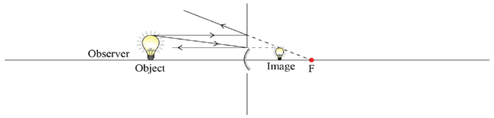
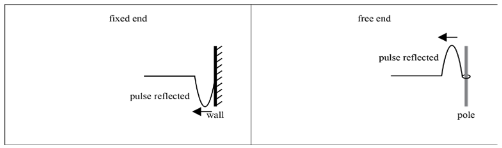
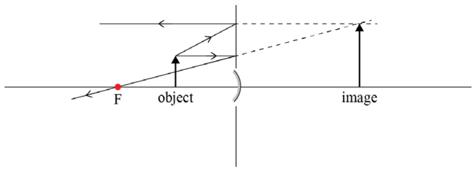
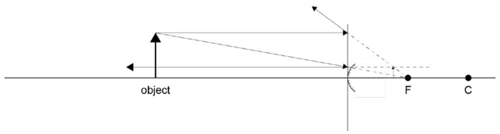
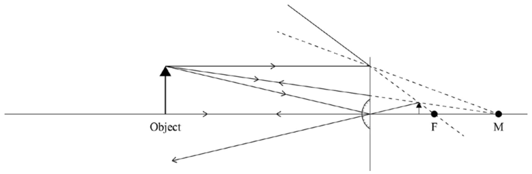
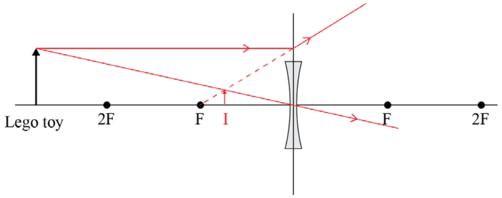
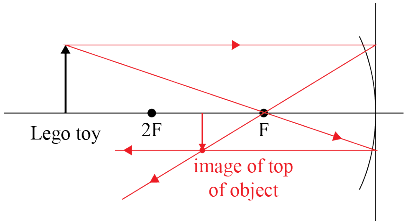
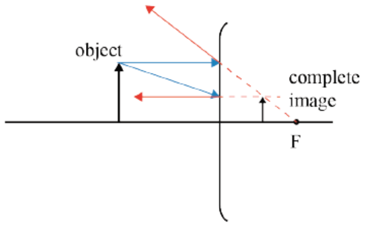
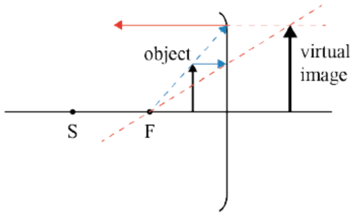
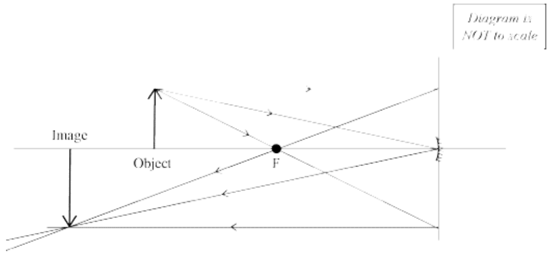
Level 2 Physics: Waves - Reflection - Answers

Question	**Evidence**	**Achievement**	**Merit**	**Excellence**
2022(3) (b)(i) (ii)	 Diminished, upright, virtual.	ONE of parts (i) and (ii).	BOTH of parts (i) and (ii).	
(c)		ONE correct phase. OR Wavelength.	BOTH correct phases and wavelengths.	
(d)(i) (ii) (iii)	 Object inside the focal point. Compared to a convex mirror, the virtual image is enlarged not diminished (both are upright / virtual).	ONE of parts (i), (ii), and (iii).	TWO of parts (i), (ii), and (iii).	All THREE.
2021(3) (a)	Diminished, upright, and virtual.	Correct answer.		

