Unit 3 Revision 2 Answers

EQP

10. A
11. D
12. C
13. E
15. E

4	a		$f = \frac{v}{\lambda}$ **(1)** $= \frac{3 \times 10^8}{656 \cdot 28 \times 10^{-9}}$ **(1)** $= 4 \cdot 57 \times 10^{14}$ (Hz) $E = hf$ **(1)** $= 4 \cdot 57 \times 10^{14} \times 6 \cdot 63 \times 10^{-34}$ **(1)** $= 3 \cdot 03 \times 10^{-19}$ (J) transition from E_3 to E_2 **(1)** or $E_3 \rightarrow E_2$ But **not:** E_3—E_2 **OR** $E_2 \rightarrow E_3$	**5**	**anywhere** **anywhere** **- this mark stands alone**
4	b	i	12 **days**	**1**	(**1**) or (**0**), no tolerance
4	b	ii	$z = \frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}}$ **(1)** $= \frac{656 \cdot 41 - 656 \cdot 28}{656 \cdot 28}$ **(1)** $= 1 \cdot 9809 \times 10^{-4}$ $v = cz$ **(1)** $= 3 \cdot 00 \times 10^8 \times 1 \cdot 98 \times 10^{-4}$ **(1)** $= 5 \cdot 94 \times 10^4$ ms^{-1} **(1)**	**5**	anywhere **must be 656·41** anywhere **accept**: 5·9, 5·943 or 5·9426 (plus units)
4	b	iii	blueshift is less than redshift **(1)** approach velocity is less **(1)**	**2**	independent marks **or "the difference in wavelength for approach is less than for recession"** **by calculation;** **(1) for magnitude of** less **(1) for *v* less** **(tolerate the dropping of the negative sign)**

5	a	$E_w = QV$ **(1)** $= 1{\cdot}60 \times 10^{-19} \times 55000$ **(1)** $= 8{\cdot}8 \times 10^{-15}$ J		2	**This is a** 'Show' question, so must state formula. Maximum of **(1)** if last line not shown.
5	b	Into the page or down/**downwards** **(1)**		1	**Do not accept "down the page".**
5	c	to ensure that the accelerating potential is in the correct direction for the particles motion **(1)** **OR** the direction of the force acting on the particle is reversed **(1)**		2	
6	a	waves *meet* out of phase or crest meets trough **(1)** or path difference $= (n + \frac{1}{2})\lambda$		1	Must have waves meeting/combining.
6	b	λ blue light is shorter (than λ red light) **(1)** and $n\lambda = d\sin\theta$ **(1)** **OR** $\sin\theta = \frac{n\lambda}{d}$		2	Explanation involving diffraction, 0 marks.
6	c	$n\lambda = d\sin\theta$ **(1)** $2 \times 4{\cdot}73 \times 10^{-7} = 2{\cdot}00 \times 10^{-6}\sin\theta$ **(1)** $\theta = 28{\cdot}2^\circ$ **(1)**		3	Accept 28, 28·23 and 28·229
8	a	$n = \frac{\sin\theta_1}{\sin\theta_2}$ **(1)** $1{\cdot}49 = \frac{\sin\theta_{air}}{\sin 19^\circ}$ **(1)** $\theta_{air} = 29^\circ$ **(1)**		3	
8	b	$n = \frac{1}{\sin\theta_c}$ **(1)** $1{\cdot}49 = \frac{1}{\sin\theta_c}$ **(1)** $\theta_c = 42{\cdot}2^\circ$ **(1)**		3	Accept 42, 42·16, 42·155
8	c	Different frequencies/colours are <u>refracted</u> through different angles **OR** The <u>refractive index</u> is different for different frequencies/colours **(1)**		1	**Do not accept: — "bending" on its own, but ignore it if follows "refraction".** **a correct answer followed by "diffract" or "defract", 0 marks.**
10	a	meson **(1)** quark/antiquark pair **(1)** **OR** made of 2 quarks		2	**must have "meson" before the second (1) can be awarded.**
10	b	$\pi^+ = u + \bar{d}$ $+1 = \frac{2}{3} + \bar{d}$ charge on anti-down $= +\frac{1}{3}$ **(1)**		1	
10	c	anti-up and down **(1)**		1	both required, **(1)** or **(0)** not "anti-anti-down"

