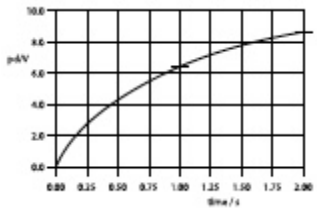
$R = 2.7 \times 10^{3}$ (Ω) ✓

Check that the unit on answer line has not been altered.

1

(c) First mark for marking a cross at 2 s and 8.5 V (by eye) ✓

Second mark for graph starting at the origin and having a decreasing gradient ie not reaching horizontal ✓



Cross must be in the bottom half but not on the 8.0 V major grid line or exactly half way up (9.0 V).

If a series of plotting crosses are given only consider the one placed at 2 s for the first mark.

2

(d) (Using $T½ = 0.69\,RC = 0.69 \times 1.0$)

$T½ = 0.69$ (s) ✓

1 sig fig is not acceptable

1

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(e) (Use of $Q = Q_o(1 - e^{-\frac{t}{RC}}) = CV_o(1 - e^{-\frac{t}{RC}})$)

Mark for max charge = CV_o which may come from substitution or seeing 3.6(2) × 10^{-3} C ✓

$3.0 \times 10^{-3} = 370 \times 10^{-6} \times 9.8 (1 - e^{-t})$ ✓

Mark for substitution ($0.8274 = (1 - e^{-t})$ so $e^t = 1/0.173 = 5.79$)

t = 1.7 s or 1.8 s ✓

OR

Voltage $V = Q/C = 3 \times 10^{-3} / 370 \times 10^{-6}$
= 8.1(1) V ✓

(Substitute into $V = V_o(1 - e^{-\frac{t}{RC}})$)

$8.1 = 9.8 (1 - e^{-t})$ ✓

t = 1.7 s or 1.8 s ✓

Alternative mark scheme uses the voltage as proportional to the charge.
Do not allow use of the graph for 2nd mark and 3rd mark.
An answer only gains only the last mark.
Evidence of working must be shown which shows substitution into a $(1 - e^{-t})$ form of the equation.

3

[9]

Q2.

B

[1]

Q3.

C

[1]

Q4.

C

[1]

Q5.

D

[1]

Q6.

C

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[1]

Q7.

D

[1]

Q8.

A

[1]

Q9.

(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 × 0.5 × 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

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

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

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:

$$V = V_0 e^{\frac{-\Delta t}{RC}}$$

rearranges *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:

$$V = V_0\left(1 - e^{\frac{-\Delta t}{RC}}\right)$$

rearranges *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 $\left(\frac{0.5}{0.2} = 2.5\right)_2$ ✓

OR

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

(so the) resolution of the time axis has increased $_3$ ✓ (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

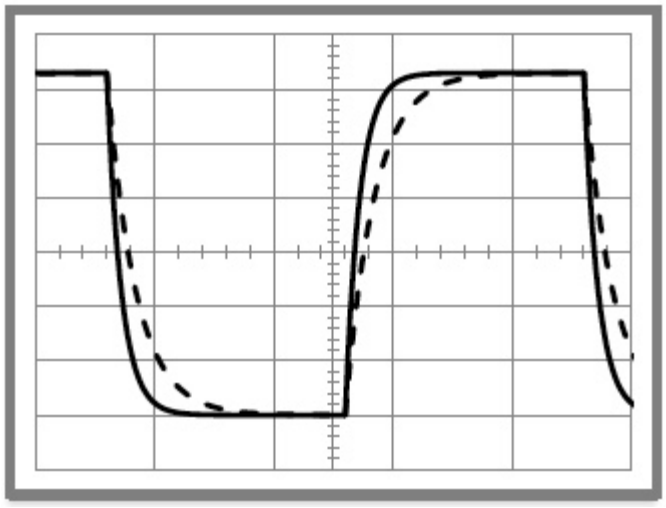
reject 'advantage because the (time) scale is easier to read'

