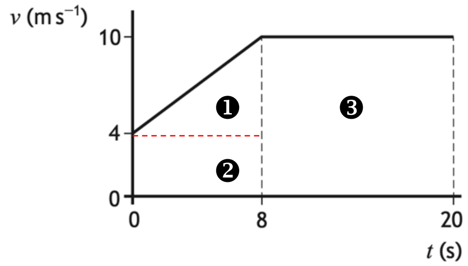
JABstem

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	% Correct	Physics Covered
1	E	61	Vector Quantity: **force**, velocity, displacement, acceleration, weight Scalar Quantity: energy, speed, **distance**, time, mass
2	C	73	☒A Toy car must have velocity above zero at point P ☒B Toy car must have higher velocity at point Q than it had at point P ☑C Average speed of 1 m s^{-1} and 3 m s^{-1} is 2 m s^{-1} ☒D Average speed of 2 m s^{-1} and 3 m s^{-1} would be 2.5 m s^{-1} ☒E Average speed must be between 2m s^{-1} and 3m s^{-1}
3	D	63	 **Area ❶**: Distance = area under graph = $\frac{1}{2}$ x 8 x 6 = 24 m **Area ❷**: Distance = area under graph = 8 x 4 = 32 m **Area ❸**: Distance = area under graph = 12 x 10 = 120 m **Total Distance** = 24m + 32m + 120m = 176m
4	B	22	The rocket pushes down on the water and the water provides an equal but opposite reaction force due to. Newton's 3rd Law.
5	B	32	**Gravitational Potential Energy at 4.0 m** E_p = ? m=0.25kg g= 9.8. N kg^{-1} h=6.0-4.0 = 2.0m E_p = m g h E_p = 0.25 x 9.8 x 2.0 E_p = 4.9 J **Kinetic Energy at 4.0 m** Kinetic energy at 4.0m is gained from conversion of potential energy from 6.0m to 4.0m. E_k = 4.9 J
6	B	19	**Statement I - Incorrect**: There is gravity in space and it is dependent on the distance of the object from planet/moon **Statement II - Correct**: Astronauts fall to earth at same acceleration as their spacecraft giving the feeling of weightlessness. **Statement III - Incorrect**: Astronauts fall to earth at same acceleration as their spacecraft giving the feeling of weightlessness. Acceleration = unbalanced forces
7	C	66	Longest ⟶ Shortest diameter of galaxy > radius of orbit of Moon > radius of Earth
8	A	82	☑A Period of orbits for X ,Y and Z increase in order. Z has a period of orbit of 24 hours ☒B if Z if geostationary then its period of orbit must be 24 hours. ☒C X and Y are closer to Earth than Z so must have period of orbits less than 24 hours ☒D X and Y are closer to Earth than Z so must have period of orbits less than 24 hours ☒E if Z if geostationary then its period of orbit must be 24 hours.
9	A	83	☑A R+S would slow spacecraft as force in in the opposite direction to direction of travel ☒B Q+S rockets would cancel each other out and would not change the speed ☒C P+Q would increase the speed of spacecraft in same direction of travel ☒D P+R rockets would cancel each other out and would not change the speed ☒E P+Q+R+S rockets would cancel each other out and would not change the speed

10	D	81	see working below

Mass (kg)	Weight (N)	$g = \frac{W}{m}$	g
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

W = m x g

W = 6.0kg x 8.8N kg^{-1}

W = 52.8N

11	C	79	see working below

Q = ? I = 2.0 A t = 5 minutes = 5x60 s

Q = I t

Q = 2.0 x 5x60

Q = 600 C

12	D	49	see working below

Statement I - **Correct**	Statement II - Incorrect	Statement III - **Correct**
The greater the gradient of a line on V-I graph the greater the resistance ∴ P has higher resistance than R	The greater the gradient of a line on V-I graph the greater the resistance ∴ R has *lower* resistance than Q	The gradient of line Q is decreasing as current increases ∴ The resistance of Q is decreasing as current increases

13	E	39	see working below

☒A Voltage is equal to the supply voltage in parallel circuit ∴ 12V in each branch

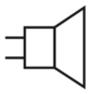
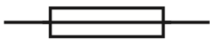
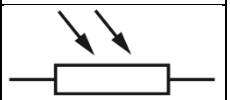
☒B Voltage is equal to the supply voltage in parallel circuit ∴ 12V in each branch

☒C Current splits in parallel branches current ∴ current at A_1 is twice current at A_2

☒D Current splits in parallel branches current ∴ current at A_1 is twice current at A_2

