Practice exam answers Units 1&2. Worked solutions to the multiple choice questions.

Note: this is the test from the obook. It is not the Unit 1 Practice Exam located on page 269-269 of the Student Book, nor the Unit 2 Practice Exam located on page 472-473 of the Student Book.

Q	Ans	Explanation
1	B	They are all SI units but by definition, only kilogram, seconds, and ampere from the list are. See Table 1 page 7 NCPQ U1&2.
2	C	The average KE is constant at a particular temperature, but individual molecules can change KE when they collide.
3	A	$-Q_{lost\,by\,metal} = Q_{gained\,by\,water}$ $-m_m c_m \Delta T_m = m_w c_w \Delta T_w$ $-50\times10^{-3}\times c_m \times(T_f - T_i) = 40\times10^{-3}\times4180\times(T_f - T_i)$ $-50\times c_m\times(30-95) = 40\times4180\times(30-25)$ $3250\times c_m = 836000$ $c_m = \frac{836000}{3250}$ $= 257\,J\,kg^{-1}K^{-1}$
4	C	$\Delta U = Q + W$ $= (Q_{in} - Q_{out}) + (W_{in} - W_{out})$ $= (50-10)+(6-25)$ $= 40 + (-19)$ $= +21J$
5	C	Nucleons are protons or neutrons. The mass number (top number) is the sum of protons and neutrons and equals 22.
6	B	The equation is supposed to be ${}^{24}_{13}\mathrm{Al} \rightarrow {}^{24}_{12}\mathrm{Mg} + {}^{0}_{+1}e + \nu_e$ but there is a typo in the first symbol. The mass number should be 24 not 23, and there should not be any 4 in front of the Al. We can eliminate (D) as it is the decay of magnesium. We can eliminate (C) as it is a beta negative ${}^{0}_{-1}e$ decay. Option (A) is wrong as it has an electron antineutrino as a product whereas it should be an electron neutrino. Option (B) is correct if that mistake is fixed.
7	C	The simplest way for this question is to count the number of half-lives that pass in going from 2400 Bq to 75 Bq: $2400 \xrightarrow{1} 1200 \xrightarrow{2} 600 \xrightarrow{3} 300 \xrightarrow{4} 150 \xrightarrow{5} 75$ That's 5 half-lives in 13 minutes 40 s (13 × 60 + 40 = 820 s). The time for one half-life is 820/5 = 164 s. Alternatively, if there are not an integer number of half lives:

		$N = N_0(\tfrac{1}{2})^n$ $A = A_0(\tfrac{1}{2})^n$ [as $A \propto N$] $75 = 2400(\tfrac{1}{2})^n$ $\frac{75}{2400} = (\tfrac{1}{2})^n$ $\ln\frac{75}{2400} = n \times \ln(\tfrac{1}{2})$ $-3.47 = n \times -0.693$ $n = \frac{3.47}{0.693} = 5.0\,half\ lives$ $t_{1/2} = \frac{(13 \times 60 + 40)}{5.0} = 164\,s$ Alternatively: $N = N_0(\tfrac{1}{2})^n$ $A = A_0(\tfrac{1}{2})^n$ [as $A \propto N$] $n = \log_{\frac{1}{2}}\left(\frac{A}{A_0}\right)$ [change of base rule] $= \log_{\frac{1}{2}}\left(\frac{75}{2400}\right)$ $= 5.0\,half\ lives$ *...and so on*
8	A	$m({}^1_1H) = 1.007825u$ $m({}^7_3Li) = 7.016003u$ $m_R = 1.007825 + 7.016003 = 8.023828u$ $m({}^4_2He) = 2 \times 4.002603u = 8.005206u$ $\Delta m = m_P - m_R = 8.005206 - 8.023828 = -0.018622u$ $mass\ defect = 0.018622u$ Mass defect is negative, so the products are lighter than the reactants, so mass is 'lost' and therefore energy is **released**. The amount of energy released can be calculated from Einstein's equation even though you haven't been asked for it. It is in the answer by mistake. $\Delta E = \Delta mc^2$ $= 0.018622u \times 1.66 \times 10^{-27} kg/u \times (3 \times 10^8)^2$ $= 2.78 \times 10^{-12} J$
9	B	$n = \frac{Q}{q_e} = \frac{10 \times 10^{-6}}{1.6 \times 10^{-19}} = 6.25 \times 10^{13}$

