

JABstem

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Past Papers

Nat 5

Physics




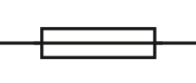

2022 Marking Scheme

Grade Awarded	Mark Required		% candidates achieving grade
	/125	%	
A	63+	63%	34.9%
B	51+	51%	20.9%
C	40+	40%	18.2%
D	28+	28%	14.5%
No award	<28	<28%	11.5%

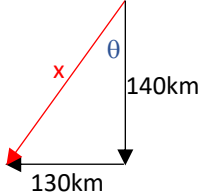
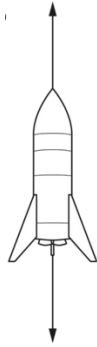
Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	14.7 /25	38.4 /75	No Assignment in 2022




2022 Nat5 Physics Marking Scheme

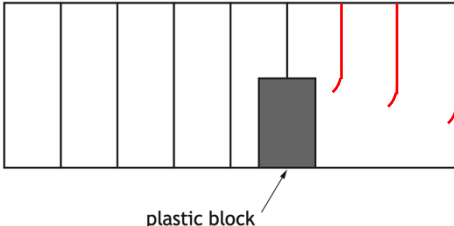
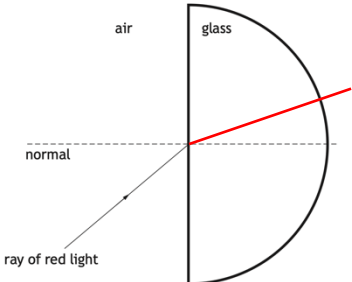
Question	Answer	Physics Covered					
1	E	Vector Quantity	force	velocity	displacement	acceleration	weight
		Scalar Quantity	energy	speed	distance	time	mass
2	C	<input checked="" type="checkbox"/> A Toy car must have velocity above zero at point P <input checked="" type="checkbox"/> B Toy car must have higher velocity at point Q than it had at point P <input checked="" type="checkbox"/> C Average speed of 1 m s^{-1} and 3 m s^{-1} is 2 m s^{-1} <input checked="" type="checkbox"/> D Average speed of 2 m s^{-1} and 3 m s^{-1} would be 2.5 m s^{-1} <input checked="" type="checkbox"/> E Average speed must be between 2 m s^{-1} and 3 m s^{-1}					
3	D						
		Area ①	Area ②	Area ③			
		Distance = area under graph $= \frac{1}{2} \times 8 \times 6$ $= 24 \text{ m}$	Distance = area under graph $= 8 \times 4$ $= 32 \text{ m}$	Distance = area under graph $= 12 \times 10$ $= 120 \text{ m}$			
		Total Distance = $24\text{m} + 32\text{m} + 120\text{m} = 176\text{m}$					
4	B	The rocket pushes down on the water and the water provides an equal but opposite reaction force due to. Newton's 3 rd Law.					
5	B	Gravitational Potential Energy at 4.0 m			Kinetic Energy at 4.0 m		
		$E_p = ?$ $m=0.25\text{kg}$ $g=9.8. \text{ N kg}^{-1}$ $h=6.0-4.0 = 2.0\text{m}$			Kinetic energy at 4.0m is gained from conversion of potential energy from 6.0m to 4.0m.		
		$E_p = m \quad g \quad h$			$E_k = 4.9 \text{ J}$		
		$E_p = 0.25 \times 9.8 \times 2.0$					
		$E_p = 4.9 \text{ J}$					
6	B	Statement I - Incorrect	Statement II - Correct		Statement III - Incorrect		
		There is gravity in space and it is dependent on the distance of the object from planet/moon	Astronauts fall to earth at same acceleration as their spacecraft giving the feeling of weightlessness.		Astronauts fall to earth at same acceleration as their spacecraft giving the feeling of weightlessness. Acceleration = unbalanced forces		
7	C	Longest → Shortest diameter of galaxy $>$ radius of orbit of Moon $>$ radius of Earth					
8	A	<input checked="" type="checkbox"/> A Period of orbits for X ,Y and Z increase in order. Z has a period of orbit of 24 hours <input checked="" type="checkbox"/> B if Z if geostationary then its period of orbit must be 24 hours. <input checked="" type="checkbox"/> C X and Y are closer to Earth than Z so must have period of orbits less than 24 hours <input checked="" type="checkbox"/> D X and Y are closer to Earth than Z so must have period of orbits less than 24 hours <input checked="" type="checkbox"/> E if Z if geostationary then its period of orbit must be 24 hours.					
9	A	<input checked="" type="checkbox"/> A R+S would slow spacecraft as force in in the opposite direction to direction of travel <input checked="" type="checkbox"/> B Q+S rockets would cancel each other out and would not change the speed <input checked="" type="checkbox"/> C P+Q would increase the speed of spacecraft in same direction of travel <input checked="" type="checkbox"/> D P+R rockets would cancel each other out and would not change the speed <input checked="" type="checkbox"/> E P+Q+R+S rockets would cancel each other out and would not change the speed					

