QCAA MOCK ASSESSMENT "SCHOOL USE ONLY - PAPER 1" 2020

Worked solutions and explanations to Paper 1 Multiple choice
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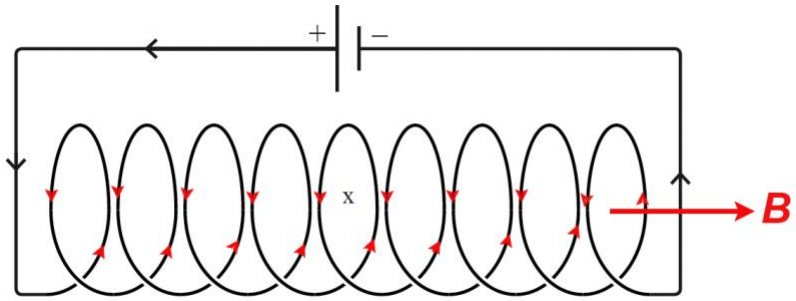
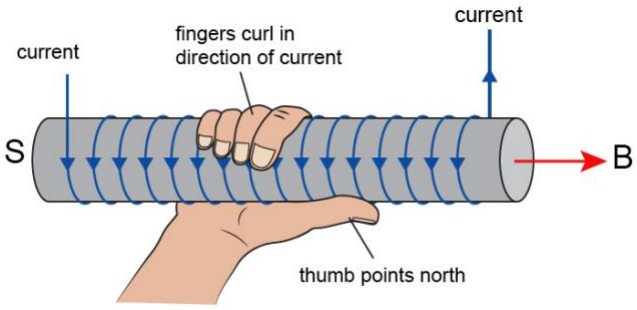
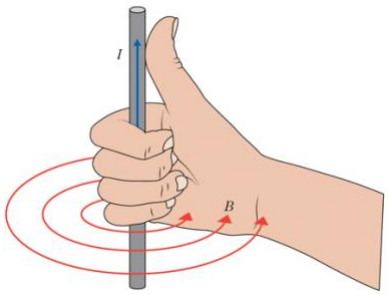
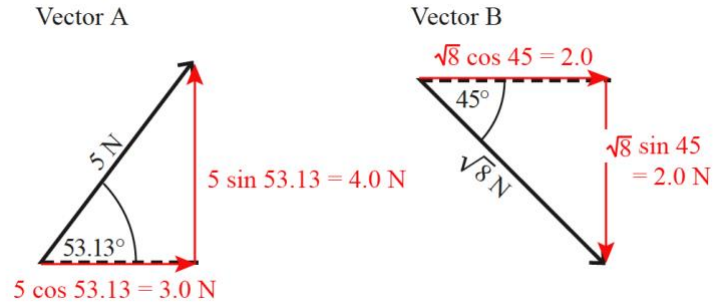
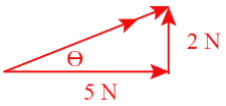
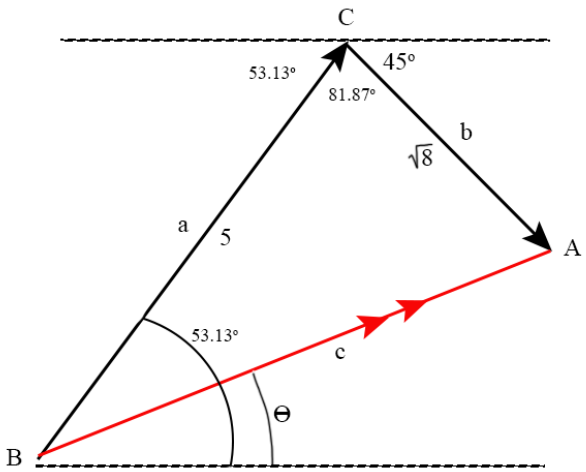
Q	Option	Solutions and explanations (validity statements and distractor justification)
1	A*	Correct. Proper length is the length as measured by an observer at rest to the object being measured, hence velocity is zero for observer with respect to object. The subscript 'o' in L_o reflects this.
	B	Incorrect. The dilated length is not a term recognised in Special Relativity. There is proper length, L_o, and relativistic or contracted length, L, only.
	C	Incorrect. The Lorentz factor the symbol gamma, γ, and is the ratio: $\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$. It is not in the syllabus. See Study Tip, page 265, Oxford New Century Physics for Queensland U3&4.
	D	Incorrect. Relativistic length is an alternative term for contracted length, that is, the length as measured by an observer moving relative to the object being measured, hence L with no zero 'o' subscript.
2	A*	Correct. $u_y = usin\theta$ $u_y = 14\ sin42^o = 9.37\ m\ s^{-1}$
	B	Incorrect. Option uses $u_y = 14\ cos42^o = 10.4\ m\ s^{-1}$
	C	Incorrect. Option uses $u_y = 14 \div cos42^o = 18.8\ m\ s^{-1}$
	D	Incorrect. Option uses $u_y = 14 \div sin42^o = 20.9\ m\ s^{-1}$
3	A	Incorrect. The maximum kinetic energy is E_K
	B	Incorrect. Wavelength has the quantity symbol lambda, λ
	C*	Correct. See page 316, Oxford New Century Physics for Queensland U3&4.
	D	Incorrect. To ionize an electron from a single atom you have to firstly give it energy required to get it to the surface of the metal (the work function, W) and then remove it from the surface to infinity.
4	A	Incorrect. Forgot to convert 10 cm to 0.10 m. Hence: $B = \frac{\mu_o I}{2\pi r} = \frac{4\pi \times 10^{-7} I}{2\pi r} = \frac{2 \times 10^{-7} I}{r} = \frac{2 \times 10^{-7} \times 2}{10} = 4 \times 10^{-8}\ T$
	B*	Correct. $B = \frac{\mu_o I}{2\pi r} = \frac{4\pi \times 10^{-7} I}{2\pi r} = \frac{2 \times 10^{-7} I}{r} = \frac{2 \times 10^{-7} \times 2}{0.10} = 4 \times 10^{-6}\ T$
	C	Incorrect. Probably converted 10 cm wrongly to 0.10×10^{-6} m, hence: $B = \frac{\mu_o I}{2\pi r} = \frac{4\pi \times 10^{-7} I}{2\pi r} = \frac{2 \times 10^{-7} I}{r} = \frac{2 \times 10^{-7} \times 2}{0.10 \times 10^{-6}} = 4\ T$
	D	Incorrect. Converted 10 cm wrongly to 10×10^{-9} m, hence: $B = \frac{\mu_o I}{2\pi r} = \frac{4\pi \times 10^{-7} I}{2\pi r} = \frac{2 \times 10^{-7} I}{r} = \frac{2 \times 10^{-7} \times 2}{10 \times 10^{-9}} = 40\ T$