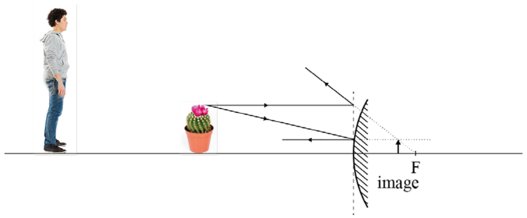
(b)	When the object is "far" away, concave mirrors will always form images that are: • inverted • diminished.	ONE bullet point.	BOTH bullet points.	
(c)		ONE correct ray	TWO correct rays and image drawn.	
(d)	$\frac{1}{f}=\frac{1}{d_i}+\frac{1}{d_o}\rightarrow\frac{1}{-20}=\frac{1}{d_i}+\frac{1}{500}$ $d_i=-19.2\text{ cm}$ $\text{Magnification}=\frac{d_i}{d_o}=\frac{19.2}{500}=0.038$ Height = $0.038\times1.5=0.057\text{ m}$ (OR 0.058 m – depends on rounding)	Recognises focal length is negative. OR Uses 20 to find d_i (20.8 cm).	Finds d_i = 19.2. OR Finds m using f = 20. (Consequential error M = 0.042, hi = 0.0625 m)	Complete answer.
2020(1) (a)		TWO rays correct.	TWO rays correct with arrows.AND Correct image.	
(b)	Upright, virtual, and diminished.	All THREE correct.		
(c)	Plane mirror will produce a virtual image that will be the same size. Concave mirror will produce a real image that is inverted and diminished.In both cases, the field of view is smaller than in the convex mirror. So, neither is suitable to see the whole pool.	TWO correct descriptions ofimages formed. OR ONE correct description and justification.	Correct descriptions AND explanation that the field of view will be less. Explanation of disadvantage of plane (smaller field of view), and concave (inverted image). So, neither is suitable.	

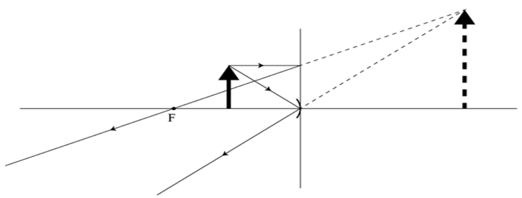
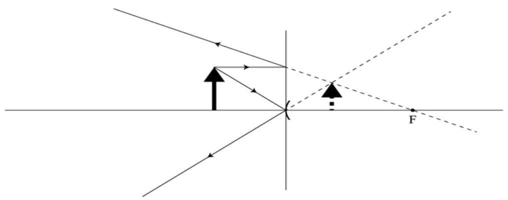
2019(1) (a)	Ray diagram completed.  Virtual image formed at I.	Image is virtual OR Any TWO rays drawn correctly.	Correct diagram, both rays and image identified as virtual.	
(b)	$d_o = 30$ cm, $h_i = 2$ cm, $h_o = 3$ cm Using $\frac{d_i}{d_o} = \frac{h_i}{h_o}$ $d_i = d_o \times \frac{h_i}{h_o}$ $d_i = 30 \times \frac{2}{3} = 20$ cm Substitute into: $\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o} = \frac{1}{20} + \frac{1}{30} = \frac{1}{12}$ $f = 12$ cm	d_i calculated or f found correctly from incorrect d_i.	Correct answer for both d_i and f.	
(c)(i) (ii)	Ray diagram drawn and arrows in place.  Image correctly drawn as real, inverted diminished. The effect of increasing the radius of curvature would be to increase the focal length, and so the image would form further away from the mirror.	TWO correct rays OR image correctly identified.	Part (i) OR Part (ii) correct.	Complete answer.

