Farr High School

NATIONAL 5 PHYSICS

Unit 2
Waves and Radi

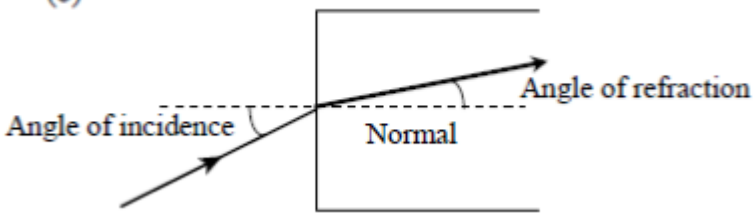
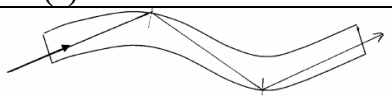
ANSWERS

Exam Questions

WAVE PARAMETERS AND BEHAVIOUR				
1		B	1	
2		FM waveband has short(er) wavelength (1) These radio waves do not diffract around hills (1)	2	First mark for describing FM as short(er) wavelength/higher frequency Second mark for indicating that short wavelength/higher frequency waves do not diffract as much. Answer can be given in the context of A and B. Do not accept: Waves "bend" These are **independent** marks. Candidates can still achieve (1) mark for correct description of long wavelengths/low frequencies diffracting. Answer can be given in the context of A and B.
3	(a)	1500 m s^{-1}	1	(1) OR (0) must show correct unit
	(b)	v = d/t (1) 1500 = 25/t (1) t = 0.0167 s (1) Total time = 2 x 0.0167 = 0.0334 s (1) Sig fig range 0.03, 0.033, 0.0333	4	Must use value for speed from (b)(i) OR correct value for speed of sound waves in water Multiplication by 2 can happen at any stage *check significant figures Check calculations to see if candidate has doubled distance at start or double time at end. This could have an impact on significant figure issues. Watch intermediate rounding issues (eg pupil may round to 0.02s x 2 = 0.04s) – this is acceptable
	(c) (i)	Time interval is unchanged	1	Any indication that changing the frequency has no effect on the time
	(ii)	Speed (of sound in water) is same/unchanged. Frequency has no effect (on the time taken for the wave to travel the 50m)	1	
4		V = f λ (1) 5200= 15 x 10^6 x λ (1) λ= 3·5 × 10^{-4} m (1)	3	sig. fig. range 1–4 3 × 10–^{4} m, 3·5 × 10^{-4} m 3·47 × 10^{-4} m, 3·467 × 10^{-4} m
5		C	1	
6	(a) (i)	v = f λ (1) f = 3 x 10^8/ 0.06 (1) = 5 × 10^9 Hz (1)	3	
	(ii)	T = 1/f (1) T = 1/5 x 10^9 (1) = 2 × 10^{-10} s (1)	3	
	(b)	Signals received at same time (1) Radio waves and microwaves have same speed (1)	2	
7	(a)	Energy (1)	1	
	(b)	d = vt (1) 1.5 x 10^{11} = 3 x 10^8 x t (1) t = 500 s (1)	3	
8		A (1)	1	
9		B (1)	1	

