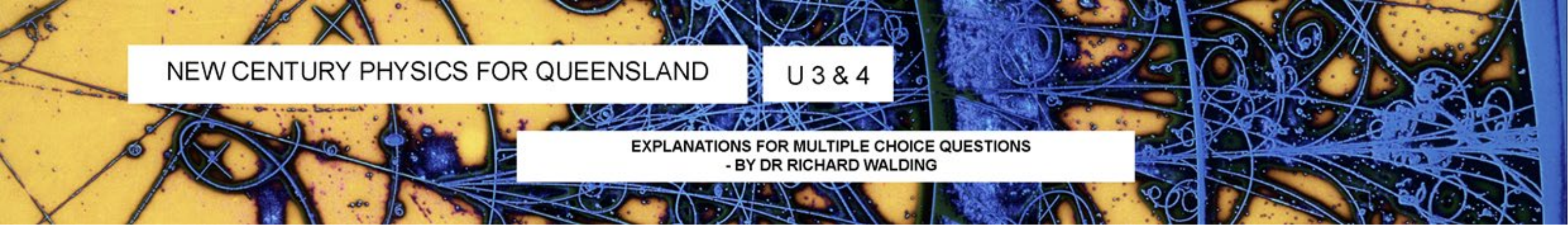

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Practice exam answers for Unit 3 and 4

Explanations for the answers to the multiple choice questions.

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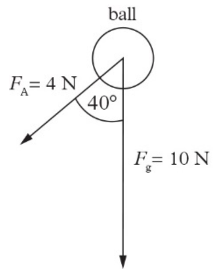
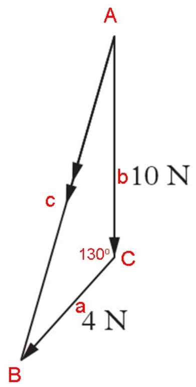
Note: to make sure you have the right test, this is the one that starts with a Question 1 like this:

1 A ball with a weight F_g of 10 N is falling to the ground and experiences an applied sideways force F_A of 4 N due to the wind. This is shown in the vector diagram on the right.

Select which of the following shows the resultant vector when the two vectors F_g and F_A are added.

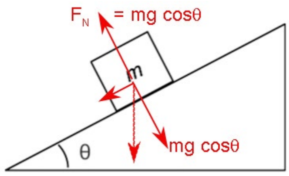


Q	**Ans**	**Explanations**
1	A	When you determine the resultant vector, you add the two vectors head to tail. In this case only Options C and D do this. The question is, which one is correct as they both seem okay. Let's draw the diagram and label it. Note that angle C is 90° + 40° = 130°.



We can use the cosine rule to solve for side *c*.

$$\begin{aligned} c^2 &= a^2 + b^2 - 2ab\cos C \\ &= 4^2 + 10^2 - 2\times4\times10\cos130^\circ \\ &= 116-(-51.42) \\ &= 167.42 \\ c &= \sqrt{167.42} \\ &= 12.94 \end{aligned}$$

2	D	$u_y = u\sin\theta = 80\sin 30^\circ = 40\,m\,s^{-1}$ $s_y = u_y t + \frac{1}{2}gt^2$ $0 = 40t + \frac{1}{2}(-9.8)t^2$ $-40t = \frac{1}{2}(-9.8)t^2$ $40 = 4.9t$ $t = \frac{40}{4.9} = 8.16\,s$ $\approx 8\,s$
3	C	The normal force is F_N 
4	C	$v = \frac{s}{t} = \frac{\text{circumference}}{\text{time for one revolution}} = \frac{2\pi r}{T}$
5	D	$g_E = \frac{GM_E}{r_E{}^2}$ $g_E = g_P$ $\frac{GM_E}{r_E{}^2} = \frac{G\times M_P}{r_P{}^2}$ $\frac{GM_E}{r_E{}^2} = \frac{G\times 4M_E}{r_P{}^2}$ $\frac{1}{r_E{}^2} = \frac{4}{r_P{}^2}$ $r_P{}^2 = 4r_E{}^2$ $r_P = \sqrt{4r_E{}^2}$ $= 2r_E$
6	D	Option (D) is correct statement of Kepler's 2nd law. Option (B) is Kepler's 3rd law, and Option (C) is Kepler's 1st law.

7	D	$\frac{1}{4\pi\varepsilon_0} = 9\times10^9\, N\, m^2\, C^{-2}$ $\varepsilon_0 = \frac{1}{4\pi\times9\times10^9\, N\, m^2\, C^{-2}}$ $= 8.8\times10^{-12}(N\, m^2\, C^{-2})^{-1}$ $= 8.8\times10^{-12}\, N^{-1}\, m^{-2}\, C^2$ $= 8.8\times10^{-12}\,(magnitude)$
8	B	$\lvert E_{PQ_1}\rvert = \lvert E_{PQ_2}\rvert$ $\frac{kQ_1}{x^2} = \frac{kQ_2}{(2.0+x)^2}$ $\frac{k\times2\times10^{-6}}{x^2} = \frac{k\times18\times10^{-6}}{(2.0+x)^2}$ $\frac{2}{x^2} = \frac{18}{(2.0+x)^2}$ $\frac{(2.0+x)^2}{x^2} = \frac{18}{2} = 9$ $\sqrt{\frac{(2.0+x)^2}{x^2}} = \sqrt{9}$ $\frac{2.0+x}{x} = 3$ $2.0+x = 3x$ $2.0 = 3x - x$ $x = 1.0$
9	A	The electron is negative so will move upwards due to the electric field (repelled by the bottom plate). To keep it moving straight a magnetic field will need to provide a force on the electron moving down the page. Using Fleming's **left-hand** rule. Force (thumb) is down the page; Current I (middle finger) points towards the left. This is because it is a negative charge so the direction of the (positive) current can be thought of as moving in the opposite direction to the (negative) electron motion. The result is that B (index finger) points into the page.
10	A	**As the N-pole approaches:** a N-pole will be induced at the top of the solenoid to repel the incoming magnet (Lenz's law). To determine the direction of current you should use Ampere's **right-hand** rule for solenoids: put your thumb in direction of the magnetic field (up the page as above the top loop of the solenoid is North, the field points away from the North which is upwards). Your fingers will curl in an anti-clockwise direction around the top loop which shows that current flows into of X and through the resistor to Y. Hence, current flows from **X to Y through the resistor**. (continued next page)