5	A	Incorrect. This is one of Kepler's Laws (First law)
	B	Incorrect. This is one of Kepler's Laws (Second law)
	C*	Correct. This is **not** one of Kepler's laws. This doesn't indicate what the *acceleration* refers to. The relationship for force between a planet and the Sun is given by Newton's Law of Universal Gravitation: $F = \frac{GmM}{r^2}$ which can be restated as the gravitational field strength, or acceleration due to gravity: $g = \frac{GM}{r^2}$ which aligns with the statement in the question and so is true in itself, but irrelevant. However, this is still not one of Kepler's laws.
	D	Incorrect. This is one of Kepler's Laws (Third law). Note, however, that it uses the term *siderial* which is not a syllabus term. It would thus be unlikely that this option would be found, as is, on the external exam.
6	A	Correct. The full syllabus definition is: *the amount of time one cycle or one event takes to occur; the length of time taken for one wavelength to pass a given point; in circular motion, period refers to the time taken to complete one revolution (symbol, T; SI unit, s).*
	B	Incorrect. This is a trap to make you think of the time it takes a particle on a wave to be in the same consecutive equilibrium positions, but this is only half a cycle and so half a period.
	C	Incorrect. This is about the distance not the time (period). It would be true if it said, "the time taken to travel the distance of one revolution in uniform circular motion".
	D	Incorrect. This is about the distance not the time (period). It would be true if it said, "the time taken by a wave when one whole wavelength passes a given point".
7	A	Incorrect. Gravitational force is one of the four fundamental forces but is not a part of the Standard Model. Quarks, however, do experience the gravitational force as they have mass – but that is irrelevant to the question.
	B	Incorrect. The weak nuclear force is one of the three fundamental forces included in the Standard Model. The weak nuclear force is responsible for radioactive decay and is mediated by W and Z bosons but is not experienced by quarks. The force between quarks is mediated by gluons.
	C*	Correct.
	D	Incorrect. The electromagnetic force is one of the four fundamental forces and is a part of the Standard Model, and quarks do experience the electromagnetic force as they have electric charge. However, the strong nuclear force is 10× the strength of the electromagnetic force and is considered the main force between quarks in the Standard Model.
8	A	Incorrect. The radius of 10 cm has been wrongly converted to 0.01 m, hence: $$m = \frac{F_c r}{v^2} = \frac{250 \times 0.01}{5^2} = 0.1\ kg$$
	B*	Correct. The formula: $F_c = mv^2/r$ can be rearranged: $$m = \frac{F_c r}{v^2} = \frac{250 \times 0.10}{5^2} = 1\ kg$$
	C	Incorrect. The radius has been left as 10 cm instead of converting it to 0.10 m: $$m = \frac{F_c r}{v^2} = \frac{250 \times 10}{5^2} = 100\ kg$$
	D	Incorrect. The radius has been left as 10 cm instead of converting it to 0.10 m. The velocity of 5 m s^{-1} has not been squared in the formula: $$m = \frac{F_c r}{v^2} = \frac{250 \times 10}{5} = 500\ kg$$