☑E Current at A_1 is 0.6A, Current at A_2 = 0.3A and Voltmeter voltage is 12V

14	B	77	see working below

A	B	C	D	E
				
Loudspeaker	Thermistor	Lamp	Fuse	LDR

15	D	35	see working below

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	45	see working below

E =? m = 1.6 kg $l = 3.34 \times 10^5$ J kg^{-1}

E = m x l

E = 1.6 x 3.34×10^5

E = 5.3×10^5 J

17	E	48	see working below

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 = 8.0×10^{-4} m^2

$$P = \frac{F}{A} = \frac{686}{8.0 \times 10^{-4}} = 8.6 \times 10^5 \text{ Pa}$$

18	E	64	see working below

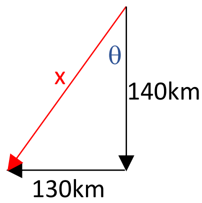
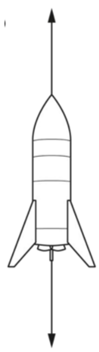
E_k = ? $k_B = 1.38 \times 10^{-23}$ J K^{-1} T = 100°C = 373K

$$E_k = \frac{3}{2} \quad K_B \quad T$$

$$E_k = \frac{3}{2} \times 1.38 \times 10^{-23} \times 373$$

$$E_k = 7.72 \times 10^{-21} \text{ J}$$

<table>
<tr><td>19</td><td>A</td><td>81</td><td>☑A sound waves are longitudinal waves with a speed of 340m s^{-1} in air
☒B radio waves are transverse waves with a speed of $3x10^8$m s^{-1}
☒C ultraviolet waves are transverse waves with a speed of $3x10^8$m s^{-1}
☒D infrared waves are transverse waves with a speed of $3x10^8$m s^{-1}
☒E visible light are transverse waves with a speed of $3x10^8$m s^{-1}</td></tr>
<tr><td>20</td><td>D</td><td>39</td><td><table><tr><td>Maximum wavelength</td><td>Minimum Wavelength</td></tr><tr><td>$v = 3x10^8 m\ s^{-1}$ $f = 3.0MHz = 3.0x10^6Hz$ $\lambda = ?$
$\lambda = \frac{v}{f} = \frac{3.0x10^8}{3.0x10^6} = \mathbf{100m}$</td><td>$v = 3x10^8 m\ s^{-1}$ $f = 6.0MHz = 6.0x10^6Hz$ $\lambda = ?$
$\lambda = \frac{v}{f} = \frac{3.0x10^8}{6.0x10^6} = 50m$</td></tr></table></td></tr>
<tr><td>21</td><td>C</td><td>83</td><td><table><tr><td>Infrared and ultraviolet should be the opposite sides of the visible light band</td><td><table><tr><td>EM Type</td><td>Gamma</td><td>X-Ray</td><td>Ultra-violet</td><td>Visible</td><td>Infra-Red</td><td>Microwave</td><td>Radio & TV</td></tr><tr><td>Energy</td><td colspan="7">High ←→ Low</td></tr><tr><td>Frequency</td><td colspan="7">High ←→ Low</td></tr><tr><td>Wavelength</td><td colspan="7">Low ←→ High</td></tr></table></td></tr></table></td></tr>
<tr><td>22</td><td>E</td><td>58</td><td>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.</td></tr>
<tr><td>23</td><td>A</td><td>78</td><td>$A = \frac{N}{t} = \frac{3000}{2x60} = 25\ Bq$</td></tr>
<tr><td>24</td><td>D</td><td>48</td><td>☒A beta radiation would not be able to leave the body to get to the detector
☒B beta radiation would not be able to leave the body to get to the detector
☒C The half-life is too short and much of the substance will have decayed.
☑D Gamma is emitted and half-life is short so not much remains in the body for long
☒E The half-life is too long and the substance will remain in the body for many years.</td></tr>
<tr><td>25</td><td>C</td><td>64</td><td>$\text{Number of lives} = \frac{\text{time elapsed}}{\text{half-life}} = \frac{120s}{30s} = 4$
3200 Bq → 1600 Bq → 800 Bq → 400 Bq → 200 Bq</td></tr>
</table>