10	(a)	3×10^8 ms^{-1}	1	Unit required
	(b)	$\lambda = v/f$ (1) $= 3 \times 10^8/1900 \times 10^6$ (1) $= 0.16$m (1)	3	significant figure range: 0.2 0.16 0.158 0.1579
	(c)	$t = d/v$ $= 72000000/3 \times 10^8$ $=0.24$ s	3	
11	(a)	Surface waves	1	
	(b)	Longer wavelength	1	accept:bigger/larger/greater/higher/ large/high not: "wider", any answer based on frequency
	(c)	The radio waves are reflected by the ionosphere	1	accept: reflection, (total internal) reflection do not accept: "bounce (off ionosphere)", refraction
	(d)	mention of satellite (1) + any valid function of satellite (1) "signals transmitted back to Earth" "signals amplified/focussed" "signal frequency altered"	2	
12		$t = d/v$ (1) $= 6.8/340$ (1) (1) for data selection of 340 ms^{-1} $= 0.02$ s (1)	4	
13	(a)	1500 ms^{-1} (1)	1	
	(b)	$d = v \times t$ (1) $= 1500 \times 0{\cdot}36$ (1) $= 540$ (m) (1) So depth $= 540 \div 2$ $= 270$ m (1)	4	If correct speed (1500) is used in (c) but 2(b) is incorrect, can still get full marks. Note: 1 mark is allocated for division by two: the division of time or distance by two can occur at any point
14	(a) (i)	Q (1)	1	
	(a) (ii)	Q (1)	1	
	(b) (i)	$v = f\lambda$ (1) $340 = 2 \times 10^3 \times \lambda$ (1) $\lambda = 0{\cdot}17$ m (3)	3	
	(b) (ii)	$d = v\,t$ (1) $20.4 = 340 \times t$ (1) $t = 0{\cdot}06$ s (1)	3	
	(c)	Wavelength decreased (1) Speed of sound slower (1)	2	
15	(a)	$v = d/t$ (1) $340 = d/2\times10^{-3}$ (1) $d = 0{\cdot}68$ m (1) $\therefore d = 0{\cdot}34$ m one way (1)	4	
	(b)	$f = 1/T$ (1) $f = 1/0.125$ (1) $f = 8$ Hz (1)	3	

THE ELECTROMAGNETIC SPECTRUM				
1		Phototransistor/photodiode/CCD (1)	1	NOT thermometer/thermopile/ thermogram - not suitable for given context NOT Infra red camera OR Infra red detector
2	(a)	P = X-rays Q = Ultra violet/UV	1	
	(b)	(Black bulb) thermometer OR photodiode OR phototransistor (1)	1	Accept: • thermofilm • thermistor • thermopile • thermocouple • thermographic film • heat sensitive paper • IR film • CCD Do not accept: • skin • IR camera • photographic film • thermogram
3		B (1)	1	
4		A (1)	1	
5	(a)	• Radio (signals/waves) have a longer wavelength than television (signals/waves) (1) • Longer wavelengths diffract more (1)	2	Must mention both points for full marks If 'radio diffracts more than TV signals' only then (1) max.
	(b)	3×10^8 ms^{-1} (1) OR 3 000 000 000 ms^{-1}	1	Must have correct value and unit NOT: 'same as speed of light' alone
6		C (1)	1	
7	(a)	Infrared (1)	1	
	(b)	both arrive at the same time (1) both travel at the same speed (or speed of light or 3×10^8 m/s) (1)	2	
8		B (1)	1	

LIGHT				
1		E	1	
2		C	1	
3	(a)	Greater	1	Accept bigger, larger, longer but not higher
	(b) (i)	Correct drawing and change of direction (b)  	1	Arrows not required.
	(ii)	All 3 labels correctly shown	1	
4		B (1)	1	
5		C (1)	1	
6	(a)	59° (1)	1	
	(b)	40° (1)	1	
7	(a)	Total internal reflection (1)	1	
	(b)	Any angle <u>less than</u> 45° (1) Angle of incidence must be more than critical angle (1)	2	First mark only available if explanation attempted
8		C (1)	1	
9		E (1)	1	
10	(a)	 Ray must obey the law of reflection (1) Appropriate number of reflections (1) line not straight (-1)	2	
	(b)	(total internal) reflection (TIR) (1)	1	

NUCLEAR RADIATION				
1	(a) (i)A	Diagram 2 (represents ionized atom)	1	
	(i)B	An electron has been removed (from the atom)	1	For this mark must explain that: Electron has been removed OR Fewer electrons **than protons**
	(ii)	Alpha (accept symbol α)	1	Accept: • Wash hands • Do not eat • Wear protective clothing • Use shielding • Return to container as soon as demo is • finished Or other *suitable* alternative
	(b)	Use forceps/don't point at eyes/wear gloves etc	1	
	(c) (i)	Instrument sterilisation/treatment of cancer	1	
	(ii)	Beta (radiation) (accept symbol β)	1	
2		C	1	
3		D	1	
4		A	1	
5	(a)	The radiation detector would detect a higher level of radiation OR count rate would be higher where there was a crack in the aircraft	1	Some indication that there would be an **increase** in the reading on the detector.
	(b) (i)	Time taken for the (radio) **activity** (of a radioactive source) to reduce by half.	1	Do not accept: Time for radiation/count rate to half.
	(ii)	Source Y (1) gamma can penetrate through the metal aircraft (1) Long half life (1).	3	Y only acceptable answer. Additional (1) marks can only be obtained if Y is selected.
	(c)	Point away from face / people OR use tongs/ forceps OR Use lead (lined) aprons/gloves etc.	1	Accept: • Wash hands • Do not eat • Wear protective clothing • Goggles • Film badge to monitor exposure • Limit exposure time • Increased distance from source. • Return to container as soon as demo is finished Or any other *sensible* alternative NOT: • "Film badge" on its own • "wear gloves' or "gloves" alone
	(d)	48/12 = 4 (half lives) (1) 128 → 64 → 32 → 16 → 8 (MBq) (1) for halving (1) for final answer	3	Unit not required but deduct (1) if wrong unit given in final answer Halving process (1) mark is independent of the calculation of the number of half lives.

