A-Level Edexcel

PHYSICS

UNIT 4(IAL)

2020 — 2025

EXAMINENT
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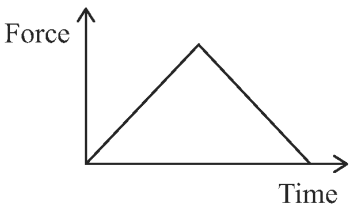
1 - (WPH11/4(IAL)_Summer_2024_Q8) - *Mechanics*

A ball collides with a wall and moves off in the opposite direction. The wall exerts a force on the ball during the collision.

The force-time graph for the collision is shown.



Which of the following is given by the area under the graph?

☒ **A** acceleration of the ball

☒ **B** average force acting on the ball

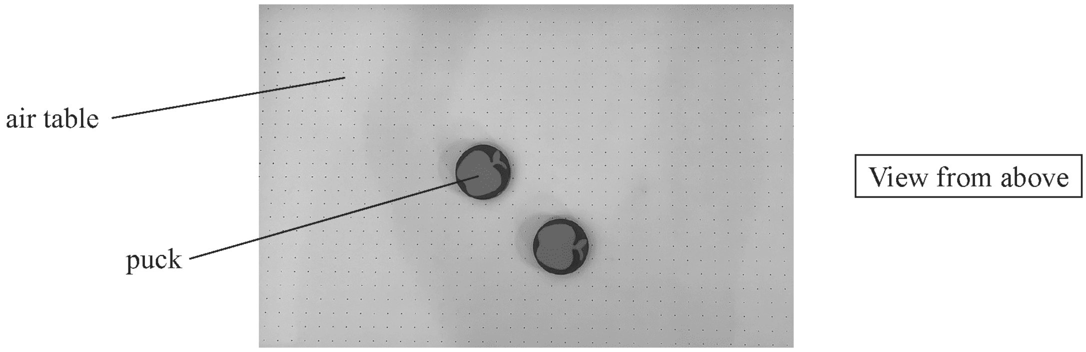
☒ **C** change in momentum of the ball

☒ **D** distance travelled by the ball

2 - (WPH11/4(IAL)_Summer_2024_Q15) - *Mechanics*

An air table has a surface with many small holes. Air is blown through the holes.
Plastic pucks can move freely over the table on a cushion of air.

The photograph shows the surface of an air table with two pucks on it.



Some students used the air table to investigate conservation of momentum.

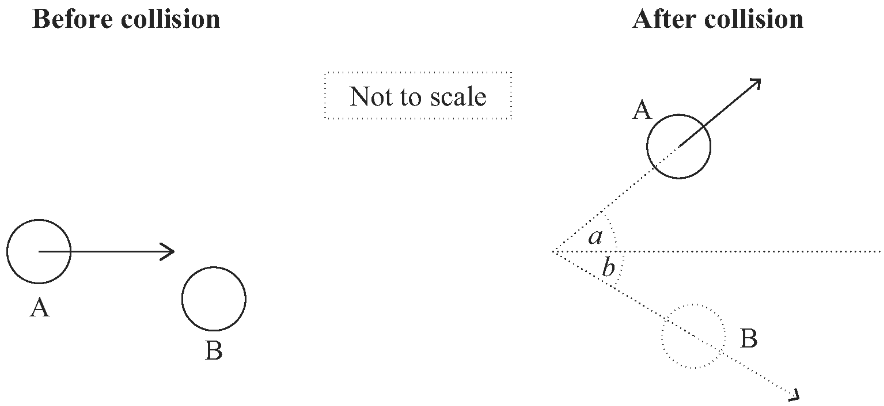
(a) Explain how using the air table ensured that momentum was conserved in collisions between the pucks.

(2)

(b) The students observed several collisions between two identical pucks, A and B.
One puck was stationary before each collision.

They noticed that after each collision the two pucks seemed to follow paths at 90° to each other.

The diagram shows one of the collisions.



The students recorded the following data for this collision.

initial momentum of A	0.046 kg m s^{-1}
angle a	33°
final momentum of A	0.039 kg m s^{-1}

(i) Deduce whether the angle between the paths of the pucks after the collision was 90°.

You should use the principle of conservation of momentum.