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] $_2$ ✓

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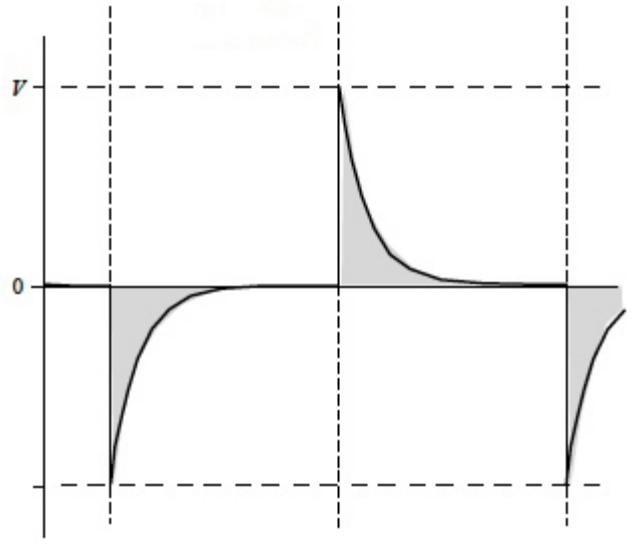
do not insist on seeing second discharge although if shown this must look correct

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

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'reduce the Y-resolution' are acceptable substitutes for 'reduce the (Y-)gain'

increase the (Y-) gain to 2 V division^{-1} $_2$ ✓ *not* $_1$ ✓

reduce 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]

Q10.

(a) the capacitor stores 120 μC of charge for each one volt of pd between the plates ✓

1

(b) $Q = C\,\Delta V = 120 \times 10^{-6} \times 4.2 = 5.0 \times 10^{-4}$ C ✓

1

(c) $I = \frac{V}{R}$ so maximum current = $\frac{9.6}{1300}$ = 7.4 ± 0.2 × 10^{-3} (A)✓

Allow ecf for incorrect read off in 01.2

1

(d) use of $E = \frac{1}{2}CV^2$ using V = 9.6V, 5.4V or 4.2V✓

Correct value of E at 9.6V or 5.4V (5.5 (3) × 10^{-3} J or 1.7(5) × 10^{-3} J✓

Both correct and subtraction 3.7(8) × 10^{-3} J ✓

Condone incorrect powers of 10

Allow 3.7 × 10^{-3}J

3

(e) Graph same shape up to point where capacitor stops discharging✓

current falls to zero at time when capacitor stops discharging✓

Scale on current axis with Initial and final currents correct

7.4 mA and 4.2 mA at the instant when foil breaks

(Allow ±0.1 mA) ✓

must show curvature during discharge time

3

(f) use of $V = V_0\,e^{-t/RC}$ Allow substitution of manipulation to *(discharge time)* $t = RC\ln(V_0/V)$✓

t = 0.156(0.16) × ln (9.6/5.4) ✓

= 0.090 or 0.092 s ✓

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v = s/t = 0.12/their time (1.3 m s^{-1})✓

correct substitutions for V, condone incorrect powers of 10 in substitution

Allow ecf for incorrect readoff for V in in Question ***(b)***

4

(g) There are resistive forces on the ball / the ball will decelerate ✓

The foil is unlikely to break at the instant the ball reaches it✓

2

[15]

Q11.

C

[1]

Q12.

D

[1]

Q13.

B

[1]

Q14.

A

[1]

Q19.

C

[1]

Q20.

A

[1]

Q21.

(a) (i) capacitance $= \left(\frac{Q}{V}\right) = \frac{98.2 - 73.9}{12.0 - 9.0}$ ✓

= 8.1 (μF) ✓ (± 0.2 μF)

1 mark only if correct value of C is found from a single point.

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2 marks if correct value of C is found from at least 2 points and a mean value, or from gradient. (Check graph.)

Accept 8 (μF) if from correct working.