6	(a)	Any two correct count rate values from the graph, i.e. second = half of the first. (1) Half-life = 2 hours (1)	2	
	(b)	Any two valid answers. 2 x (1)	2	Weapons, atmosphere, rocks etc must be qualified in terms of radioactivity.
	(c)	A type of electromagnetic radiation / wave/ ray	1	Don't accept EM
7		$A = \frac{N}{t}$ (1) $= \frac{24{,}000}{(5 \times 60)}$ (1) = 80 Bq (1)	3	If time not/wrongly converted max (2)
8		C	1	
9		E	1	
10		E	1	
11		Time (hr) 0 6 12 18 Activity MBq 320 160 80 40 halving (1) halving activity 3 times (1) Answer = 40 MBq (1)	3	Accept other methods if correct Answer not made clear (– 1)
12	(a)	Fission	1	Accept induced fission Chain reaction 0 marks Must be spelt correctly
	(b)	P (slow) neutron Q (fissionable) nucleus R (fast) neutron S fission fragment/daughter product	2	Smaller nucleus
13		C	1	
14		A	1	
15		E	1	
16		C	1	
17		C	1	
18		E	1	
19		A	1	
20	(a)	A particle containing two protons and two neutrons OR A helium nucleus (1)	1	
	(b)	The gain/loss of electrons by an atom (1)	1	
	(c)	$4800 \xrightarrow{1} 2400 \xrightarrow{2} 1200 \xrightarrow{3} 600 \xrightarrow{4} 300$ or equivalent (1) $4 \times 2{\cdot}5 = 10$ hours (1)	2	
	(d)	A = N/t (1) N = 1200 × 2 × 60 (1) = 144,000 (decays) (1)	3	
	(e)	Source may also emit β and/or γ radiation (accept other valid non-standard answer eg neutrons, positrons) (1)	1	

VARIOUS				
1	(a) (ii)	3×10^8 m s^{-1} OR 3 00 000 000 m s^{-1}	1	Must have correct value and unit marks (1 or 0) NOT: 'same as speed of light' alone
	(ii)	d = v t (1) = 3 x 10^8 x 0.68 (1) = 20 400 000 m (1)	3	Must use value for speed from (a) OR correct value for speed of radio signals If *v* = 340, then *d* = 23·12 m
	(b)	$v = f\lambda$ **(1)** $3{\cdot}0 \times 10^8 = 2100 \times 10^6 \times \lambda$ **(1)** $\lambda = \frac{3{\cdot}0 \times 10^8}{2100 \times 10^6}$ $= 0{\cdot}14$ m **(1)**	3	Must use value for speed from (a) OR correct value for speed of radio signals Sig. fig range: 0·1, 0·14, 0·143, 0·1429 If *v* = 340, then λ = 1·62 × 10-7m
2	(a)	3 x 10^8 m s^{-1} OR 300 000 000 m s^{-1}	1	(1) OR (0) must show correct unit Do not accept: "The speed of light"
	(b)	$v = f\lambda$ (1) $3 \times 10^8 = 12 \times 10^9 \times \lambda$ (1) $\lambda = 0{\cdot}025$ m (1)	3	Must use value for speed from (a) OR correct value for speed of microwave signals deduct for wrong/missing unit (1) If v = 340, then λ = 2·83 × 10^{-8} m