Question	Answer	Physics Covered
1a(i)	190 km	 $x = \sqrt{(130)^2 + (140)^2}$ $x = \sqrt{16900 + 19600}$ $x = \sqrt{36500}$ x = 190 km
1a(ii)	223	$\tan\theta = \frac{opp}{adj} = \frac{130}{140} = 0.929 \quad \therefore \theta = 43^o$ Bearing = $180^o + 43^0$ = 223
1b(i)	110 m s^{-1}	d = 190 km = 190000m $\bar{v}$ = ? t = 0.5 hours = 0.5x60x60s d = $\bar{v}$ t (1 mark) 190000 = $\bar{v}$ x 0.5x60x60 (1 mark) $\bar{v}$ = 110 m s^{-1} (1 mark)
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:	<u>1 mark</u> suitable scales, labels and units | <u>1 mark</u> all points plotted accurately to ± half a division | <u>1 mark</u> best fit straight line
2a(ii)	0.57m	
2a(iii)	One answer from:	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:	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 = 1.3x10^6 kg g = 3.7 N kg^{-1} W = m x g (1 mark) W = 1.3x10^6 x 3.7 (1 mark) W = 4.8x10^6 N (1 mark)
3a(ii)	Two answers from:	<u>Direction Up</u> ↑ One from: thrust rocket thrust engine thrust (1 mark)  (1 mark) <u>Direction Up</u> ↓ One from: weight pull of gravity gravitational pull force due to gravity' force from exhaust gases on rocket
3a(iii)	5.5 m s^{-2}	F_{un} = engine thrust - weight F_{un} = 1.2x10^7 - 4.8x10^6 F_{un} = 7.2x10^6 N (1 mark) F = m x a (1 mark) 7.2x10^6 = 1.3x10^6 x a (1 mark) a = 5.5 m s^{-2} (1 mark)

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**: 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. **2 marks**: 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. **3 marks**: 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)	8.1×10^{18} m	$d = v \times t$ (1 mark) $d = 3.0\times10^{8} \times 860 \times 365.25 \times 24 \times 60 \times 60$ (1 mark) $d = 8.1\times10^{18}$ m (1 mark)
5a(ii)	1.5×10^{8} m s^{-1}	5% of 3.0×10^{8} m s^{-1} = $^{5}/_{100} \times 3.0\times10^{8}$ m s^{-1} = 1.5×10^{7} m s^{-1}
5a(iii)	5.4×10^{11} s	$d = v \times t$ (1 mark) $8.1\times10^{18} = 1.5\times10^{7} \times t$ (1 mark) $t = 5.4\times10^{11}$ s (1 mark)
5b	One answer from:	The light/EM radiation from the supernova has not reached the Earth yet <u>or</u> The light / EM radiation takes 860 years to reach Earth
5c(i)	Line spectrum Or Adorrption	**Type of Spectra** / **Diagram** / **Description** Continuous Spectrum:  Colour spectrum with no lines Adsorption Line Spectrum:  Colour Spectrum with black lines. At various points. Emission Line Spectrum:  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	$V_s = 6.0$ 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) $V_2 = 1.2$ V (1 mark)
6c(i)	3.2 Ω	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ (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 kW = 350 W • 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	150 Ω	P = 0.35 kW = 350 W, V = 230 V, R = ? $P = \frac{V^2}{R}$ (1 mark) $\therefore$ $350 = \frac{(230)^2}{R}$ (1 mark) $\therefore$ $R = \frac{52900}{350} = 150\ \Omega$ (1 mark)

Question	Answer	Notes
7c(i)	 or 	Diodes and LEDs must have the correct orientation if they are to work in a Circuit. The triangular shape points to the negative end of the power supply.
7c(ii)	Answer to include:	1 mark: Voltage across variable resistor increases 1 mark: Transistor switches on
7c(iii)	One answer from:	To {adjust / control} the moisture level at which the {dehumidifier / transistor / LED / fan} switches on
8a	7.6 A	P = 1750 W I = ? V = 230 V $P = IV$ (1 mark) $1750 = I \times 230$ (1 mark) $I = 7.6$ A (1 mark)
8b(i)	237°C	$E_h = 126000$ J $c = 902$ J kg^{-1} °C^{-1} $m = 0.650$ kg $\Delta T = ?$ $E = c \times m \times \Delta T$ (1 mark) $126000 = 902 \times 0.650 \times \Delta T$ (1 mark) $\Delta T = 215$°C (1 mark) Final Temperature = Initial Temperature + ΔT = 22°C + 215°C = 237°C
8b(ii)	One answer from:	<u>Heat</u> (energy) is lost to the {surroundings / rest of iron / clothes}
9a	One of the 3 methods shown:	See below
9b	138kPa – 142kPa	See below
9c	One answer from:	See below