10	d	$t' = \dfrac{t}{\sqrt{1-\dfrac{v^2}{c^2}}}$ (1) $= \dfrac{2{\cdot}6\times10^{-8}}{\sqrt{1-\dfrac{(0{\cdot}9c)^2}{c^2}}}$ (1) $= 6{\cdot}0\times10^{-8}$ s (1)	3	accept: 6×10^{-8} s $5{\cdot}96 \times 10^{-8}$ s $5{\cdot}965 \times 10^{-8}$ s
11	a	$E_k = hf - hf_0$ (1) $= \left(6{\cdot}63\times10^{-34} \times 6{\cdot}74\times10^{14}\right) - 3{\cdot}78\times10^{-19}$ (1) $= 6{\cdot}89\times10^{-20}$ J (1)	3	"$E = hf$" on its own (0) Accept: $6{\cdot}9 \times 10^{-20}$ J $6{\cdot}886 \times 10^{-20}$ J $6{\cdot}8862 \times 10^{-20}$ J Accept $6{\cdot}90\times10^{-20}$ J here ie using $E = hf$ $= 4{\cdot}47\times10^{-19}$ J
11	b	$E_k = \frac{1}{2}mv^2$ (1) $v^2 = \dfrac{2\times6{\cdot}89\times10^{-20}}{9{\cdot}11\times10^{-31}}$ (1) $v = 3{\cdot}89\times10^{5}$ ms^{-1} (1)	3	Or consistent with (a) **The max number of sig figs is five, but this depends on the candidate's substitution for *E*.**

SQP Rev H Amended

29	(*a*)	(i)	d = 1/200 × 1000 = 5×10^{-6} (m) n $\lambda = d \sin\theta$ $2 \times \lambda = 5 \times 10^{-6} \times \sin 11{\cdot}8$ $\lambda = 5{\cdot}11 \times 10^{-7}$ m	1 ½ ½ 1		3
		(ii)	Colour is green	1	Look up spectral line in data sheet	1
	(*b*)		Maxima are spaced further apart d and $\sin\theta$ are inversely proportional	1 1		2
	(*c*)		Dark lines are absorption lines caused by certain elements in sun absorbing particular frequencies	1 1		2

2013 Rev H

12. D

2014 Rev H

29.	**(a)**	$\sin\theta_1 / \sin\theta_2 = n$	(½)	this mark anywhere in part(a)	**2**
		$n = 1{\cdot}615$	(½)	this mark is awarded anywhere (e.g. the value might appear in the substitution)	
		$\sin\theta_1 / \sin 38° = 1{\cdot}615$	(½)	if there is a wrong value for n here, then max (½) for formula if it is shown (e.g. in first line of answer)	
		$\theta_1 = 83{\cdot}9°$	(½)	deduct (½) for wrong or missing units	
	(b)	Refractive index larger.	(½)	Must have v_g smaller, else **(0)** (You cannot justify a wrong answer)	**2**
		$v_{air} / v_{glass} = {}_a n_g$ **or** $n = v_1/v_2$ **or** "there is a greater decrease/change in speed"	(½)		**(2A)**
		$v_{(glass)}$ smaller	**(1)**	- look for this first - it stands alone Do not accept up and down arrows. If a candidate uses $v = f\lambda$ and says "v is smaller because is λ smaller and f is constant on refraction" – this is wrong Physics in this situation.	