10	D	Mass (kg)	Weight (N)	$g = \frac{W}{m}$	g	$W = m \times g$ $W = 6.0\text{kg} \times 8.8\text{N kg}^{-1}$ $W = 52.8\text{N}$
		0.50	4.4	$g = \frac{W}{m} = \frac{4.4}{0.50} =$	8.8	
		2.5	22	$g = \frac{W}{m} = \frac{22}{2.5} =$	8.8	
		4.0	35	$g = \frac{W}{m} = \frac{3.5}{4.0} =$	8.75	
11	C	Q = ?		I = 2.0 A	t = 5 minutes = 5x60 s	
				Q = I x t		
				Q = 2.0 x 5x60		
				Q = 600 C		
12	D	Statement I - Correct	Statement II - Incorrect	Statement III - Correct		
		The greater the gradient of a line on V-I graph the greater the resistance \therefore P has higher resistance than R	The greater the gradient of a line on V-I graph the greater the resistance \therefore R has <i>lower</i> resistance than Q	The gradient of line Q is decreasing as current increases \therefore The resistance of Q is decreasing as current increases		
13	E	<input checked="" type="checkbox"/> A Voltage is equal to the supply voltage in parallel circuit \therefore 12V in each branch <input checked="" type="checkbox"/> B Voltage is equal to the supply voltage in parallel circuit \therefore 12V in each branch <input checked="" type="checkbox"/> C Current splits in parallel branches current \therefore current at A ₁ is twice current at A ₂ <input checked="" type="checkbox"/> D Current splits in parallel branches current \therefore current at A ₁ is twice current at A ₂ <input checked="" type="checkbox"/> E Current at A ₁ is 0.6A, Current at A ₂ = 0.3A and Voltmeter voltage is 12V				
14	B	A	B	C	D	E
						
		Loudspeaker	Thermistor	Lamp	Fuse	LDR
15	D	Statement I - Incorrect	Statement II - Correct	Statement III - Correct		
		The higher the specific heat capacity the more heat is needed to raise the temperature of the solid. This means Y has the higher specific heat capacity.	The horizontal portion of the graph represents the change of state from solid to liquid. Line X has a higher horizontal line indicating a higher melting point.	The latent heat of fusion for X is greater than Y as the horizontal line is longer for X than Y indicating more energy is needed to melt X than Y		
16	D	E = ?		m = 1.6 kg	l = 3.34x10 ⁵ J kg ⁻¹	
				E = m x l		
				E = 1.6 x 3.34x10 ⁵		
				E = 5.3x10 ⁵ J		
17	E	W = ?		m = 70.0 kg	g = 9.8 N kg ⁻¹	
				W = m x g		
				W = 70.0 x 9.8		
				W = 686N		
		P = ?		F = 686N	A = 8.0x10 ⁻⁴ m ²	
				$P = \frac{F}{A} = \frac{686}{8.0 \times 10^{-4}} = 8.6 \times 10^5 \text{ Pa}$		
18	E	E _k = ?		k _B = 1.38x10 ⁻²³ J K ⁻¹	T = 100°C = 373K	
				$E_k = \frac{3}{2} k_B T$		
				$E_k = \frac{3}{2} \times 1.38 \times 10^{-23} \times 373$		
				E _k = 7.72x10 ⁻²¹ J		