(5)

(ii) Deduce whether the collision was elastic.

mass of each puck = 0.110 kg

(5)

1 - (WPH11/4(IAL)_Winter_2025_Q1) - *Waves And Particle Nature Of Light*

Two sources produce waves with a phase difference of 40°.

Which of the following gives the angle of 40° in radians?

☒ **A** $\dfrac{40 \times 2\pi}{360}$

☒ **B** $\dfrac{360}{40 \times 2\pi}$

☒ **C** $\dfrac{40 \times}{360}$

☒ **D** $\dfrac{360}{40 \times}$

2 - (WPH11/4(IAL)_Winter_2025_Q7) - *Nuclear And Particle Physics, Waves And Particle Nature Of Light*

In pair production, a high energy photon creates a particle-antiparticle pair.

In one interaction, a photon produces an electron and a positron.

Which of the following gives the photon energy, in joules?

☒ **A** $9.11 \times 10^{-31} \times (3 \times 10^{8})^{2}$

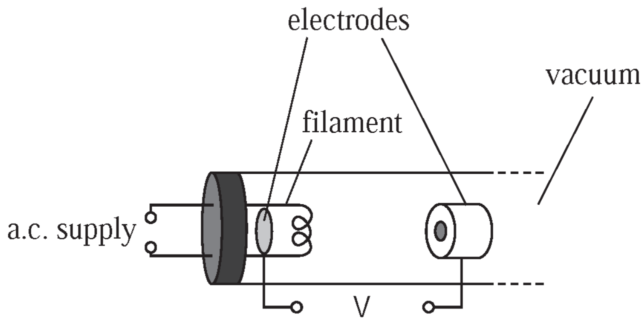
☒ **B** $1.67 \times 10^{-27} \times (3 \times 10^{8})^{2}$

☒ **C** $2 \times 1.67 \times 10^{-27} \times (3 \times 10^{8})^{2}$

☒ **D** $2 \times 9.11 \times 10^{-31} \times (3 \times 10^{8})^{2}$

3 - (WPH11/4(IAL)_Winter_2025_Q14) - *Waves And Particle Nature Of Light, Electric And Magnetic Fields*

A cathode ray tube can be used to demonstrate the properties of electrons. In the cathode ray tube, a beam of electrons is produced using the arrangement shown.



(a) Explain why electrons are released when there is a current in the filament.

(2)

(b) In one cathode ray tube, the electrons in the beam had a de Broglie wavelength of 2.65×10^{-11} m.

Calculate the potential difference V required to accelerate these electrons between the electrodes.

(4)

1 - (WPH11/4(IAL)_Summer_2024_Q1) - *Electric Circuits*

Which of the following is an SI base unit?

☒ **A** ampere

☒ **B** coulomb

☒ **C** joule

☒ **D** tesla

2 - (WPH11/4(IAL)_Summer_2024_Q6) - *Electric Circuits*

A capacitor of capacitance C is charged to a potential difference of V_0. The capacitor then discharges through a resistor of resistance R.

After time t the potential difference across the capacitor is V.

Which of the following gives the time constant for this circuit?

☒ **A** $\dfrac{-t}{\ln\left(V - V_0\right)}$

☒ **B** $\dfrac{-t}{\ln V + \ln V_0}$

☒ **C** $\dfrac{-t}{\left(\dfrac{\ln V}{\ln V_0}\right)}$

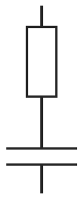
☒ **D** $\dfrac{-t}{\ln\left(\dfrac{V}{V_0}\right)}$