2

(ii) additional energy = area between line and Q or V axis ✓
= {½ × (98.2 − 73.9) × 3.0} + {(98.2 − 73.9) × 9.0} ✓
= {36.5 + 218.7) = 255 J or 2.6 10^{-4} (J) ✓

[**or**, using ½ QV:
additional energy = ½ Q_2V_2 − ½ Q_1V_1 ✓
= ½ {(98.2 × 12) − (73.9 × 9)} ✓
= 257 μJ or 2.6 × 10^{-4} (J) ✓]

[**or**, using ½ CV^2:
additional energy = ½ CV_2^2 – ½ CV_1^2 ✓
= ½ 8.1 × (12^2 – 9^2) ✓
= 255 μJ or 2.6 × 10^{-4} (J) ✓]

[**or**, using ½ Q^2/C:
additional energy = ½ Q_2^2/C – ½ Q_1^2/C ✓
= (98.2^2 – 73.9^2) ÷ (2 × 8.1) ✓
= 258 μJ or 2.6 × 10^{-4} (J) ✓]

First scheme: alternative for 2nd mark

= {½ × (98.2 − 73.9) × 3.0} + {73.9 × 3.0} ✓

All schemes:

second mark subsumes the first mark.

In all methods, allow tolerance of ± 10 μJ in final answer to allow for variation in graph measurements.

Allow ECF for incorrect C value from (a)(i).

3

(b) (i) ($V = V_0e^{-t/RC}$ gives) $0.2V_0 = V_0e^{-t/RC}$
and $0.2 = e^{-45/RC}$ ✓

Condone use of 0.8 for 0.2 in first mark only.

$\ln 0.2 = -\frac{45}{RC}$ **or** $\ln 5 = \frac{45}{RC}$ ✓

time constant $RC = \frac{45}{\ln 0.2}$ **or** $\ln 5 = \frac{45}{\ln 5}$ = 28.(0) (s) ✓

3

(ii) resistance of R = $\left(= \frac{\text{time constant}}{C}\right) = \frac{28.0}{470 \times 10^{-6}}$ ✓
= 5.96 × 10^4 (Ω) or 60 kΩ ✓

Allow ECF for incorrect RC value from (b)(i).

2

(ii) tick in 4th box **only**

1

[11]

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Q22.

C

[1]

Q23.

D

[1]

Q24.

B

[1]

Q25.

(a) (i) determine area under the graph
[**or** determine area between line and time axis] ✓

1

(ii) *as seen*
line starts at very low current (within bottom half of first square) ✓
either line continuing as (almost) horizontal straight line to end ✓✓
or very slight exponential decay curve ✓
which does not meet time axis ✓

OR suitable verbal comment that shows appreciation of difficulty of representing this line on the scales involved ✓✓✓

Use this scheme for answers which treat the information in the question literally.

3

as intended
line starts at half of original initial current ✓
slower discharging exponential (ie. smaller initial gradient) than the original curve ✓
correct line that intersects the original curve (**or** meets it at the end) ✓

Use this scheme for answers which assume that both resistance values should be in Ω or kΩ.

½ initial current to be marked within ±2mm of expected value.

3

(b) (i) energy stored (= ½ CV^2) = ½ × 0.12 × 9.0^2 ✓ (= 4.86 (J))
4.86 = 3.5 Δ*h* ✓
gives Δ*h* = (1.39) = 1.4 (m) ✓
to 2SF only ✓

SF mark is independent.

Students who make a PE in the 1st mark may still be awarded the remaining marks: treat as ECF.

4

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(ii) energy is lost through heating of wires **or** heating the motor (as capacitor discharges) ✓

*Allow heating of circuit **or** $I^2 R$ heating.*

energy is lost in overcoming frictional forces in the motor (or in other rotating parts) ✓

Location of energy loss (wires, or motor, etc) should be indicated in each correct answer.

[**or** any other well-expressed sensible reason that is valid
e.g. capacitor will not drive motor when voltage becomes low ✓]

Don't allow losses due to sound, air resistance or resistance (rather than heating of) wires.

max 2

[10]

Q26.

