QCAA ALTERNATIVE SEQUENCE PHYSICS EXTERNAL EXAM – 2020

MULTIPLE CHOICE QUESTIONS - SOLUTIONS AND EXPLANATIONS

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Q		Reasons
1	A	Incorrect. Didn't convert nm to m. $f = \frac{c}{\lambda} = \frac{3\times10^8}{537} = 5.59\times10^5$ Hz
	B	Incorrect. Rearranged formula incorrectly and didn't convert nm to m. $f = c\lambda = 3\times10^8 \times 537 = 1.61\times10^{11}$ Hz
	*C	Correct. $f = \frac{c}{\lambda} = \frac{3\times10^8}{537\times10^{-9}} = 5.59\times10^{14}$ Hz
	D	Incorrect. Rearranged formula incorrectly. $f = \frac{\lambda}{c} = \frac{537\times10^{-9}}{3\times10^8} = 1.79\times10^{15}$ Hz
2	A	Incorrect. Said $Q = I \times q_e = 3\times1.6\times10^{-19} = 4.8\times10^{-19}$ C
	B	Incorrect. Said $Q = \frac{I}{t} = \frac{3}{3\times60} = 1.7\times10^{-2}$ C
	C	Incorrect. Didn't convert minutes to seconds.
	*D	Correct. $Q = It = 3\times(3\times60) = 540\,\text{C} = 5.4\times10^2$ C
3	A	Incorrect as it uses mT to mean 10^{-4} T instead of 10^{-3} T.
	*B	Correct. $emf = -n\frac{\Delta(BA_\perp)}{\Delta t}$ where, $n = 1$ (single loop) $A = \pi r^2$ $= \pi\times(0.04)^2 = 0.005m^2$ $\Delta B = 3.00mT - 1.5mT = 1.5mT = 1.5\times10^{-3}T$ $emf = 1\times\frac{(1.5\times10^{-3})\times(0.005)}{0.600} = 1.26\times10^{-5}V$
	C	Incorrect as it leaves the radius as 4 cm instead of 0.04 m.
	D	Incorrect as it uses the radius as 4 cm rather than 0.04 m, and leaves out the 10^{-3} for the milli (m) in mT.
4	A	Incorrect. Didn't convert g to kg, and used T_f as ΔT
	B	Incorrect. Didn't convert g to kg
	C	Incorrect. Used T_f as ΔT
	*D	Correct.

		$Q = mc\Delta T$ $c = \frac{Q}{m\Delta T} = \frac{340}{10.2\times10^{-3}\times(84-21)} = 529 = 5.29\times10^{2}\ \text{J kg}^{-1}\ \text{K}^{-1}$
5	A	Incorrect. Refers to conservation of electric charge
	B	Incorrect. Based on Oersted's equation
	*C	Correct. Lenz's law states that the direction of an induced electric current always opposes the change in the circuit or the magnetic field that produces it.
	D	Incorrect. Snell's Law for refraction of light.
6	*A	Correct. $R_{4\Omega+2\Omega} = 4+2 = 6\,\Omega$ $\frac{1}{R_{parallel}} = \frac{1}{6}+\frac{1}{6} = \frac{1}{3}$ $R_{parallel} = 3\,\Omega$ $R_T = R_{parallel} + 3\,\Omega = 3+3 = 6\,\Omega$ $I_T = \frac{V_T}{R_T} = \frac{12}{6} = 2\,\text{A}$ $I_{2\Omega} = 1\text{A}\,[\text{as half the current goes through each equal branch}]$ $V_{2\Omega} = I_{2\Omega}R_{2\Omega} = 1\times2 = 2\,\text{V}$
	B	Incorrect. There is a 6 V drop across the parallel branch and the answer assumes there is 3 V drop across each branch and the 2 Ω resistor.
	C	Incorrect. Assumed the total current of 2 A was going through the 2 Ω resistor, hence a 4 V drop.
	D	Incorrect. There is a 6 V drop across the parallel branch and the answer assumes there is a 6 V drop across 2 Ω resistor.
7	*A	Correct. A photon is also called quanta and defined as the smallest discrete packets of energy of electromagnetic waves, as proposed by Einstein in 1904.
	B	Incorrect. Option (B) refers to a form of emr at a particular spectral region (high frequency) and thus does not meet the criterion "any form".
	C	Incorrect. Refers to subatomic particles which admittedly can produce electromagnetic radiation when oscillating or accelerating.
	D	Incorrect. Refers to subatomic particles which admittedly can produce electromagnetic radiation when oscillating or accelerating.
8	A	Incorrect. Left the angles in degrees, plus other mistakes. Said $n_{1\to2} = \frac{1}{2}\times\frac{39}{60} = 0.32$
	B	Incorrect. Use the ratio upside down. Said $n_{1\to2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{\sin39^\circ}{\sin60^\circ} = 0.73$