3 - (WPH11/4(IAL)_Summer_2024_Q12) - *Electric Circuits*

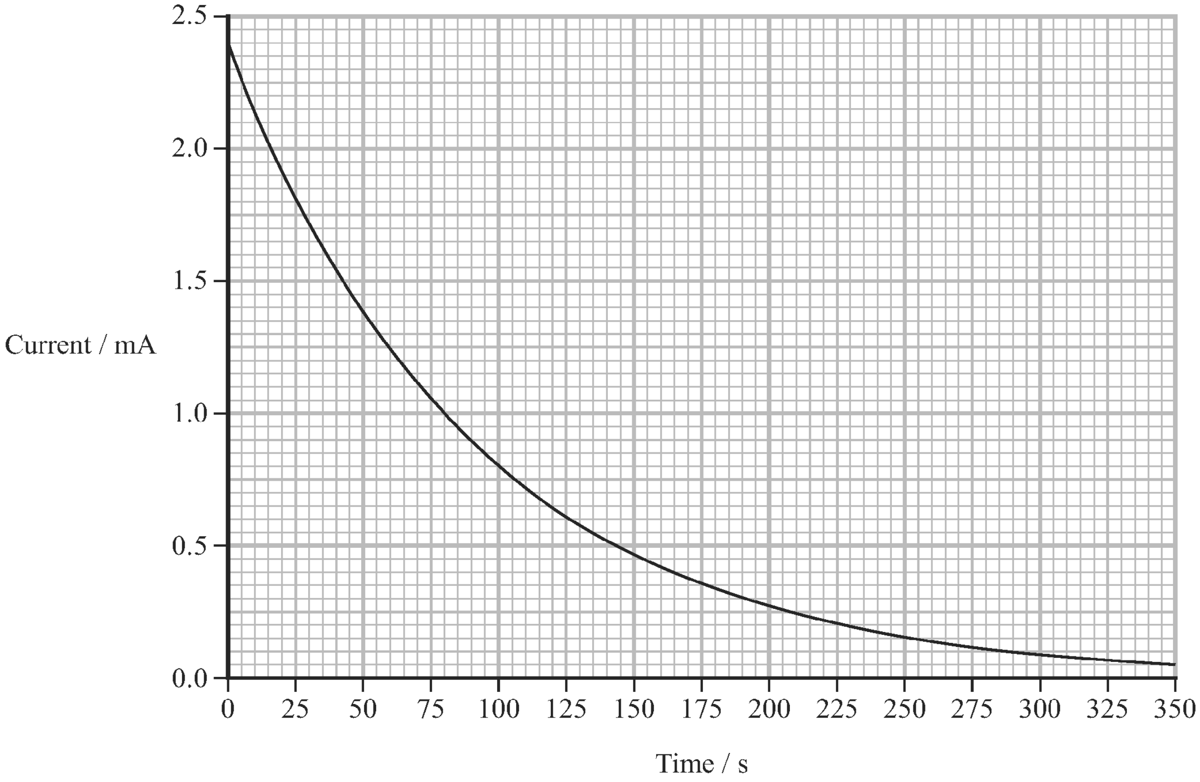
A student investigated the charging of a capacitor. She measured the current in the capacitor circuit as the capacitor charged through a resistor.

(a) Add to the diagram to show a suitable circuit for measuring the current as the capacitor charged.

(1)



(b) The graph shows how the current in the circuit varied with time as the capacitor charged.



(i) The resistance of the resistor is $5.1\,k\Omega$.

Show that the capacitance of the capacitor is about $0.02\,F$.

(3)

(ii) Calculate the charge on the capacitor when it is fully charged.

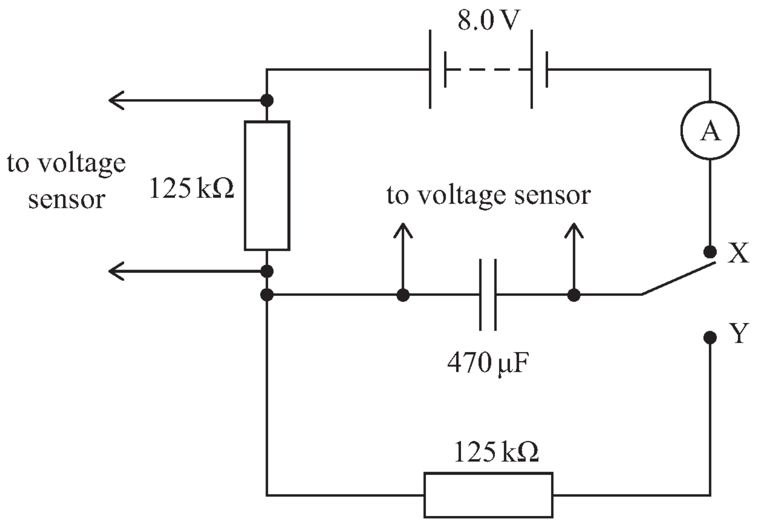
(3)

(iii) Calculate the energy stored by the capacitor when it is fully charged.