19	A	<input checked="" type="checkbox"/> A sound waves are longitudinal waves with a speed of 340m s^{-1} in air <input checked="" type="checkbox"/> B radio waves are transverse waves with a speed of $3 \times 10^8\text{m s}^{-1}$ <input checked="" type="checkbox"/> C ultraviolet waves are transverse waves with a speed of $3 \times 10^8\text{m s}^{-1}$ <input checked="" type="checkbox"/> D infrared waves are transverse waves with a speed of $3 \times 10^8\text{m s}^{-1}$ <input checked="" type="checkbox"/> E visible light are transverse waves with a speed of $3 \times 10^8\text{m s}^{-1}$																																	
20	D	<table border="1" style="width: 100%;"> <thead> <tr> <th style="width: 50%;">Maximum wavelength</th> <th style="width: 50%;">Minimum Wavelength</th> </tr> </thead> <tbody> <tr> <td> $v = 3 \times 10^8\text{m s}^{-1}$ $f = 3.0\text{MHz} = 3.0 \times 10^6\text{Hz}$ $\lambda = ?$ $\lambda = \frac{v}{f} = \frac{3.0 \times 10^8}{3.0 \times 10^6} = 100\text{m}$ </td> <td> $v = 3 \times 10^8\text{m s}^{-1}$ $f = 6.0\text{MHz} = 6.0 \times 10^6\text{Hz}$ $\lambda = ?$ $\lambda = \frac{v}{f} = \frac{3.0 \times 10^8}{6.0 \times 10^6} = 50\text{m}$ </td> </tr> </tbody> </table>	Maximum wavelength	Minimum Wavelength	$v = 3 \times 10^8\text{m s}^{-1}$ $f = 3.0\text{MHz} = 3.0 \times 10^6\text{Hz}$ $\lambda = ?$ $\lambda = \frac{v}{f} = \frac{3.0 \times 10^8}{3.0 \times 10^6} = 100\text{m}$	$v = 3 \times 10^8\text{m s}^{-1}$ $f = 6.0\text{MHz} = 6.0 \times 10^6\text{Hz}$ $\lambda = ?$ $\lambda = \frac{v}{f} = \frac{3.0 \times 10^8}{6.0 \times 10^6} = 50\text{m}$																													
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21	C	<table border="1" style="width: 100%;"> <tr> <td rowspan="4" style="width: 40%; vertical-align: middle;">Infrared and ultraviolet should be the opposite sides of the visible light band</td> <td style="text-align: center;">EM Type</td> <td style="text-align: center;">Gamma</td> <td style="text-align: center;">X-Ray</td> <td style="text-align: center;">Ultra-violet</td> <td style="text-align: center;">Visible</td> <td style="text-align: center;">Infra-Red</td> <td style="text-align: center;">Microwave</td> <td style="text-align: center;">Radio & TV</td> </tr> <tr> <td style="text-align: center;">Energy</td> <td style="text-align: center;">High</td> <td style="text-align: center;">←</td> <td style="text-align: center;">→</td> <td style="text-align: center;">Low</td> <td colspan="3"></td> </tr> <tr> <td style="text-align: center;">Frequency</td> <td style="text-align: center;">High</td> <td style="text-align: center;">←</td> <td style="text-align: center;">→</td> <td style="text-align: center;">Low</td> <td colspan="3"></td> </tr> <tr> <td style="text-align: center;">Wavelength</td> <td style="text-align: center;">Low</td> <td style="text-align: center;">←</td> <td style="text-align: center;">→</td> <td style="text-align: center;">High</td> <td colspan="3"></td> </tr> </table>	Infrared and ultraviolet should be the opposite sides of the visible light band	EM Type	Gamma	X-Ray	Ultra-violet	Visible	Infra-Red	Microwave	Radio & TV	Energy	High	←	→	Low				Frequency	High	←	→	Low				Wavelength	Low	←	→	High			
Infrared and ultraviolet should be the opposite sides of the visible light band	EM Type	Gamma		X-Ray	Ultra-violet	Visible	Infra-Red	Microwave	Radio & TV																										
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22	E	10mm of aluminium will stop beta particles. There will be no beta particles at P or Q Alpha particles are stopped by 100mm aluminium in addition to a piece of paper. Only gamma is penetrating enough to pass through 10mm of aluminium.																																	
23	A	$A = \frac{N}{t} = \frac{3000}{2 \times 60} = 25\text{ Bq}$																																	
24	D	<input checked="" type="checkbox"/> A beta radiation would not be able to leave the body to get to the detector <input checked="" type="checkbox"/> B beta radiation would not be able to leave the body to get to the detector <input checked="" type="checkbox"/> C The half-life is too short and much of the substance will have decayed. <input checked="" type="checkbox"/> D Gamma is emitted and half-life is short so not much remains in the body for long <input checked="" type="checkbox"/> E The half-life is too long and the substance will remain in the body for many years.																																	
25	C	$\text{Number of lives} = \frac{\text{time elapsed}}{\text{half-life}} = \frac{120\text{s}}{30\text{s}} = 4$ $3200\text{ Bq} \rightarrow 1600\text{ Bq} \rightarrow 800\text{ Bq} \rightarrow 400\text{ Bq} \rightarrow 200\text{ Bq}$																																	