(a) (i) 7.5×10^{-6} (C) or 7.5 μ(C)

B1
1

(ii) Suitable scale and charge from (i) correctly plotted at 2.5 V

Large square = 1 or 2 μC ***or***
With false origin then large square = 0.5 μC

B1

Only a Straight line drawn through or toward origin

C1

Line must be straight, toward origin **and** only drawn between 2.5 V and 1.2 V (± 1 / 2 square on plotted points)

A1
3

(b) Attempted use of E= ½ CV^2 Or attempted use of E=½ QV

C1

9.38 (μJ) − 2.16 (μJ) seen
or E = $\frac{1}{2} \times 3 \times 10^{-6} \times 2.5^2 - \frac{1}{2} \times 3 \times 10^{-6} \times 1.2^2$ *seen*
or E = $\frac{1}{2} \times 3 \times 10^{-6} \times (2.5^2 - 1.2^2)$ *seen*
or E =$\frac{1}{2} \times 7.5 \times 10^{-6} \times 2.5 - \frac{1}{2} \times 3.6 \times 10^{-6} \times 1.2$ *seen*

C1

7.2×10^{-6} (J) c.a.o

A1
3

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(c) (i) *Use of* $V = V_0 e^{-\frac{t}{RC}}$

or equivalent with

$Q = Q_0 e^{-\frac{t}{RC}}$

C1

$R = -\left(\frac{1.4\times10^{-3}}{ln\left(\frac{1.2}{2.5}\right)\times3\times10^{-6}}\right)$ or $R = -\left(\frac{t}{ln\left(\frac{V_o}{V}\right)\times C}\right)$ or $R = \left(\frac{t}{ln\left(\frac{V_o}{V}\right)\times C}\right)$

C1

636 or 640 (Ω)

A1

3

(ii) Current decreases (I = V / R) / describes rate of flow of electrons decreasing / rate of flow of charge decreases

M1

Charge lost more slowly <u>so</u> pd falls more slowly <u>because</u> V∝Q or Q=CV where C is constant

A1

MAX 2

[12]

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Q1.

(a) A majority of students knew that capacitance relates to charge and pd. Marks were missed simply because of missed detail such as using appropriate units. Also, some scripts lacked a sense of explanation. ‘Charge per volt’, leaves off the essential fact that the charge is stored. 79% of students scored at least one mark here.

(b) This was an easy question for most students; nearly 90% wrote the correct answer.

(c) This question discriminated well, with a majority of students knowing what the growth graph should look like. Some showed a lack of care in reading the vertical scale and placed the X above 9V. Others drew the curve with a flattened top or showing a slight peak. Some of the weaker students elected to draw an exponential decay type graph.

(d) This was another straightforward calculation which a majority of students (55.4%) could do well. However, a significant minority did not know the simple equation for the half-life.

(e) This was quite a difficult exponential calculation so it was encouraging to see well over half of the students scoring at least one mark. Most students can clearly deal with this type of exponential equation and cope with the re-arrangements and calculation. The common error made by others was to try to use an exponential decay equation rather than an exponential charging equation. These students were able to score marks by evaluating the maximum charge. Overall, it was more common for students to use the charge equation rather than the voltage equation. Nearly 8% of students made no attempt at this question.

Q2.

13.3% correct

Q3.

52.4% correct

Q4.

54.0% correct

Q9.

This question addressed the ideas behind assessed practical activity 9. Students who had seen the second set of specimen questions should have been well prepared for the parts relating to the use of the oscilloscope. It was clear from the descriptive parts of this question, however, that many students had not had direct experience of using an oscilloscope, as shown by the lack of much, if any, use of correct terminology to describe the controls.

Even if some students thought the waveform shown in Figure 1 showed an ac signal, the instruction to determine the peak to peak voltage should have made question (a)

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straightforward. However, a disappointing number of students found a variety of ways to get this wrong and were similarly unsuccessful with question (b).

