QCAA Physics EA 2020 Paper 1 MCQ Solutions by Richard Walding

MCQ	Answer	Explanation
1	B	The force due to gravity (weight), the normal force and the force opposing motion must be included in the diagram. Only diagram (B) has this. Diagram (A) is correct in that the weight is resolved into two components at right angles – one down the incline, and one perpendicular to the surface. The question states that the object is "resting", that is, it is not moving. This means that the force down the incline equals the friction force up the incline. Diagram (A) shows this. Diagram (A) also shows the normal force as being approximately equal to the perpendicular component of the weight. However, the components are not acting on the object as the questions states, so (B) is the only correct option. We can rule out (D) as the vector showing the weight of the object has only been resolved into the parallel component and not the perpendicular component. For a similar reason we can rule out (C) as the parallel component of the weight is not show, only the perpendicular.
2	B	Average speed is the rate of change of distance over time, as per the formula $v = \frac{d}{t}$. Speed is a scalar quantity; therefore, it does not involve a vector quantity such as displacement.
3	A	Resolving vectors top to tail and applying Pythagoras theorem will give, $c = \sqrt{(12^2) + (9^2)}$ $= 15km$
4	B	Use $emf = -n\frac{\Delta(BA_\perp)}{\Delta t}$ where, $n = 1(\text{single loop})$ $A = \pi r^2$ $= \pi \times (0.04)^2 = 0.005m^2$ $\Delta B = 3.00mT - 1.5mT = 1.5mT = 1.5\times10^{-3}T$ $emf = 1\times\frac{(1.5\times10^{-3})\times(0.005)}{0.600} = 1.26\times10^{-5}V$ Option A is incorrect as it uses mT to mean 10^{-4} T instead of 10^{-3} T. Option C is incorrect as it leaves the radius as 4 cm instead of 0.04 m. Option D is 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.
5	C	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. We can rule out (A) as that refers to conservation of electric charge; rule out (B) as that is based on Oersted's equation; and rule out (D) as that is Snell's Law for refraction of light.
6	C	An object has momentum when it is measured as moving. It would be relativistic if it is moving at high speeds, but we can still say it is relativistic at any speed although it may not differ from the Newtonian momentum. If an observer is travelling in the same frame of reference as the object, then the object would be perceived a not moving and hence have no momentum. This rules out (D). We can rule out (B) as it could apply to a frame of reference where the object is stationary. We can also rule out (A) as a Newtonian Frame of Reference is merely a frame in which Newton's laws of motion apply. This would apply to a frame in which the object is stationary.
7	A	A photon is also called quanta and defined as the smallest discrete packets of energy of electromagnetic waves, as proposed by Einstein in 1904. Option (B) refers to a form of emr at a particular spectral region (high frequency) and thus does not meet the criterion

		"any form". Options (C) and (D) refer to subatomic particles which admittedly can produce electromagnetic radiation when oscillating or accelerating.
8	A	Need to use $s_x = u_x t$ so first find t. $s_y = u_y t + \frac{1}{2}gt^2$ $-46 = \frac{1}{2}\times -9.8\times t^2$ [note that the displacement is negative] $t = 3.06\,s$ Since $u_x = 25\,m\,s^{-1}$, $s_x = 25\times 3.06$ $= 76.5\,m$ Option D is incorrect as it doesn't take the square root of 9.39 to calculate *t*.
9	C	The six types of quarks are up, down, charm, strange, top and bottom. The terms in, out, right, left refer to directions of motion.
10	B	Option (A) – the weak force - applies to quarks but also to leptons such as positrons and electrons (in beta positive and beta negative decay). Option (C) is not a standard model force. Option (D) applies to quarks and charged leptons, although uncharged leptons such as the neutrinos don't experience it. Note that the syllabus term is "strong nuclear force", but it is commonly referred to as the "strong force".
11	D	Mathematically, we could calculate the quantities referred to in the question. $u_{y(A)} = 10.00\sin 45^\circ = 7.07\,m\,s^{-1}$ $u_{x(A)} = 10.00\cos 45^\circ = 7.07\,m\,s^{-1}$ $u_{y(B)} = 13.00\sin 30^\circ = 6.50\,m\,s^{-1}$ $u_{x(B)} = 13.00\cos 30^\circ = 11.26\,m\,s^{-1}$ $t_A = \frac{v_{y(A)} - u_{y(A)}}{g} = \frac{-7.07-(+7.07)}{-9.8} = 1.44\,s$ $s_{x(A)} = u_{x(A)}t = 7.07\times 1.44 = 10.2\,m$ $t_B = \frac{v_{y(B)} - u_{y(B)}}{g} = \frac{-11.26-(+6.50)}{-9.8} = 1.33\,s$ $s_{x(B)} = u_{x(B)}t = 11.26\times 1.33 = 15.0\,m$ $s_{y(A)} = 2.55m$ using $v_{y(A)}^2 = u_{y(A)}^2 + 2gs_{y(A)}$ $s_{y(B)} = 2.16m$ using $v_{y(B)}^2 = u_{y(B)}^2 + 2gs_{y(B)}$ (D) is correct. Object A has a smaller horizontal displacement (10.2 m) than does Object B (15.0 m). (A) is false. Object A has a flight time of 1.44 s which is larger than for Object B (1.33 s). (B) is false. Object A has a larger maximum height (2.55 m) than Object B (2.16 m) as the vertical component of A's velocity (6.5 m s^{-1}) is smaller than for Object B (7.07 m s^{-1}) so does not travel as high. (C) is false. Object A has a smaller horizontal velocity (7.07 m s^{-1}) than does Object B (11.3 m s^{-1}).
12	B	Option (A) and (C) applies to Special Relativity, not Kepler's laws of planetary motion, so these are incorrect. Kepler's third law states that the square of the sidereal periods of the planets are directly proportional to the cubes of their average distance from the sun, $T^2 \propto r^3$, therefore, Option (B) is correct. Option (B) is Kepler's first law of planetary motion. Option (D) is incorrect as it refers to Newton's Universal Law of Gravitation.
13	B	Option (C) is J. J Thompson's "plum pudding model" of the atom and Option (D) is the Bohr model of the atom, so these are incorrect. Option (A) does not describe any model of