9a

2 marks for using 2 or more sets of data to work out $^p/_T$ values. ($^T/_p$ also acceptable)			
$\frac{p}{T} = \frac{121\times10^3}{323} = 375$	$\frac{p}{T} = \frac{124\times10^3}{333} = 372$	$\frac{p}{T} = \frac{128\times10^3}{343} = 373$	$\frac{p}{T} = \frac{132\times10^3}{353} = 374$

1 mark for a statement of relationship: $\frac{p}{T}$ = constant

<u>or</u>

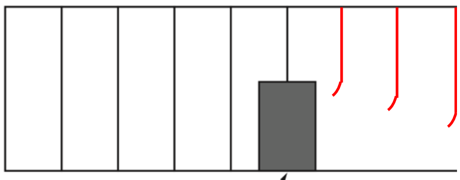
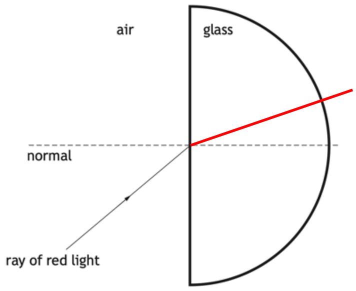
<u>Alternative Method 1</u>:	<u>Alternative Method 2</u>: Graphical Method
Use of $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ to verify relationship	Graph drawn on graph paper with
1 mark: all four sets of data (min 3 calculations)	1 mark: Suitable scales, labels and units
1 mark: all calculations correct	1 mark: All points plotted accurately
1 mark: Relationship stated and supported	1 mark: relationship stated

9b

Temperature (°C)	Temperature (K)	Pressure (kPa)	Difference	Estimate (kPa)
50	323	121		-
60	333	124	3	-
70	343	128	4	-
80	353	132	4	-
90	363	-	(4)	136
100	373	-	(4)	**140**

9c

Repeat the experiment	Add more water (in the beaker)	Have more of the flask in the water	Increase the range (of temperatures)
Stir the water	Reduce the length/diameter of the connecting tube	Take readings at more (different) temperatures within the range	

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 <u>or</u> 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}	$v = ?$ $f = 15\text{Hz}$ $\lambda = 0.20\text{m}$ $v = f \times \lambda$ (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 
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	$1.7\text{x}10^{-3}$ s	P = 25 W $E = 42.5\text{x}10^{-3}$ J t = ? $P = \frac{E}{t} \therefore 25 = \frac{42.5\text{x}10^{-3}}{t} \therefore t = 25 \text{ x } 42.5\text{x}10^{-3} = 1.7\text{x}10^{-3}\text{ s}$ (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**: 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. **2 marks**: 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. **3 marks**: 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.
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

13b(i)	Z	<table><tr><td>Source</td><td>X</td><td>Y</td><td>Z</td></tr><tr><td>Estimate of half-life (time taken for 100kBq to 50kBq)</td><td>80 days</td><td>20 days</td><td>250 days</td></tr></table>
13b(ii)	Answer to include:	<table><tr><td>1 mark</td><td colspan="2">The half-life of the sources are too short</td></tr><tr><td>1 mark</td><td>The smoke detectors would</td><td>only work for a short time need to be replaced frequently not last 10 years</td></tr></table>
13c	7.2×10^{-4} Sv	H = ? D = 4.5 μGy = 4.5×10^{-6} Gy W_r = 20 For 1 hour: $H = D \times W_r$ (1 mark) $H = 4.5\times10^{-6} \times 20$ (1 mark) $H = 9.0\times10^{-5}$ Sv For 8 hours: $H = 9.0\times10^{-5}\ \text{Sv} \times 8$ (1 mark) $H = 7.2\times10^{-4}$ Sv (1 mark)
14a	nucleus splits into two or more smaller nuclei	Nuclear fission is when a large nucleus of an atom splits into two or more smaller nuclei. Energy can be released from a fission reaction if the original nucleus is large enough,
14b(i)	1.9×10^{22} fissions	P = 150MW = 250×10^{6} W E = ? t = 1 hour = 60x60s $P = \frac{E}{t}$ (1 mark) $150\times10^{6} = \frac{E}{60\times60}$ (1 mark) $E = 5.4\times10^{11}$ J Number of fissions $= \frac{5.4\times10^{11}}{2.9\times10^{-11}}$ (1 mark) Number of fissions $= 1.9\times10^{22}$ (1 mark)
14b(ii)	One answer from:	<table><tr><td>Requires high temperatures</td><td>Difficult to control/contain plasma</td><td>Requires strong magnetic fields</td></tr></table>