Those students who obtained 6.3 V and 250 Hz were well-placed to score in question (c) and a popular and successful approach was to use $V = V_0 e^{\frac{-\Delta t}{RC}}$; a transparent, viable attempt along these lines could earn a mark, even if the final answer fell outside the required range. Others read off the time interval for *V* to fall to 37% when the capacitor was discharging, but poor communication often made it harder to give any credit, if the final result obtained by this method was unsuccessful. Those using the idea that the capacitor would completely discharge in five time constants were almost invariably unsuccessful due to difficulty in accurately pinpointing the time for 5RC from Figure 5.

In question (d), most students knew what would happen to the waveform displayed in the oscilloscope when the time-base was adjusted, but often struggled to give a convincing explanation. Stating that the 'waveform would not fit' left examiners looking for further evidence to decide whether the student was referring to vertical or horizontal direction. Some students referred to the 'wavelength increasing', or equivocated by suggested that the waveform 'might not fit'. While better answers suggesting that either the charging or discharging parts (but not both) would now be displayed, very few students took a quantitative approach, e.g. that the discharge curve would now be 2.5 times wider. Here and elsewhere in the paper, some students explained that uncertainty would be reduced, but without supporting reasoning this gained no credit.

Question (e) discriminated well, with better students stating that the resistance, and hence the time constant, is halved, and spotted the opportunity to give the quantitative detail suggested by the information in the question. The sketches on Figure 7 showed that some students thought that adding the extra resistor would change the amplitude or the period of the waveform; relatively few students supplied the sketch examiners were looking for.

In the sketch for question (f), examiners wanted to see a complete half cycle while the signal generator output was *V*, and a complete half cycle when the output was zero. Students were generally more successful with the latter, but often failed to consider how Figures 8a and 8b could be used in combination to deduce the other part of the waveform.

In question (g), "reduce Y-gain", or "increase volt per division" could score but an equivocal "change the Y-gain" could not. Once again, extra credit was available for quantitative detail such as "set the gain to 2 V per division". Some students clearly failed to appreciate that Figure 8c showed a graph and was not the way the waveform would appear on the oscilloscope; these students stated that the waveform was already fully visible, so no changes were necessary.

Q19.

When the capacitance of the charged, isolated variable capacitor in this question has its capacitance reduced, the pd across it must increase so that the charge (= *C V*) remains unchanged. 69% of the students appreciated this, giving C as their answer. The remaining responses were fairly evenly distributed amongst the other three distractors.

Q20.

This question required the selection of the best pair of graphs of pd and current against time for a capacitor as it charged through a resistor. The facility of this question was 74%, an advance from 60% when the same question had appeared in an earlier test. Only one of the graph pairings showed pd increasing and current decreasing, which has to be correct.

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Q21.

The majority of answers to part (a)(i) showed that most students realised that an accurate value for the capacitance could not be obtained from the graph by using one point alone. Those who thought otherwise were limited to one mark only. In part (a)(ii) the additional energy stored by the capacitor when the pd is raised from 9.0 V to 12.0 V could be found either by an area calculation or by the application of an appropriate formula. The correct area is that enclosed by the line between 9.0 V and 12.0 V and either of the axes. This can be calculated in several ways, typically (area of rectangle + triangle) or (area of trapezium). When attempting this, many students did not take account of the fact that the figure did not include the origin of the axes, often ending up with (area of triangle) only. The more popular approaches were undoubtedly by formula. Here, again, a large proportion of responses were incorrect because they relied upon $\frac{1}{2} C (V_2 - V_1)^2$ or its equivalent rather than on $\frac{1}{2} C (V_2^2 - V_1^2)$.

The principal error in part (b)(i) was to misunderstand the data by using 0.8 V_0 instead of 0.2 V_0 as the pd after 45 s; those who did this could be awarded one compensation mark only. Otherwise, many very competent answers with fully correct exponential solutions were seen. R = T / C was usually then applied correctly in part (b)(i) to find the resistance, although a few students wrongly substituted 8.1 μF, from part (a), instead of the given 470 μF.