2013 Rev H

10. C

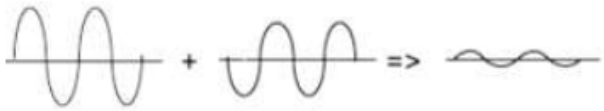
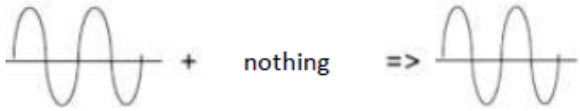
EQP

8	**a**	$n = \dfrac{\sin\theta_1}{\sin\theta_2}$	**(1)**		**3**
		$1{\cdot}49 = \dfrac{\sin\theta_{air}}{\sin 19^\circ}$	**(1)**		
		$\theta_{air} = 29^\circ$	**(1)**		
8	**b**	$n = \dfrac{1}{\sin\theta_c}$	**(1)**		**3**
		$1{\cdot}49 = \dfrac{1}{\sin\theta_c}$	**(1)**		
		$\theta_c = 42{\cdot}2^\circ$	**(1)**	Accept 42, 42·16, 42·155	
8	**c**	Different frequencies/colours are <u>refracted</u> through different angles **OR** The <u>refractive index</u> is different for different frequencies/colours **(1)**		**1**	**Do not accept: — "bending" on its own, but ignore it if follows "refraction".** **a correct answer followed by "diffract" or "defract", 0 marks.**

10	a	meson (1) quark/antiquark pair (1) **OR** made of 2 quarks		2	**must have "meson" before the second (1) can be awarded.**
10	b	$\pi^+ = u + \bar{d}$ $+1 = \frac{2}{3} + \bar{d}$ charge on anti-down $= +\frac{1}{3}$ (1)		1	
10	c	anti-up and down (1)		1	both required, (1) or (0) not "anti-anti-down"
10	d	$t' = \frac{t}{\sqrt{1-\frac{v^2}{c^2}}}$ (1) $= \frac{2{\cdot}6\times10^{-8}}{\sqrt{1-\frac{(0{\cdot}9c)^2}{c^2}}}$ (1) $= 6{\cdot}0\times10^{-8}$ s (1)		3	accept: 6×10^{-8} s $5{\cdot}96 \times 10^{-8}$ s $5{\cdot}965 \times 10^{-8}$ s
11	a	$E_k = hf - hf_0$ (1) $= \left(6{\cdot}63\times10^{-34} \times 6{\cdot}74\times10^{14}\right) - 3{\cdot}78\times10^{-19}$ (1) $= 6{\cdot}89\times10^{-20}$ J (1)		3	"$E = hf$" on its own (0) Accept: $6{\cdot}9 \times 10^{-20}$ J $6{\cdot}886 \times 10^{-20}$ J $6{\cdot}8862 \times 10^{-20}$ J Accept $6{\cdot}90\times10^{-20}$ J here ie using $E = hf$ $= 4{\cdot}47\times10^{-19}$ J
11	b	$E_k = \frac{1}{2}mv^2$ (1) $v^2 = \frac{2\times6{\cdot}89\times10^{-20}}{9{\cdot}11\times10^{-31}}$ (1) $v = 3{\cdot}89\times10^{5}$ ms^{-1} (1)		3	Or consistent with (a) **The max number of sig figs is five, but this depends on the candidate's substitution for *E*.**

2014 Rev H

28.	(a)	$d \sin\theta = m\lambda$ (½) $5{\cdot}0 \times 10^{-6} \sin\theta = 3 \times 589 \times 10^{-9}$ (½) $\theta = 21°$ (1)	deduct (½) for wrong or missing units	2	

(b)	**(i)**	Path difference = 500 − 425 Path difference = 75 mm **(½)** number of wavelengths 75/30 number of wavelengths 2·5 **(½)** Destructive interface **(1)** Look for this first – must be this (or a demonstrated arithmetic error) for any marks. A demonstrated arithmetic error could allow (1½) marks to be awarded.	If there is no calculation shown – no marks can be awarded. do not accept "a minimum" or 'deconstructive'. Must be 'destructive' to gain any marks (unless there is a demonstrated arithmetic error).	**2**
	(ii)	increases **(1)** (dest.) interference no longer occurs. **(1)** **OR** /'now only one set of waves, so they cannot cancel out'/suitable diagram e.g. before:  after:  	- look for this first There must be an attempt at a justification (and not wrong Physics) to get first mark.	**2** **(2A)**