Question	Answer	Physics Covered						
1a(i)	190 km	 $x = \sqrt{(130)^2 + (140)^2}$ $x = \sqrt{16900 + 19600}$ $x = \sqrt{36500}$ $x = 190 \text{ km}$						
1a(ii)	223	$\tan \theta = \frac{\text{opp}}{\text{adj}} = \frac{130}{140} = 0.929 \quad \therefore \theta = 43^\circ$ $\text{Bearing} = 180^\circ + 43^\circ = 223$						
1b(i)	110 m s ⁻¹	$d = 190 \text{ km} = 190000\text{m}$ $d = \bar{v} \times t$ $190000 = \bar{v} \times 0.5 \times 60 \times 60$ $\bar{v} = 110 \text{ m s}^{-1}$						
1b(ii)	110 m s ⁻¹ at bearing 043	Velocity = 110 m s ⁻¹ Bearing from Glasgow to Aberdeen = 220 – 180 = 043						
2a(i)	Graph showing:	<table border="1" style="width:100%; text-align:center;"> <tr> <td style="width:33%;">1 mark</td> <td style="width:33%;">1 mark</td> <td style="width:33%;">1 mark</td> </tr> <tr> <td>suitable scales, labels and units</td> <td>all points plotted accurately to \pm half a division</td> <td>best fit straight line</td> </tr> </table>	1 mark	1 mark	1 mark	suitable scales, labels and units	all points plotted accurately to \pm half a division	best fit straight line
1 mark	1 mark	1 mark						
suitable scales, labels and units	all points plotted accurately to \pm half a division	best fit straight line						
2a(ii)	0.57m							
2a(iii)	One answer from:	<table border="1" style="width:100%; text-align:center;"> <tr> <td>Place carbon paper under landing site</td> <td>Place sand tray under landing site</td> <td>Use video analysis</td> </tr> </table>	Place carbon paper under landing site	Place sand tray under landing site	Use video analysis			
Place carbon paper under landing site	Place sand tray under landing site	Use video analysis						
2b(i)	Any suitable variable							
2b(ii)	Answer to include:	<table border="1" style="width:100%;"> <tr> <td style="width:10%;">1 mark</td> <td>Description of how independent variable will be changed.</td> </tr> <tr> <td>1 mark</td> <td>Indication of how a fair test is achieved.</td> </tr> </table>	1 mark	Description of how independent variable will be changed.	1 mark	Indication of how a fair test is achieved.		
1 mark	Description of how independent variable will be changed.							
1 mark	Indication of how a fair test is achieved.							
3a(i)	4.8x10 ⁶ N	$W = ?$ $m = 1.3 \times 10^6 \text{ kg}$ $g = 3.7 \text{ N kg}^{-1}$ $W = m \times g$ $W = 1.3 \times 10^6 \times 3.7$ $W = 4.8 \times 10^6 \text{ N}$						
3a(ii)	Two answers from:	<p><u>Direction Up</u> \uparrow One from:</p> <ul style="list-style-type: none"> thrust rocket thrust engine thrust <p>(1 mark)</p>  <p>(1 mark)</p> <p><u>Direction Up</u> \downarrow One from:</p> <ul style="list-style-type: none"> weight pull of gravity gravitational pull force due to gravity' force from exhaust gases on rocket 						
3a(iii)	5.5 m s ⁻²	$F_{\text{un}} = \text{engine thrust} - \text{weight}$ $F_{\text{un}} = 1.2 \times 10^7 - 4.8 \times 10^6$ $F_{\text{un}} = 7.2 \times 10^6 \text{ N}$ $F = m \times a$ $7.2 \times 10^6 = 1.3 \times 10^6 \times a$ $a = 5.5 \text{ m s}^{-2}$						