(2)

4 - (WPH11/4(IAL)_Winter_2025_Q20) - *Electric Circuits, Electric And Magnetic Fields*

A student connected the circuit shown to investigate the charging and discharging of a capacitor.



(a) She connected the switch to position X to charge the capacitor.

(i) Explain how the current in the circuit varies when the switch is connected to position X.

You do not need to do any calculations.

(4)

(ii) Sketch a graph to show the variation of current in the circuit as the capacitor is charged.

Include the maximum value of current in the circuit.

(3)

(b) To discharge the capacitor, the student connected the switch to position Y.

(i) Show that the time constant of the circuit is about 60 s.

(2)

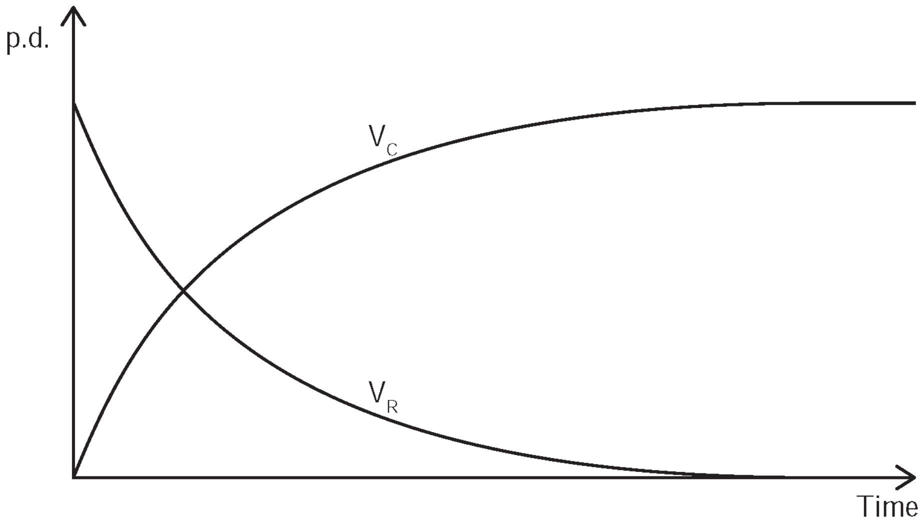
(ii) The student connected the switch to position Y for a time of 3 minutes.

Determine, using the time constant of the circuit, the percentage of the original potential difference (p.d.) remaining across the capacitor.

(3)

(c) After the capacitor was fully discharged, the student connected the switch back to position X to recharge the capacitor. The student used the voltage sensors to measure the p.d. V_C across the capacitor and the p.d. V_R across the resistor. Both sensors were attached to a data logger.

The output from the data logger is shown below.



Determine the value of the p.d. and the value of the time where the two lines intersect.

(4)

(d) The student connected a second identical capacitor in series with the first capacitor. She connected the switch to position X to charge both capacitors.

Explain how the magnitude of charge stored on each capacitor compares with the charge that was stored on the single capacitor.

You do not need to do any further calculations.

(2)

ANSWERS

1 - (WPH11/4(IAL)_Summer_2024_Q8) - *Mechanics*

	C is the only correct answer because the area under a force-time graph is the change in momentum A is not correct because the area under a force-time graph is not acceleration B is not correct because the area under a force-time graph is not force D is not correct because the area under a force-time graph is not distance	**1**

