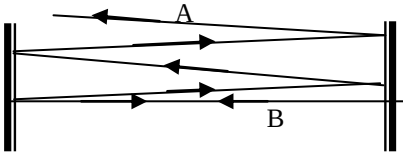
Question			Answers / Explanatory notes	Marks available
3	(a)		It provides energy to the amplifying medium [**not** energizing]	1
	(b)		 Either zig-zag rays drawn with arrows (A) , **or** back and forth rays with arrows (B) (1)	
			Statement that multiple reflections are required and that this only occurs for well-aligned rays. (1)	2
	(c)		Any 2 × 1 of: ▪ Reflections provide multiple passes for amplification ✓ ▪ One mirror transmits a little light (output beam) ✓ ▪ Produces standing wave **or** makes light monochromatic [not improve spectral purity] ✓	2
	(d)		Any 2 × 1 of: ▪ spontaneous – electron drops 'by itself' / randomly ✓ ▪ stimulated – electrons 'stimulated' to drop by photon [of the right energy] ✓ ▪ stimulated – 2 photons in phase ✓	2
	(e)		More electrons in higher state than in ground state (1) for stimulated emission to be more probable than absorption (1).	2
			[**or** conversely – before pop. inv. there are more e's in ground state – 1st mark by impl.]	
	(f)		Broader range of photons [or λ, E or f] or more colours can be absorbed [or provide pumping]	1
	(g)		Any 2 × 1 of: ▪ electrons drop quickly to metastable state ✓ ▪ electrons stay in metastable state for a long time ✓ ▪ F-levels don't become full ✓	2
	(h)	(i)	$I = I_0 \exp(\alpha x) = 1{\cdot}0255\times10^{-6}\,\text{Wm}^{-2}$ [accept 1·03, not 1·0]	1
		(ii)	$I = I_0 \exp(\alpha x) \times R_1R_2$ [or 0·98](1)	
			$=1{\cdot}005\times10^{-6}\text{Wm}^{-2}$ [e.c.f. on 1·03 etc](1)	2
		(iii)	Number of round trips $= \dfrac{10^{-6}}{1{\cdot}6\times10^{-9}} = 625$ [or equiv.](1)	
			$I = 1{\cdot}005^{625} I_0(1) \cong 23 I_0(1)$ [or 23 μW m^{-2}] [e.c.f.]	
			[accept: 0·005 × 625 (1) → 4·13 I_0 (1)]	3
		(iv)	2 × 1 sensible points: e.g. a limit to the number of energy levels / emissions; intensity is increasing by × 23 every μs [or exponentially, or very rapidly]; will melt, go out of control etc.	2
				[20]