3b	Answer to include:	1 mark	Acceleration increases
		1 mark	Weight/mass decreases (as fuel is used) <u>or</u> Gravitational field strength decreases
4	Open ended question:	1 mark	2 marks
		Candidate has demonstrated a limited understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood at least a little of the physics within the problem.	Candidate has demonstrated a reasonable understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem.
		Candidate has demonstrated a good understanding of the physics involved. They show a good comprehension of the physics of the situation and provide a logically correct answer to the question posed. This type of response might include a statement of the principles involved, a relationship or an equation, and the application of these to respond to the problem. The answer does not need to be 'excellent' or 'complete' for the candidate to gain full marks.	
5a(i)	$8.1 \times 10^{18} \text{ m}$	$d = v \times t$ (1 mark)	
		$d = 3.0 \times 10^8 \times 860 \times 365.25 \times 24 \times 60 \times 60$ (1 mark)	
		$d = 8.1 \times 10^{18} \text{ m}$ (1 mark)	
5a(ii)	$1.5 \times 10^8 \text{ m s}^{-1}$	$5\% \text{ of } 3.0 \times 10^8 \text{ m s}^{-1} = \frac{5}{100} \times 3.0 \times 10^8 \text{ m s}^{-1} = 1.5 \times 10^7 \text{ m s}^{-1}$	
5a(iii)	$5.4 \times 10^{11} \text{ s}$	$d = v \times t$ (1 mark)	
		$8.1 \times 10^{18} = 1.5 \times 10^7 \times t$ (1 mark)	
		$t = 5.4 \times 10^{11} \text{ s}$ (1 mark)	
5b	One answer from:	The light/EM radiation from the supernova has <u>not</u> reached the Earth yet <u>or</u> The light EM radiation takes 860 years to reach Earth	
5c(i)	Line spectrum Or Adsorption Spectrum	Type of Spectra	Diagram
		Continuous Spectrum	
		Absorption Line Spectrum	
		Emission Line Spectrum	
		Description	Colour spectrum with no lines Colour Spectrum with black lines. At various points. Black background with coloured lines
5c(ii)	Answer to include:	Lines in this spectrum can be matched compared with lines in the spectrum from the element.	
6a	Answer to include:	1 mark	Resistor 1
		1 mark	Lower resistance (produces a larger current)
6b	1.2 V	$V_s = 6.0 \text{ V}$	$V_2 = ?$
		$R_1 = 16.0 \Omega$	$R_2 = 4.0 \Omega$
		$V_2 = \frac{R_2}{R_1 + R_2} \times V_s$ (1 mark)	
		$V_2 = \frac{4.0}{16.0 + 4.0} \times 6.0$ (1 mark)	
		$V_2 = 1.2 \text{ V}$ (1 mark)	
6c(i)	3.2Ω	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ (1 mark)	
		$\frac{1}{R_T} = \frac{1}{4.0} + \frac{1}{16.0}$ (1 mark)	
		$\frac{1}{R_T} = \frac{5}{16}$	
		$R_T = 3.2 \Omega$ (1 mark)	
6c(ii)	Answer to include:	1 mark	(Reading on ammeter) increases
		1 mark	Total resistance decreases
7a	3 A	Power Rating = $0.35 \text{ kW} = 350 \text{ W}$ <ul style="list-style-type: none"> Devices with a Power Rating of 720 W or below have a 3A fuse fitted Devices with a Power Rating above 720 W have a 13A fuse fitted. 	
7b	150Ω	$P = 0.35 \text{ kW} = 350 \text{ W}$	$V = 230 \text{ V}$
		$P = \frac{V^2}{R} \therefore 350 = \frac{(230)^2}{R} \therefore R = \frac{52900}{350} = 150 \Omega$	$R = ?$
		(1 mark)	(1 mark)