2 – (WPH11/4(IAL)_Summer_2024_Q15) – *Mechanics*

(a)	No/minimal/negligible friction (between the surfaces) So there are no resultant/net/unbalanced external forces acting on the pucks **Or** (so the pucks) can be treated as a closed system	**(1)** **(1)**	**2**
(b)(i)	Use of trigonometrical function for *x* component of A momentum after collision **Or** Use of trigonometrical function for *y* component of A momentum after collision Applies conservation of momentum Applies trigonometry to calculate final angle for B Angle between A and B = 91(°) Comparison between calculated angle and 90° including conclusion in words <u>Example of calculation</u> x component of A after = 0.039 kg m s^{-1} × cos 33° = 0.0327 kg m s^{-1} y component of A after = 0.039 kg m s^{-1} × sin 33° = 0.0212 kg m s^{-1} x component of B after = 0.046 kg m s^{-1} – 0.0327 kg m s^{-1} = 0.0133 kg m s^{-1} y component of B after = 0.0212 kg m s^{-1} tan θ = 0.0212 kg m s^{-1} ÷ 0.0133 kg m s^{-1} = 1.59 θ = 57.9° 58° + 33° = 91° which is about 90°	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**
(b)(ii)	Applies trigonometry or Pythagoras appropriate to calculate magnitude of B momentum [mark may be awarded if calculated in (b)(i)] Use of $E_\mathrm{k} = \frac{p^2}{2m}$ **Or** Use of $E_\mathrm{k} = \frac{1}{2} mv^2$ **and** $p = mv$ Correct calculation of one kinetic energy (ecf from (a)) Correct calculation of all kinetic energies (ecf from (a)) Comparison and conclusion consistent with calculated values of kinetic energy (ecf from (a)) <u>Example of calculation</u> Momentum of B = y component of B / sin 58° = 0.0212 kg m s^{-1} / sin 58° = 0.025 kg m s^{-1} $E_\mathrm{k} = \frac{(0.046\ \mathrm{kg\ m\ s^{-1}})^2}{2 \times 0.11\ \mathrm{kg}}$ = 9.62 × 10^{-3} J (A before) $E_\mathrm{k} = \frac{(0.039\ \mathrm{kg\ m\ s^{-1}})^2}{2 \times 0.11\ \mathrm{kg}}$ = 6.91 × 10^{-3} J (A after) $E_\mathrm{k} = \frac{(0.025\ \mathrm{kg\ m\ s^{-1}})^2}{2 \times 0.11\ \mathrm{kg}}$ = 2.84 × 10^{-3} J (B after) 6.91 × 10^{-3} J + 2.84 × 10^{-3} J = 9.75 × 10^{-3} J = initial disc A kinetic energy, so it is elastic	**(1)** **(1)** **(1)** **(1)** **(1)**	**5**

1 - (WPH11/4(IAL)_Winter_2025_Q1) - *Waves And Particle Nature Of Light*

	The only correct answer is A $\left(\frac{40 \times 2\pi}{360}\right)$ B is not correct because it does not equal 40º C is not correct because it does not equal 40º D is not correct because it does not equal 40º	**1**

2 - (WPH11/4(IAL)_Winter_2025_Q7) - *Nuclear And Particle Physics, Waves And Particle Nature Of Light*

	The only correct answer is D $(2 \times 9.11 \times 10^{-31} \times (3 \times 10^{8})^{2})$ A is not correct because this does not consider the mass of the positron B is not correct because this uses the mass of a single proton / antiproton C is not correct because this gives uses the mass of a proton / antiproton	**1**

3 - (WPH11/4(IAL)_Winter_2025_Q14) - *Waves And Particle Nature Of Light, Electric And Magnetic Fields*

(a)	The (metal in the) filament is heated (by the current) The electrons are released by thermionic emission	**(1)** **(1)**	**2**
(b)	Use of $p = \frac{h}{\lambda}$ Use of $E_\mathrm{k} = \frac{p^2}{2m}$ **Or** p=mv and $E_\mathrm{k} = \frac{1}{2}mv^2$ Use of $V = \frac{W}{Q}$ V = 2100 V Example of calculation $p = \frac{6.63 \times 10^{-34}\ \mathrm{J\ s}}{2.65 \times 10^{-11}\ \mathrm{m}} = 2.50 \times 10^{-23}\ \mathrm{kg\ m\ s^{-1}}$ $E_\mathrm{k} = \frac{(2.50 \times 10^{-23}\ \mathrm{kg\ m\ s^{-1}})^2}{2 \times 9.11 \times 10^{-31}\ \mathrm{kg}} = 3.44 \times 10^{-16}\ \mathrm{J}$ $V = \frac{3.44 \times 10^{-16}\ \mathrm{J}}{1.6 \times 10^{-19}\ \mathrm{C}} = 2147\ \mathrm{V}$	**(1)** **(1)** **(1)** **(1)**	**4**

1 - (WPH11/4(IAL)_Summer_2024_Q1) - *Electric Circuits*

	A is the correct answer because ampere is the only SI base unit given B is not correct because coulomb is not a base unit in SI C is not correct because joule is not a base unit in SI D is not correct because tesla is not a base unit in SI	**1**