2018(1) (d)	A concave mirror would be needed. A concave mirror produces an upright magnified image, compared to a diminished upright image for a convex mirror and a plane mirror has a m = 1.   John's eye would need to be positioned within the focal length $d_o < f$. John's eye would need to be positioned as close to the focal point (but not at it) as possible. AND At this position, the reflected rays are nearly parallel, causing a large d_i, h_i. OR As d_o gets closer to f, from $d_i = \left(\frac{1}{f} - \frac{1}{d_0}\right)^{-1}$, d_i gets very large, causing the height of the image to be much larger.	Concave mirror stated.	Concave mirror stated correctly. AND Statement why concave mirror is better. OR $d_o < f$ OR A ray diagram showing object within focal point on a concave mirror. OR Largest image when d_0 is as close to f as possible.	Concave mirror, since it is the ONLY mirror that can produce an enlarged image AND $d_o < f$ AND Largest image when d_0 is as close to f as possible AND attempt at reason. (If one point missing, then max of E7.)

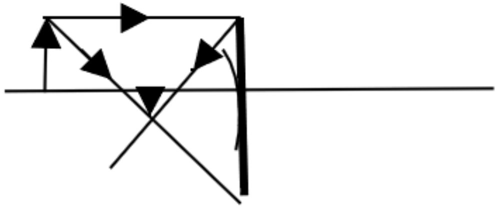
2017(1) (a)		Correct answer.		
(b)	$\frac{1}{d_i}+\frac{1}{d_o}=\frac{1}{f}$ $\frac{1}{d_i}+\frac{1}{140}=\frac{1}{80}$ $\frac{1}{d_i}=0.005357$ $d_i=187\text{ cm}$ $h_i=20\times\frac{187}{140}=26.7\text{ cm}$	Correct d_i. OR Uses $h_i=h_o\times\frac{d_i}{d_o}$ with incorrectly calculated d_i.	Correct height.	

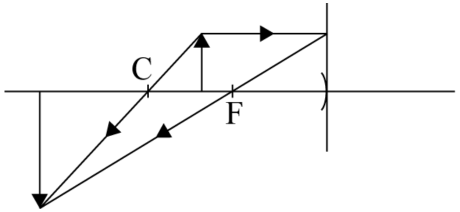
(c)	The image formed by the concave mirror is inverted, enlarged, and real. The image formed by the convex mirror is upright, diminished, and virtual. Convex mirrors are diverging mirrors, which means no real light rays intersect on the same side of the mirror as the light source. This means all images in a convex mirror are virtual. All virtual images are upright and diminished. The image formed by the convex mirror is diminished because (virtual) rays travel less before they appear to meet. A concave mirror is a converging mirror, which means real light rays will intersect (if the object is beyond the focal point), creating a real image which is inverted and enlarged. The image formed by concave mirror is enlarged because reflected rays travel longer before they meet (There are many more correct reasons for different aspects of the images.)	Two aspects of both types of mirror images are described. OR Two aspects of one type of mirror image are described, and the reason for one aspect is explained correctly. OR One aspect described for each type of mirror, and the reason explained correctly for each aspect.	Two aspects of both types of mirror images are described. AND One aspect of both types of mirror images is explained correctly.	