9	A	Incorrect. A meson is a subatomic particle made up of two quarks (actually, a quark and an antiquark). A particle made of three quarks (or combinations of three quarks and/or antiquarks) is a baryon.
	B*	Correct. See syllabus p 83: *subatomic particles composed of one quark and one antiquark*
	C	Incorrect. This is not a well-written option as it is inappropriate for this syllabus. Hadrons are particles that experience the strong nuclear force. This means that they contain quarks. A meson is also a type of hadron, and it contains one quark and one antiquark. However, the term *hadron* is not in the syllabus except in the term Large Hadron Collider found on page 55. It is correct but should not be accepted as correct for this syllabus. It needs changing.
	D	Incorrect. Mesons are electrically uncharged so do not experience the electromagnetic force.
10	A	Incorrect. The *F* stands for force, not field
	B*	Correct. See syllabus age 73. It is also written in the syllabus as *emf* so don't let that confuse you.
	C	Incorrect. The electromagnetic field appears to have the same initial letters *e, m, f* but is never given the symbol *emf*, or *EMF*.
	D	Incorrect. The *F* stands for force, not field. This is a common mistake. Every person in my class chose this option when they did this test.
11	A	Incorrect. This is Newton's 3rd law applied to a gravitational force between Earth and an object.
	B	Incorrect. The parallel force is used when talking about the component of the gravitational force an object on an incline plane experiences that acts parallel to the surface.
	C*	Correct
	D	Incorrect. This is centripetal force. It is true that the centripetal force acts at right angles (normal) to the direction of motion for an object travelling in circular horizontal motion.
12	A	Incorrect. *T* works out to 502217 minutes (see below) which equals 8370 hours not 8370 days.
	B*	Correct. $\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$ $T = \sqrt[2]{\frac{4\pi^2 r^3}{GM}} = \sqrt[2]{\frac{4\pi^2 \times (1.50 \times 10^{11})^3}{6.67 \times 10^{11} \times 2.20 \times 10^{30}}} = 30133000\ seconds$ = 502217 minutes = 8370 hours = 349 days
	C	Incorrect. *T* works out to 502217 minutes which equals 8370 hours not 8370 minutes.
	D	Incorrect. T works out to be 349 days, not 349 minutes.
13	A	Incorrect. This is *parallel* force used when talking about the component of the gravitational force an object on an incline plane experiences that acts parallel to the surface.
	B	Incorrect. This is the *normal* force.
	C*	Correct
	D	Incorrect. The centripetal force pulls or pushes the object <u>*inwards*</u> not outwards. In earlier days there was a fictitious force called the centrifugal force that was said to push or pull the object outwards. It is no longer used in physics.

14	A	Incorrect. Only electrons and muons are leptons. The photon is a boson.
	B	Incorrect. Only the electron, electron neutrino and positron are leptons. The proton is a baryon as it has three quarks (and a hadron as it contains more than one quark).
	C*	Correct. There are six leptons in the Standard Model: electron, electron neutrino, muon, muon neutrino, tau and tau neutrino. Leptons are defined as particles that are governed by the weak nuclear force and for those that have charge (electron, muon, tau), are also influenced by electromagnetism. Note that the syllabus has a mistake in the definition on page 81 as it says they all have electric charge.
	D	Incorrect. Quarks are not leptons.
15	A	Incorrect. The point X is not the tail feathers of an arrow pointing into the page. This was meant to trap you.
	B	Incorrect. There is no logical reason for choosing this.
	C	Incorrect. This is either using your left hand, or not understanding the way the current flows in the diagram. I have drawn arrows on the diagram below to show the current.
	D*	Correct. Here's an annotated drawing. The current flows down the front of the solenoid and up the back. It is not easy to decipher the diagram. Using the right-hand rule for solenoids, wrap the fingers of your right and around the solenoid so that your fingers curl in the direction of the current. Your thumb will point in the direction of the field.  
16	A	Incorrect. This is the force due to gravity.
	B	Incorrect. This is gravitational field strength and has been derived from Newton's Law of Universal Gravitation.
	C*	Correct. See QCAA *Formula and Data Book*, page 2, or page 84 of the physics syllabus. See also, page 118 of my Oxford *New Century Physics for Queensland* U3&4.
	D	Incorrect. This is the formula for centripetal force.