2 - (WPH11/4(IAL)_Summer_2024_Q6) - *Electric Circuits*

	D is the only correct answer because $t = \frac{-t}{\ln\left(\frac{V}{V_0}\right)}$ A is not correct because it is not $\frac{-t}{\ln\left(\frac{V}{V_0}\right)}$ B is not correct because it is not $\frac{-t}{\ln\left(\frac{V}{V_0}\right)}$ C is not correct because it is not $\frac{-t}{\ln\left(\frac{V}{V_0}\right)}$	**1**

3 - (WPH11/4(IAL)_Summer_2024_Q12) - *Electric Circuits*

(a)	Complete circuit with ammeter **and** cell / battery in series with the capacitor and the resistor	**(1)**	**1**
(b)(i)	Use of $I = I_0 / e$ to find time constant **Or** Intercept with t axis using initial tangent to find time constant Use of time constant = RC C = 0.018 (F) (2 s.f.) **OR** Attempts a pair of readings of I and t from graph Use of $I = I_0 e^{-t/RC}$ **or** Use of $\ln I = \ln I_0 - \frac{t}{RC}$ C = 0.018 (F) (2 s.f.) <u>Example of calculation</u> I = 2.4 mA / e = 0.9 mA Time constant = 90 s C = 90 s / 5100 Ω = 0.0176 F	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)**	**3**
(b)(ii)	Use of $V = IR$ for initial p.d. using initial current Use of $C = Q / V$ (ecf from (b)(i)) Q = 0.22 C <u>Example of calculation</u> V = 0.0024 A × 5100 Ω = 12.2 V $Q = 1.8 \times 10^{-2}$ F × 12.2 V = 0.22 C	**(1)** **(1)** **(1)**	**3**
(b)(iii)	Use of suitable equation, e.g. $W = ½ QV$ (ecf from (b)(i) and (b)(ii)) W = 1.3 J <u>Example of calculation</u> W = ½ × 0.22 C × 12.2 V W = 1.34 J	**(1)** **(1)**	**2**

4 - (WPH11/4(IAL)_Winter_2025_Q20) - *Electric Circuits, Electric And Magnetic Fields*

(a)(i)	Initially the current in the circuit is a maximum The p.d. across the capacitor increases (as the capacitor charges) The current in the circuit decreases because the p.d. across resistor decreases When the capacitor is fully charged, the current is 0 because the p.d. across the resistor is 0 **Or** Capacitor is fully charged when p.d. across the capacitor equals p.d. across the supply, and the current is 0	**(1)** **(1)** **(1)** **(1)**	**4**
(a)(ii)	Axes labelled with I and t, exponential decreasing curve starting at y axis Use of $I = V/R$ $I_0 = 0.064$ mA and marked on the current axis (at time = 0) <u>Example of calculation</u> $I_0 = 8\text{V} / 125 \times 10^3\ \Omega = 0.064$ mA	**(1)** **(1)** **(1)**	**3**
(b)(i)	Use of time constant = RC 58.8(s) <u>Example of calculation</u> Max value = $470 \times 10^{-6}\ \text{F} \times 125 \times 10^3\ \Omega = 58.75$(s)	**(1)** **(1)**	**2**
(b)(ii)	3 minutes is about $3RC$ **Or** Use of $V = V_0 e^{-t/RC}$ ecf (20 (b) (i)) Percentage reduction = 1/e in one time constant **Or** % reduction $= \frac{V}{V_0} \times 100$ The potential difference will be reduced to 5% <u>Example of calculation</u> $1/e^3 = 0.0498$ $0.0498 \times 100 = 4.98\%$	**(1)** **(1)** **(1)**	**3**

(c)	$V_R + V_C = 8$ V **(1)** $V = 4.0$ V **(1)** Use of $\ln V = \ln V_0 - \frac{t}{RC}$ **(1)** $t = 41$ s **(1)** <u>Example of calculation</u> $\frac{4}{8} = e^{-\frac{t}{59\text{ s}}}$ $t = -59\text{ s}\ln(\frac{1}{2})$ $t = 40.9$ s $V = 4.00$ V	**4**
(d)	charge stored in each capacitor is less than the original value **(1)** (because) the potential difference is shared between the capacitors **(1)**	**2**

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