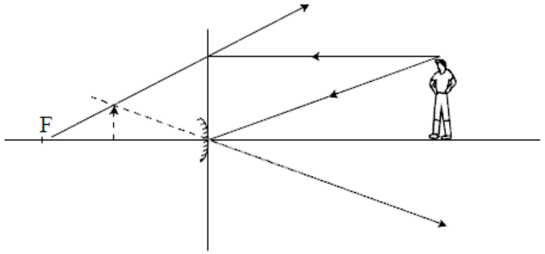
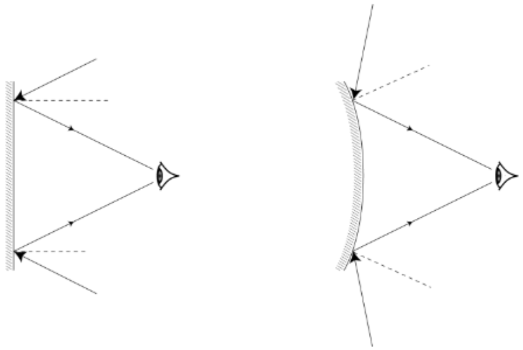
(d)(i) (ii)	The image distance is negative, as the image formed is virtual. The image is x 3, so the image distance is x 3 of the object distance from the mirror. Or mathematically: $m = \frac{d_i}{d_o} = \frac{h_i}{h_o} \rightarrow \frac{d_i}{d_o} = \frac{-60}{20} = -3 \text{ so } d_i = -3d_o$ $\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$ $\frac{1}{d_o} - \frac{1}{3d_o} = \frac{1}{80}$ $\frac{2}{3d_o} = \frac{1}{80}$ $d_o = 53.3 \text{ cm}$	The image is virtual. OR Image distance is negative. OR Idea that the magnification m = 3, so the image distance is x 3 of the object distance ($d_i = 3d_o$)	Idea that the magnification m = 3, so the image distance is x 3 of the object distance. AND The idea that the image distance is negative as the image formed is virtual. OR Missed negative sign with correct follow-on working, obtaining an answer of 107 cm.	Correct answer.
2016(1) (a)		Correct image position shown.		
2013(1) (a)	Focal point OR Principal focus.	Correct (focus, F)		
(b)(i) (ii)	Centre of curvature OR Radius. The ray is travelling along the normal so reflects back along the normal.	One part correct (C, centre)	Both correct	

(c)	$f = 25\text{ cm}$ $h_i = 2 \times h_o$ $\frac{d_i}{d_o} = \frac{h_i}{h_o} \therefore d_i = 2 \times d_o$ $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ $\frac{1}{25} = \frac{1}{d_o} + \frac{1}{2d_o} = \frac{3}{2d_o}$ $d_o = 37.5(38)\text{cm}$ $m = \frac{f}{S_0}$ $S_0 = \frac{25}{2}$ $= 12.5\text{ cm}$ $d_0 = f + S_0$ $= 25 + 12.5$ $= 37.5\text{ cm}$	Recognition of $d_i = 2d_o$ OR correct S_o	Correct except for one error.	Correct.
(d)	  Mirror 1 is concave. Mirror 2 is convex.	TWO identifications correct. OR ONE correct diagram and one correct identification if concave and convex wrong way round).	ONE correct diagram and ONE correct identification. OR TWO correct diagrams.	TWO correct diagrams and correct identification.

Question	Achievement	Merit	Excellence
2012(1) (a)(i)	Object positioned between mirror and F for concave mirror.	Rays drawn correctly to obtain enlarged virtual image for concave mirror.	
(ii)	Rays drawn correctly to obtain diminished upright virtual image.		
(b)	Any ONE of: Rays only appear to intersect to form image. OR Image is always upright. OR Image cannot be formed on a screen. OR Image is always behind the mirror.	Any TWO of: Rays only appear to intersect to form image. OR Image is always upright. OR Image cannot be formed on a screen. OR Image is always behind the mirror.	
(c)	$d_i = \left(-\frac{1}{6.0} - \frac{1}{4.5}\right)^{-1}$ OR Using S_o = 10.5 cm OR Using f = +6 giving h_i = 8 cm	$d_i = -2.57$ Correct substitution in Newton's formula, but incorrect answer	$h_i = \frac{2 \times 2.57}{4.5}$ $h_i = 1.14$ cm