10	D	R=V/I = 8.0/(2.0 × 10^{-3}) = 4000 Ω
11	D	Firstly, calculate the voltage across the 6 Ω resistor: V = IR = 2 × 6 = 12 V This is the same voltage across the 2 Ω resistor. The current through the 2 Ω resistor is I = V/R = 12/2 = 6 A. The total current is 2 A + 6 A = 8 A. The voltage across the 3 Ω resistor is V = IR = 8 × 3 = 24 V. The total voltage drop across the whole circuit is 12 V + 24 V = 36 V.
12	C	P = VI = V^2/R = 12^2/10 = 14.4 W W = Pt = 14.4 × (3 × 60) = 2592 J
13	A	distance = area under a v/t graph = (4 × 2)/2 + 4 × 4 + (4 × 4)/2 = 4 + 16 = 8 = 28 m
14	A not B	In free fall, displacement varies with time squared (s = ut +1/2 at^2) so an s vs t graph will have the shape of a y ∝ x^2 and curve upwards. This could be graphs A or D. We can eliminate graphs B and C. However, because of air resistance the ball's initial acceleration (9.8 ms^{-2}) will then slows to zero as it reaches a constant velocity. A constant velocity on an s/t graph is a straight line. We can rule out graph D. The answer is graph A.
15	B	$F_{net} = ma = 20 \times 5 = 100N$ $\overline{F}_{net} = \overline{F}_{applied} + \overline{F}_f$ $100 = 250 + \overline{F}_f$ $\overline{F}_f = 100 - 250 = -150\,N$
16	C	In an elastic collision kinetic energy is conserved. The total KE is given by: $E_{k(total)} = \frac{1}{2}mv^2 + \frac{1}{2}m(-v)^2 = mv^2$ After the collision the total KE will be the same (= mv^2)
17	B	$\Delta E_P = \Delta E_K$ $mgh = \frac{1}{2}mv^2$ $gh = \frac{1}{2}v^2$ $v = \sqrt{2gh}$ $= \sqrt{2 \times 9.8 \times 0.15}$ $= \sqrt{2.94}$ $= 1.71\,m\,s^{-1}$
18	C	PR is one wavelength from crest to the next successive crest of the travelling wave (eg the solid line, or the dotted line). It is not from the crest of the standing wave to the next crest of the standing wave (which would be PQ). Points P and R are in phase as they both rise and all in unison (together). We would say P and Q are one-half a wavelength out of phase.
19	B	This is the definition of 'period'. See page 383 NCPQ U1 & 2 SB.
20	C	v_{sound} = 331 + 0.6 × 20 = 343 m s^{-1} v = fλ λ = v/f = 342/27.5 = 12.47 m

21	A	$v = f\lambda$ $200 = f \times 2.0$ $f = 100$ Hz Strings produce all harmonics, so the next harmonic f_2 will be $2 \times f_1 = 2 \times 100$ Hz = 200 Hz Alternatively, the length and velocity are constant so: $L_{string} = \frac{n\lambda}{2} = \frac{nv}{2f}$ $\frac{n_1 v}{2f_1} = \frac{n_2 v}{2f_2}$ $\frac{1v}{2f_1} = \frac{2v}{2f_2}$ $\frac{1}{2f_1} = \frac{1}{f_2}$ $f_2 = 2f_1$ $= 2 \times 100$ $= 200Hz$
22	D	$n_1 \sin\theta_1 = n_2 \sin\theta_2$ $n_x \sin 30^\circ = 1.33 \times \sin 45^\circ$ $n_x = \frac{9.40}{0.5} = 1.88$
23	D	All three forms can. You may have seen interference of light when you looked at a laser shone through a thin slit or diffraction grating and got bright and dark bands on a screen. You may have seen a demonstration of interference of water waves when a barrier with two openings was place in a ripple tank of water and you got lines of maximum and minimum amplitudes; and you may have seen interference of sound when you investigated resonance of sound in a closed tube.