		As the top of the magnet (S-pole) departs the bottom of the solenoid: : a N-pole will be induced at the bottom of the solenoid to attract the S-pole of the departing magnet (Lenz's law). To determine the direction of current you should use Ampere's right hand rule for solenoids: put your thumb in direction of the magnetic field (down the page as below the bottom loop of the solenoid is North, the field points away from the North which is downwards). Your fingers will curl in a clockwise direction around the bottom loop which shows that current flows into Y and through the resistor to X. Hence, current flows from **Y to X through the resistor**. Whew, that's a lot for 1 mark.
11	C	$t_0 = 26ns$ $v = 0.98c$ $t = \frac{t_0}{\sqrt{1-(v/c)^2}}$ $= \frac{26}{\sqrt{1-(0.98)^2}} = \frac{26}{\sqrt{0.0396}} = \frac{26}{0.20}$ $= 130ns$
12	D	To measure proper time for the light pulse travelling between two points, the start and finish of its journey have to be at rest to one another. To observers in both spaceships the start and finish of the journey is not in the same frame of reference. The light pulse starts in Castor and finishes in Pollux and they are moving relative to each other. Likewise, observers at rest to the fixed stars would see the start in a moving frame of reference (Castor) and the finish in a moving frame of reference (Pollux). Answer is that neither would measure proper time.
13	C	In Newtonian physics, the time is just the rest time interval (proper time interval, t_0). $v = 0.9c$ $t_0 = 4.86y$ $t = t_0\sqrt{1-(v/c)^2}$ $= 4.86\sqrt{1-(0.9)^2}$ $= 4.86 \times \sqrt{0.19}$ $= 2.12y$
14	A	$\Delta E = 334kJ = 334 \times 10^3 J$ $\Delta E = \Delta mc^2$ $\Delta m = \frac{\Delta E}{c^2}$ $= \frac{334 \times 10^3}{(3 \times 10^8)^2}$

15	A	$E_{K(\max)} = hf - W$ $= 5.3eV - 3.3eV$ $= 2.0eV$ $= 2.0eV \times 1.6 \times 10^{-19} J/eV$ $= 2.0 \times 1.6 \times 10^{-19} J$
16	B	$E = 4.2eV = 4.2eV \times 1.6 \times 10^{-19} J/eV = 6.72 \times 10^{-19} J$ $E = hf = \frac{hc}{\lambda}$ $\lambda = \frac{hc}{E}$ $= \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{6.72 \times 10^{-19}}$ $= 2.96 \times 10^{-7} m$ $\lambda = \frac{h}{p}$ $p = \frac{h}{\lambda} = \frac{6.626 \times 10^{-34}}{2.96 \times 10^{-7} m}$ $= 2.24 \times 10^{-27} kg\, m\, s^{-1}$ *Alternatively* $\lambda = \frac{hc}{E}$ and $\lambda = \frac{h}{p}$ $\frac{c}{E} = \frac{1}{p}$ $p = \frac{E}{c} = \frac{6.72 \times 10^{-19}}{3 \times 10^{8}} =$ $= 2.24 \times 10^{-27} kg\, m\, s^{-1}$
17	A	$\lambda_e = \frac{h}{m_e v_e} = \frac{6.626 \times 10^{-34}}{9.109 \times 10^{-31} \times 2 \times 10^{8}} = 3.6 \times 10^{-12} m$ Assume cricket ball to have a mass of about 0.15 kg $\lambda_{cb} = \frac{h}{m_{cb} v_{cb}} = \frac{6.626 \times 10^{-34}}{0.15 \times 20} = 2.2 \times 10^{-34} m$ $3.6 \times 10^{-12} m > 2.2 \times 10^{-34} m$ *Thus*, $\lambda_e > \lambda_{cb}$

18	B	Gluon is the force particle between quarks in a nucleus. A lepton such as an electron orbits the nucleus.
19	C	Option (C) has four quarks. Option (A) has a muon which is not a quark. Option (B) has a tau which is a lepton. Option (D) has a muon (a lepton), a boson (a force particle), a meson (a quark/antiquark pair), and a gluon (a gauge boson).
20	C	Option (C) has turned all particles to antiparticles on the opposite side, and all antiparticles to particles on the opposite side. Option A has turned the electron neutrino to an electron antineutrino and the muon antineutrino to a muon neutrino but has left them on the original side. Option (B) has jst turned the muon to an antimuon on the opposite side but left the rest as is. Option (D) has a mixture of incorrect symbols.