Question	Evidence	Achievement	Merit	Excellence
2010(2) (b)		One ray drawn correctly including direction (arrow) OR image found correctly.	Image obtained correctly using 2 correct rays (arrows)	
(c)	$\frac{1}{f}=\frac{1}{d_o}+\frac{1}{d_i}$ $\frac{1}{3.6}=\frac{1}{12.5}+\frac{1}{d_i}$ $d_i = 5.056\text{ cm}$ $\frac{d_i}{d_o}=\frac{h_i}{h_o}$ $h_i = 1.62\text{ cm}$ OR Use Newton's formulae.	Correct formula and substitution to obtain image distance OR S_o = 8.9 cm	Image distance correct (d_i = 5.056 cm) OR M = 0.4045	Correct answer for h_i = 1.6 cm
(d)	When the pin is very close to the concave mirror, a virtual image is formed. The rays of light upon reflection in the mirror diverge and appear to meet at a point behind the mirror. This means that the image cannot be formed on a screen and is formed behind the mirror.	Idea of the image being virtual (Correct diagram + no words)	Plus The rays appear to meet behind the mirror OR Since the rays diverge on reflection.	Complete answer using words and/or diagram.
2009(1) (d)	Convex / diverging	Correct answer.		

(e)	$\frac{1}{f}=\frac{1}{d_o}+\frac{1}{d_i}$ $\frac{1}{-0.4}=\frac{1}{11}+\frac{1}{d_i}$ $\frac{1}{d_i}=-\frac{1}{11}-\frac{1}{0.4}$ $d_i=-0.386\ \text{m}$ $\frac{h_i}{h_o}=\frac{d_i}{d_o}$ $h_i=1.8\times\frac{0.386}{11}$ $h_i=0.063\ \text{m}$	Correct image distance except for sign.	Correct image distance including sign.	Correct answer for height of image.
2008(3) (a)	Concave mirror or converging mirror.	Correct answer.		
(b)		Any two correct rays AND object between F and C.	As for Achievement, plus correct object drawn in. Arrows on rays correct.	
(c)	$\frac{1}{d_o}=\frac{1}{f}-\frac{1}{d_i}$ $\frac{1}{d_o}=\frac{1}{24}-\frac{1}{60}$ $d_o=40\ \text{cm}$	Correct formula and substitution OR correct substitution.	Correct answer.	

2005(1) (a)		Two rays reflected correctly from the mirror. Arrows not required.	Achieved plus correct full image. Arrows required on rays.	
(b)	m = $\frac{0.6}{1.5}$ = 0.40 **or** $\frac{d_i}{d_o} = \frac{1.6}{4.1}$ = 0.39	0.4 + 0.1, or consistent with 1(a). Ignore negative sign on magnification.		
(c)	$d_o = 3$ m $f = -1.0$ m n.b. $S_i \times S_o = f^2$ $0.25 \times 4 = (1)^2$ $-1/1 = 1/3 + 1/d_i$ $d_i = -3/4$ distance = 3 m + 0.75 m = 3.75 m	Value of *f* calculated correctly. Negative sign not required.	Value of *di* calculated correctly. *Si*,(0.25) calculated correctly	Correct distance between Robbie and his image, correct unit.
(d)		Correct incident rays for both diagrams or correct explanation.	Correct incident rays and normals for both diagrams and correct explanation. Arrows not required.	

Level 2 Physics: AS 91170 replaced AS 90254.

The Mess that is NCEA Assessment Schedules….

In 90254, from 2004 to 2011, there was an Evidence column with the correct answer and Achieved, Merit and Excellence columns explaining the required level of performance to get that grade. Each part of the question (row in the Assessment Schedule) contributed a single grade in either Criteria 1 (Explain stuff) or Criteria 2 (Solve stuff). From 2003 to 2008, the NCEA shaded columns that were not relevant to that question (Sorry haven't had time to do 2004 yet).

In 91170, from 2012 onwards, the answers/required level of performance are now within the Achieved, Merit and Excellence columns. Each part of a question contributes to the overall Grade Score Marking of the question and there are no longer separate criteria. There is no shading anymore. At least their equation editor has stopped displaying random characters over the units.

And in 2013, with 91170, we are back to an Evidence column with the correct answer and Achieved, Merit and Excellence columns explaining the required level of performance to get that part. Each part of a question contributes to the overall Grade Score Marking of the question.