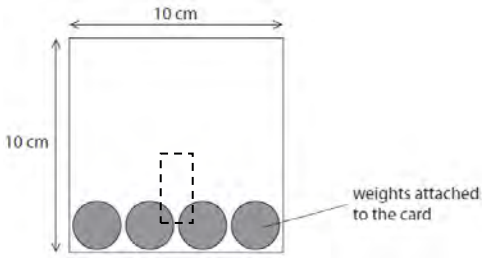
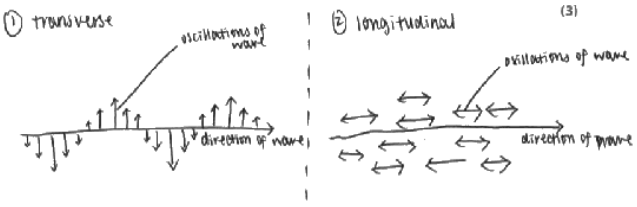
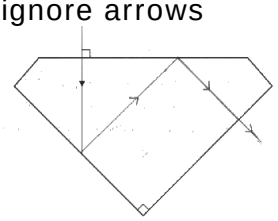
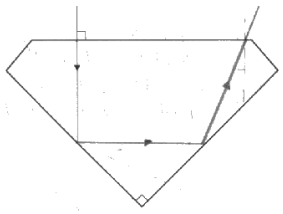
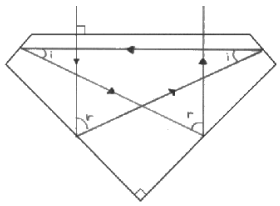
Question number	Answer	Notes	Marks
3 (a)	X drawn at the horizontal centre AND <u>below</u> the vertical centre (by eye); i.e.  	allow any clear symbol in place of the X X must be in the area marked by the dashed lines	1
(b)	A – the final speed of the card; The only correct answer is A B is not correct because it's the independent variable C is not correct because it's a control variable D is not correct because it's a control variable		1
(c) (i)	correct value; given to 2 decimal places; e.g. 3.3966... 3.40	allow any value given to 2 d.p. 3.39 gains 1 mark only	2

(d)	vibrations / oscillations / disturbance; (are) parallel or perpendicular to direction of energy transfer / wave (travel/movement); correct identification of <u>both</u> types; e.g.  gets 3 marks	allow suitably labelled diagrams	3

Total for question 5 = 8 marks

Question number	Answer	Notes	Marks
6 (a)	MP1. any internal reflection at first surface; MP2. approximately correct angle of reflection at first surface; MP3. ray reflects from second surface and emerges parallel to incident ray (by eye);	ignore arrows  gets MP1 only  gets MP1 and MP2  gets MP1 and MP3	3
(b) (i)	sin(c) = 1/n;	allow in standard symbols or in words	1
(ii)	substitution; rearrangement; evaluation; e.g. sin(24°) = 1/n (n=) 1/sin(24°) (n =) 2.5	can be in either order (n =) 2.459, 2.46 condone 2.45	3
(c)	any sensible use; e.g. • optical fibres in {communication / sending information / decorative lamps} • endoscopes • safety reflector • prism in {binoculars / telescope / camera / periscope / rangefinder}	allow 'broadband' for communication allow described use of endoscope e.g. bicycle/car reflector, cat's eye	1

Total for question 6 = 8 marks

Question number	Answer	Notes	Marks
9 (a)	downward arrow labelled weight; upward arrow of equal length to downward arrow (by eye);	ignore starting position of arrows horizontal arrows allow <u>force</u> of gravity ignore label on upward force	2
(b) (i)	pressure difference = height x density x g	allow in standard symbols or in words e.g. $p = h \times \rho \times g$ condone d for density	1
(ii)	substitution; answer seen in pascals / conversion to kPa; e.g. (P =) 48 x 1030 x 10 (P =) 490 000 (Pa)	allow use of g=9.8 allow ÷1000 seen anywhere 1 mark max for RA allow 494 400, 500 000 (Pa)	2
(c) (i)	600 (kPa);	allow 594.4, 594, 590 (kPa) ecf from (b)(ii)	1
(ii)	substitution into $p_1V_1 = p_2V_2$; rearrangement; evaluation; e.g. $100 \times 24 = 600 \times V_2$ $V_2 = 100 \times 24 / 600$ (V_2 =) 4.0 (m^3)	ecf from (c)(i) -1 for POT error allow 2 marks max for use of 500 (kPa) as final pressure, giving 4.8 m^3 allow answers in range 4.0 - 4.1(m^3)	3

Total for question 9 = 9 marks

Question number	Answer	Notes	Marks
13 (a)	B – 143; The only correct answer is B A is not correct because it's the number of protons C is not correct because it's the number of nucleons D is not correct because it's the number of nucleons + protons		1
(b) (i)	1 mark for each correct label;; e.g. largest circle labelled as <u>parent</u> (nucleus) either second largest circle labelled as <u>daughter</u> (nucleus)		2
(ii)	MP1. more neutrons released (in fission); MP2. neutrons can be absorbed by other (uranium) nuclei; MP3. causing further fissions / splitting;	allow 2 / 3 neutrons released allow 'collides', 'hits', 'enters' for 'absorbed' allow 'process repeats'	3
(c)	absorb <u>neutrons</u>; to vary / control {rate of reaction / energy output};	allow slow down / speed up reaction allow 'prevent overheating' ignore 'stop reaction'	2