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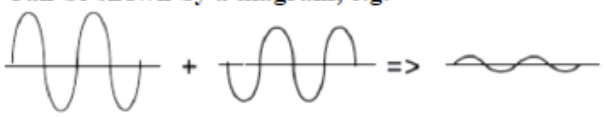
28.	**(a)(i)**	waves <u>meet</u> out of phase **OR** crests <u>meet</u> troughs **1** **superpose, overlap (must convey meeting of the waves)** **Can be shown by a diagram, e.g.** 		**1**
	(a)(ii)	Path diff = $m\lambda$ p.d. = $3 \times 28 \times 10^{-3}$ ½ p.d. = 84 (mm) ½ distance from S_2 to P = 620 + 84 S_2 to P = 704 mm **1**	**Can still get 1 mark for p.d. = 84 even when it is wrongly subtracted from 620.**	**2**

(b)(i)	$m\lambda = d\sin\theta$ ½ m x $420 \times 10^{-9} = 3{\cdot}27 \times 10^{-6} \times \sin 40$ ½ $m = 5$ 1 total no. of maxima = 5 above + 5 below + central = 11 1	Watch sub. of sin 40. sin 80 substituted gives $n = 7{\cdot}7$ **If any 'units' given, *deduct ½ mark***	**3+**
(b)(ii)	greater λ/wavelength ½ when λ increases ($\sin\theta$ and) θ increases ½ the number of visible maxima will decrease 1	No marks for a statement with no justification.	**2 (1A)**

2012 Rev H

26.	(a)	These particles cannot be broken down (into other sub-particles). (1)	Key point: it is not that they can be used to make bigger 'things', but rather that they are not made from smaller things.		1
	(b)	For the sigma plus particle $2 \times (+\frac{2}{3}) + q_s = +1$ $q_s = -\frac{1}{3}$ Charge on strange quark = $-\frac{1}{3}$ (1)			1
	(c)	Strong force (associated with the gluon) acts over a very short distance. (½) The gravitational force extends over very large/infinite distances. (½)			1 (1A)
	(d) (i)	(It is deflected) downwards (1)	Not "south".		1
	(ii)	Neutrons don't carry/have (net) charge (½) so cannot be accelerated/guided/ deflected by magnetic fields (½)			1
27.	(a)	$d\sin\theta = m\lambda$ (½) $d \times \sin 35{\cdot}3 = 3 \times 633 \times 10^{-9}$ (½) $d =$ **$3{\cdot}29 \times 10^{-6}$ m** (1)			2
	(b)	Number of lines per metre $= \frac{1}{3{\cdot}29 \times 10^{-5}}$ (½) **$= 3{\cdot}04 \times 10^{5}$** (½)	or consistent with answer to part (a)		1

		Substitution here must be to at least three significant figures				
	(c)	Difference = $(3{\cdot}04 - 3{\cdot}00) \times 10^5$ = $0{\cdot}04 \times 10^5$		If answer to (b) is wrong, but answer to (c) is consistent – full marks	2 (2A)
		Percentage difference = $\frac{0{\cdot}04 \times 10^5}{3{\cdot}00 \times 10^5} \times 100$	(½)	Could answer question by calculating 2% of $3{\cdot}00 \times 10^5$ and comparing	
		= 1·33%	(½)		
		Technician's value <u>does</u> agree	(1)		
29.	(a)	$n = \frac{\sin \theta_1}{\sin \theta_2}$	(½)		2
		$1{\cdot}33 = \frac{\sin X}{\sin 36}$	(½)	Accept 51·42, 51·4, 51 and 50° but 51·0° - (½) off	
		X = 51°	(1)	Degree symbol missing - (½) off	
	(b) (i)	Angle of <u>refraction</u> is 90° or <u>Refracted</u> ray makes an angle of 90° with normal or <u>Refracted</u> ray is along surface of water	1	"There is no refracted ray" – zero marks "Total internal reflection is about to take place" – zero marks	1
	(ii)	$\sin \theta_C = 1/n$	(½)		2
		= 1/1·33	(½)		
		θ_C = **49°**	(1)		