		the atom, but rather defines it, and it predates Rutherford. Option (B) accurately describes Rutherford's model of the atom.
14	C	There are four gauge bosons: W and Z bosons, photon and gluon. Mesons, hadrons and leptons are matter particles and are not bosons.
15	B	$\frac{T^2}{r^3} = \frac{4\pi^2}{GM}$ $T^2 = \frac{4\pi^2}{GM} \times r^3$ $T^2 = \frac{4\pi^2 \times (3.00 \times 10^8)^3}{(6.67 \times 10^{-11}) \times (5.97 \times 10^{24})}$ $T = 1636515.844\, s$ $T = 27275.26 \min$ $T = 454.58\, h$ $T = 4.54 \times 10^2\, h$ Option A is incorrect as the radius in metres was converted to *km* but should have been left in *m*. Option C is incorrect as it uses the value for seconds (1.64 x 10^6 s) as hours. Option D is incorrect as the square root of T^2 is not taken in line 3.
16	C	The syllabus definition states "the relation between two events assumed to happen at the same time in a frame of reference", so the concept of simultaneity is best described by that statement. We can expand on that. Two events in a reference frame are simultaneous if light signals from the events reach an observer halfway between the events at the same time or can be shown to have happened at the same time. In reference frames that are moving with respect to one another two events that are simultaneous to one observer are not necessarily simultaneous to a second observer.
17	D	A magnetic field is defined as a region of space where a magnetic force is experienced, since Option (B) and (C) describe an electrostatic field, they are incorrect. Option (A) does not fully describe a magnetic field, and so Option (D) is correct.
18	C	$u_y = u \sin\theta$ $= 68 \times \sin 51^\circ$ $= 52.8\, m\, s^{-1}$ Option A is incorrect as it uses cos 51° for initial vertical velocity. Option B is incorrect as it uses the angle as the initial velocity. Option D is incorrect as it uses the initial velocity of 68 m s^{-1} as the initial vertical velocity u_y.
19	A	$emf = -n\frac{\Delta\phi}{\Delta t}$ $36 = 24 \times \frac{0.3}{t}$ $t = 0.2s$ Option B uses the equation upside down: t = (36 x 0.3)/45 Option C uses t = 24/(36 x 0.3) Option D uses t = 36/(24 x 0.3)

20	D	$E_k = hf_0 - W$ 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, $W(J) = 4.73 \times (1.60 \times 10^{-19}) = 7.568 \times 10^{-19}\ J$ $f_0 = \frac{E_k + W}{h}$ $= \frac{1.644 \times 10^{-18} + 7.568 \times 10^{-19}}{6.626 \times 10^{-34}}$ $= 3.62 \times 10^{15}\ Hz$ Option A uses $f_o = W/h$ and has left out the v_e Option B is incorrect as it uses $E_k = hf_o + W$ Option C is incorrect as it left out the W value.