	*C	$n_{1\to2} = \frac{\sin\theta_1}{\sin\theta_2} = \frac{\sin 60^\circ}{\sin 39^\circ} = 1.37$ *or* Correct. $n_1 \sin\theta_1 = n_2 \sin\theta_2$ $n_2 = \frac{n_1 \sin\theta_1}{\sin\theta_2}$ $= \frac{1.00 \times \sin 60^\circ}{\sin 39^\circ} = 1.37$
	D	Incorrect. Left the angles in degrees. Said $n_{1\to2} = \frac{60}{39} = 1.53$
9	A	Incorrect. Kinetic energy increases ONLY while temperature increases
	*B	Correct. Internal energy is the sum of $E_{P(micro)}$ and $E_{k(micro)}$ and the sum of these increases as the ice is heated.
	C	Incorrect. Potential energy increases ONLY during a phase change
	D	Incorrect. Chemical energy increases only when there is a bond rearrangement (making or breaking)
10	A	Incorrect. This only applies when there is a temperature change, and this is not equilibrium.
	*B	Correct. This is the definition of thermal equilibrium similar to that used in OUP *Physics for Queensland* (2025*): thermal equilibrium is a state in which there is no net exchange of thermal energy between any components of a system; the components have the same temperature and the same average kinetic energy* (Glossary).
	C	Incorrect. This is true for a system approaching equilibrium, NOT at equilibrium.
	D	Incorrect. There will be an exchange of thermal and kinetic energy as the system approaches equilibrium, not not at equilibrium
11	A	Incorrect. This looks like some non-linear device whose resistance gets less as the current increases. For example, a diode
	*B	Correct. A linear V/I graph is a characteristic of a ohmic resistor
	C	Incorrect. This looks a resistance wire that gets hot as the current increases. This means an increase in resistance with temperature
	D	Incorrect. This case represents a device that has a constant current as voltage increases. It is thus non-ohmic
12	*A	Correct. The displacement from the equilibrium position to the crest is the amplitude.
	B	Incorrect. This is the particle's displacement from the bottom of the trough to the crest of the wave.
	C	Incorrect. This is just half the period (time)
	D	Incorrect. This is just the period of the wave.
13	A	Incorrect. Option (A) does not describe any model of the atom, but rather defines it, and it predates Rutherford.
	*B	Correct. Option (B) accurately describes Rutherford's model of the atom.
	C	Incorrect. Option (C) is J. J Thompson's "plum pudding model" of the atom
	D	Incorrect. Option (D) is the Bohr model of the atom
14	A	Incorrect. This is the shape of the A pulse after moving along another division. The B pulse is not shown.
	B	Incorrect. This is the shape of the B pulse after moving along another division. The A pulse is not shown.
	*C	Correct. The amplitudes of the two pulses is added. This is superposition
	D	Incorrect. The pulses do not cancel as they have different amplitudes

15	A	Incorrect. Surface waves are mechanical waves that travel along an interface between two different media, such as wind-driven ocean waves at the surface of water or seismic surface waves at the Earth's surface. The term 'surface waves' is not a syllabus term and should be discounted. In this question there is no mention of a second medium
	B	Incorrect. Sound is a longitudinal wave
	*C	Correct. Sound is a longitudinal wave
	D	Incorrect. Sound is not an electromagnetic wave because it is not caused by oscillating electric charges
16	A	Incorrect. Wrongly calculated this as: $n\% = \frac{E_{out}}{E_{in}}$ $E_{in} = \frac{E_{out}}{n\%} = \frac{1290}{43} = 300\,\text{J}$
	B	Incorrect. Used wrong formula: $\eta\% = \frac{E_{in}}{E_{out}} \times 100$. $E_{in} = \frac{E_{out} \times \eta\%}{100} = \frac{1290 \times 43}{100} = 555\,\text{J}$
	*C	Correct. $\eta\% = \frac{E_{out}}{E_{in}} \times 100$ $E_{in} = \frac{E_{out}}{\eta\%} \times 100 = \frac{1290}{43} \times 100 = 3000\,\text{J}$
	D	Incorrect. Used wrong formula: $\eta\% = \frac{E_{in}}{E_{out}}$ $E_{in} = E_{out} \times \eta\% = 1290 \times 43 = 55\,470\,\text{J}$
17	A	Incorrect. Option (A) does not fully describe a magnetic field
	B	Incorrect. Option (B) describes an electrostatic field
	C	Incorrect. Option (C) describe an electrostatic field
	*D	Correct. A magnetic field is defined as a region of space where a magnetic force is experienced.
18	*A	Correct. $I = \frac{Q}{t} = \frac{13\,\text{C}}{1s} = 13\,\text{A}$
	B	Incorrect. The rate of movement of charge carriers is electric current and when charge is in coulomb, and time in seconds, the rate is in ampere A not voltage V
	C	The rate of movement of charge carriers is electric current and when charge is in coulomb, and time in seconds, the rate is in ampere A not ohms Ω
	D	The rate of movement of charge carriers is electric current and when charge is in coulomb, and time in seconds, the rate is in ampere A not power W
19	*A	Correct. $emf = -n\frac{\Delta\phi}{\Delta t}$ $36 = 24 \times \frac{0.3}{t}$ $t = 0.2s$

		Option B uses the equation upside down: t = (36 x 0.3)/45
	B	Incorrect. Option B uses the equation upside down: t = (36 x 0.3)/45
	C	Incorrect. Option C uses t = 24/(36 x 0.3)
	D	Incorrect. Option D uses t = 36/(24 x 0.3)
20	A	Incorrect. Option A uses $f_o = W/h$ and has left out the v_e
	B	Incorrect. Option B is incorrect as it uses $E_k = hf_o + W$
	C	Incorrect. Option C is incorrect as it left out the W value.
	*D	Correct. $E_k = hf_0 - W$ Find E_k and then substitute to find f_0 m = almost zero, so ignore $E_k = \frac{1}{2}mv^2$ $= 0.5 \times 9.109 \times 10^{-31} \times (1.9 \times 10^6)^2$ $= 1.644 \times 10^{-18} J$ Convert W to Joules, W(J) = $4.73 \times (1.60 \times 10^{-19}) = 7.568 \times 10^{-19} J$ $f_0 = \frac{E_k + W}{h}$ $= \frac{1.644 \times 10^{-18} + 7.568 \times 10^{-19}}{6.626 \times 10^{-34}}$ $= 3.62 \times 10^{15} Hz$