17	A	Incorrect. It is true that electromagnetic radiation is emissions of energy as electromagnetic waves, but they do not necessarily cause ionisation.
	B	Incorrect. It is true that it is radiant energy, but it does not consist of oscillating electric charges in mutually perpendicular electric and magnetic fields. It would be correct if it read: *radiant energy consisting of mutually perpendicular electric and magnetic fields caused by oscillating electric charges.*
	C	Incorrect. It is true that it is *emissions of energy as electromagnetic waves or moving subatomic particles*. It can consist of 'especially high-energy particles, that cause ionisation' but it doesn't always.
	D*	Correct. This is straight from the syllabus, page 73. Radiant energy (true); synchronised oscillations of electric and magnetic fields (true). What this means is that the electric and magnetic field waves are in phase (synchronised) so they oscillate together.
18	A*	Correct. $F = \frac{1}{4\pi\varepsilon_o}\frac{q}{r^2} = 9\times10^9 \times \frac{Qq}{r^2}$ $F = \frac{9\times10^9 \times 1.6\times10^{-6} \times 1.6\times10^{-6}}{0.150^2} = 1.0\ N$
	B	Incorrect. Wrongly used 10^{-3} for μ in separation distance: $F = \frac{9\times10^9 \times 1.6\times10^{-3} \times 1.6\times10^{-3}}{0.150^2} = 1.0\times10^6\ N$
	C	Incorrect. Wrongly left distance as 150 mm instead of converting it to 0.150 m: $F = \frac{9\times10^9 \times 1.6\times10^{-6} \times 1.6\times10^{-6}}{150^2} = 1.0\times10^{-6}\ N$ Note: earlier version of the answers on the QCAA website had option (C) as the correct answer. This was corrected in later versions.
	D	Incorrect. Wrongly left distance as 150 mm instead of converting it to 0.150 m and didn't square the distance. $F = \frac{9\times10^9 \times 1.6\times10^{-6} \times 1.6\times10^{-6}}{150} = 1.5\times10^{-4}\ N$
19	A*	Correct. Using Ampere's right-hand rule for current carrying conductors you place your thumb pointing up the page, and your fingers curl to the right in front of the wire.  From Oxford *New Century Physics for Queensland*, 2019, U3&4, page 187
	B	Incorrect. Field is always at right angles to direction of current. This diagram has it as being parallel.
	C	Incorrect. May have used left hand instead of right hand.
	D	Incorrect. Field should be anticlockwise if current is moving into the page as shown by the cross 'X'.

20	A	Incorrect. Has vertical component as 4.0 + 2.0 = 6.0 N
	B	Incorrect. Has the vertical component as 2 N down
	C*	Correct  $F_{Vertical}$ = 4.0 + (-2.0) = 2.0 N up; $F_{Horizontal}$ = 3.0 + 2.0 = 5.0 N right  Resultant: $F = \sqrt{5^2 + 2^2} = \sqrt{29} = 5.4\ N$ Angle: $\theta = tan^{-1}\frac{2}{5} = 21.8^{\circ}$
		ALTERNATIVE METHOD:  $c^2 = a^2 + b^2 - 2ab\ cosC$ $c^2 = 5^2 + \left(\sqrt{8}\right)^2 - 2 \times 5 \times \cos 81.87$ $c^2 = 25 + 8 - 4$ $c = \sqrt{29}$ $\frac{\sin B}{b} = \frac{\sin C}{c}$ $\sin B = \frac{\sqrt{8}\sin 81.87}{\sqrt{29}}$ $sinB = 0.52$ $B = 31.32^{\circ}$ $\theta = 53.13 - 31.32 = 21.8^{\circ}$
	D	Incorrect. Seems to have F_V = 4 N down, and F_H = 1 N right.

The end. Good luck!