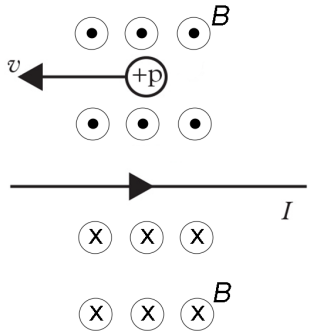
New Century Physics for Queensland (3rd ed, 2019) – Oxford University Press.

Cumulative test answers for Unit 3

Explanations for the answers to the multiple choice questions.

By Dr Richard Walding

Q	Ans	Explanations
1	A	Complementary elevation angles give the same horizontal range (in the absence of air resistance). Complementary angles are a pair that add to 90°. Option A (30/60) is correct. The others do not add to 90°.
2	D	Vertical displacement on impact is -45 m. $s_y = u_y t + \frac{1}{2} g t^2$ $-45 = 0 + -4.9t^2$ $t^2 = \frac{45}{4.9} = 9.18$ $t = 3.0\,s$ $s_x = v_x t$ $60 = v_x \times 3.0$ $v_x = \frac{60}{3.0} = 20\,m\,s^{-1}\,(D)$
3	B	It is frictionless so the only force acting parallel to the inclined plane is the parallel component of its weight down the incline (F_P = mg sinθ). This will be the net force parallel to the inlcine and thus equal to m x a. $F_{net} = F_P = mg\sin\theta$ $ma = mg\sin\theta$ $4.0 \times 4.90 = 4.0 \times 9.8 \times \sin\theta$ $19.6 = 39.2 \times \sin\theta$ $\sin\theta = \frac{19.6}{39.2} = 0.5$ $\theta = \sin^{-1} 0.5$ $= 30^\circ$ You could of course cancel down in line 2 of the solution but I've shown it here to make it clear.
4	C	There is no change in acceleration as the changes cancel out: $a_1 = \frac{v_1^2}{r_1}$ $a_2 = \frac{v_2^2}{r_2} = \frac{(2v_1)^2}{4r_1} = \frac{4v_1^2}{4r_1} = \frac{v_1^2}{r_1} = a_1$

5	A	$F = \frac{GMm}{r^2} = \frac{6.67\times10^{-11}\times100\times100}{100^2}$ $= 6.67\times10^{-11}\,N$
6	B	$F = \frac{kQ_1Q_2}{r^2}$ [where $k = \frac{1}{4\pi\varepsilon_0} = 9\times10^9$] $F_{final} = \frac{k(2Q_1)(3Q_2)}{r^2} = \frac{kQ_1Q_2}{r^2}\times6 = F\times6$
7	D	$F_{Q1\ due\ to\ q} = \frac{kQ_1q}{r^2} = \frac{9\times10^9\times40\times10^{-6}\times40\times10^{-6}}{2.0^2}$ $= \frac{14.4}{4.0}$ $= 3.6\,N$
8	A	The magnetic field about the wire can be shown to be out of the page above the wire, and into the page below the wire (using Ampere's right hand rule).  Using Fleming's left hand rule you can work out the force on the proton. B(index finger) is out of the page, I (middle finger) is to the left in the direction of v (west), and F (thumb) points up the page (that is, north). Answer (A), north.
9	B	$\phi = BA_{\perp} = 2\times(0.2\times0.5) = 0.2\,Wb$
10	A	As the strength of the field is increasing, by Lenz's law a current will be induced in the loop to oppose this increase. Thus, a field will be produced facing down through the loop. To achieve this, a **clockwise** current is induced in the loop, which by Ampere's rule will produce a field pointing down.