Over 60% of the responses to part (b)(iii) were correct.

Q22.

This question involved a calculation of the number of electrons transferred when a capacitor becomes fully charged. This needed the application of $Q = CV$ followed by $Q = ne$. Almost four-fifths of the students could do this satisfactorily.

Q23.

This question was similar but a little more demanding, because its facility was 67%. The 15% of students who gave distractor B may have had difficulty in combining mF with μA, because they arrived at an answer of 100 s instead of 1000 s.

Q24.

This question looked at various factors − energy stored, energy supplied, voltages across *C* and *R* − for a capacitor that had been fully charged from a battery through a resistor. An *incorrect* statement had to be identified. The facility of the question was 61%. 21% of the students chose distractor D; evidently they did not understand that there is no current once *C* has been fully charged.

Q25.

AQA apologises for the unfortunate typographical error which crept in to the resistor values in part (a) of this question. Both values ought to have been given in kΩ. The majority of students actually answered the question as it had been intended to appear, and so the mark scheme that would have applied to the intended question in part (ii) was used when marking their work. The students who answered the question as it appeared in the paper were not disadvantaged, because an alternative mark scheme which gave full credit for completely correct responses was adopted for them. The main weaknesses in either approach were a lack of appreciation of the effect of the resistor value on the initial current, and doubt as to whether increasing resistance would speed up the decay or slow it down. In the case of the question as it had been intended, the curve crosses the original curve within the time scale of the graph; this was rarely spotted and so the award of all

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three marks was quite unusual. The determination of the initial charge on the capacitor from the area under the curve was not as well known as expected. There were many references to the intercept on the current axis, to the initial gradient, and some to "*the initial* area under the curve".

Most students wrote correct and complete answers in part (b)(i). A small number of students mixed up mass and weight, leading to the unnecessary introduction of *g* into the calculation. The more able ones who had done this then realised that *g* was self-cancelling. It was pleasing to see that an appropriate number of significant figures was generally quoted in the final answers. The reasons looked for in the answers to part (b)(ii) were those which cause the greatest energy loss as the weight is raised by an electric motor: losses caused by heating of the connecting wires or the motor and energy lost in overcoming frictional forces as the motor rotates. By comparison, the energy lost in overcoming air resistance (for example) is trivial and was therefore discounted. Examiners expected to see that the locations of the energy losses (wires, motor, circuit, etc) were identified in acceptable answers.

Q26.

(a) (i) This calculation was very well done with over 90% of candidates able to complete it successfully. Mistakes seen were mostly power of ten errors on the value of the capacitor (3×10^{-3} often quoted).

(ii) The majority of candidates were able to achieve at least 2 marks. Of course, many candidates attempted to draw discharge curves instead of the required straight line. Candidates should treat these graphs with caution and be aware of the $Q \propto V$ is always directly proportional irrespective of charging and discharging.

(b) There were lots of mistakes in this calculation. The most common error was the use of $E = \frac{1}{2} CV^2$ where candidates substituted ΔV = 1.3 *V* into this formula, effectively calculating

1.3^2 instead of calculating $2.5^2 \times 1.2^2$. Another common mistake seen was treating Q as a constant in the equation $E = \frac{1}{2} QV$, that is E = $\frac{1}{2} \times 7.2 \times 10^{-6} \times \Delta V$

(c) (i) A common mistake seen here was the use of the wrong formula, a significant number of candidates chose to use $T_{½} = 0.69\,RC$ even though the fall in voltage was not quite 50%. Other candidates selected the correct formula but then had difficulty in their rearranging of the formula; many made the mistake of misplacing C in the rearrangement of the equation: R = $\frac{-t}{\ln(\frac{Q}{Q_0})/C}$ instead of R = $\frac{-t}{C\ln(\frac{Q}{Q_0})}$

(ii) Candidates found this explanation difficult, with only the best candidates able to deliver a detailed, coherent response. Most answers were limited to less charge less potential difference arguments rather than dealing with the rate aspect of the question.

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