9d	Answer to include:	1 mark	(The increase in temperature) increases the kinetic energy of the gas particles/the particles move faster.		
		1 mark	The particles hit the tyre walls more frequently	or The particles hit the tyre walls with greater force.	
		1 mark	Pressure (in the tyre) increases		
10a(i)	0.020m	$\lambda = \frac{\text{Distance of waves}}{\text{Number of waves}} = \frac{0.12\text{m}}{6} = 0.020\text{m}$			
10a(ii)	15Hz	Number of waves N = 6	t = 0.40s	f = ?	
		$f = \frac{N}{t} = \frac{6}{0.4} = 15\text{Hz}$ (1 mark) (1mark)			
10a(iii)	0.3m s ⁻¹	v = ?	f = 15Hz	λ = 0.20m	
		$v = f \times \lambda$ (1mark)			
		$v = 15 \times 0.20$ (1mark)			
		$v = 0.3 \text{ m s}^{-1}$ (1mark)			
10b	Diagram showing	<u>1 mark</u> diffraction of waves into right 'shadow' region of the plastic block <u>1 mark</u> consistent wavelengths before and after plastic block		direction of water waves  plastic block	
11a(i)	refraction	Refraction occurs when waves pass from one medium to another			
11a(ii)	Diagram showing:				
11a(iii)	less	Change of properties	Change of Medium Less dense to more dense e.g. air to glass	Change of Medium More dense to less dense e.g. glass to air	
		Speed of waves	Speed decreases	Speed increases	
		Wavelength of wave	Wavelength decreases	Wavelength increases	
		Direction of wave	Bends towards normal	Bends away from normal	
11b	1.7x10 ⁻³ s	P = 25 W	E = 42.5x10 ⁻³ J	t = ?	
		$P = \frac{E}{t} \therefore 25 = \frac{42.5 \times 10^{-3}}{t} \therefore t = \frac{42.5 \times 10^{-3}}{25} = 1.7 \times 10^{-3} \text{ s}$ (1 mark) (1 mark) (1 mark)			
12a(i)	Answer to include:	As the distance increases the infrared radiation detected decreases			
12a(ii)	Answer to include:	1 mark	Similar shape to original curve		
		1 mark	Line always below original curve		
12b	Open ended question:	1 mark	2 marks	3 marks	
		Candidate has demonstrated a limited understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood at least a little of the physics within the problem.		Candidate has demonstrated a reasonable understanding of the physics involved. They make some statement(s) that are relevant to the situation, showing that they have understood the problem.	
13a	Answer to include:	1 mark	Alpha is (more easily) absorbed by air/smoke/detector or Alpha has a short(er) range in air		
		1 mark	Alpha is the most ionising		

