JABstem

Past Papers Nat 5 Physics

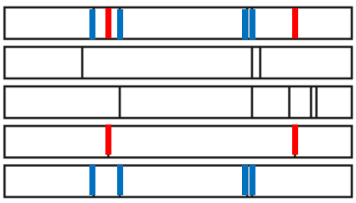
2020

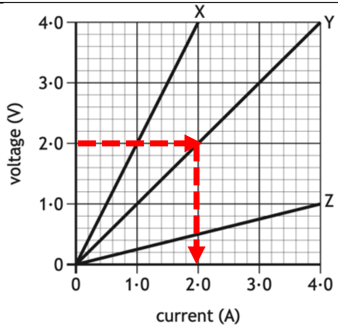
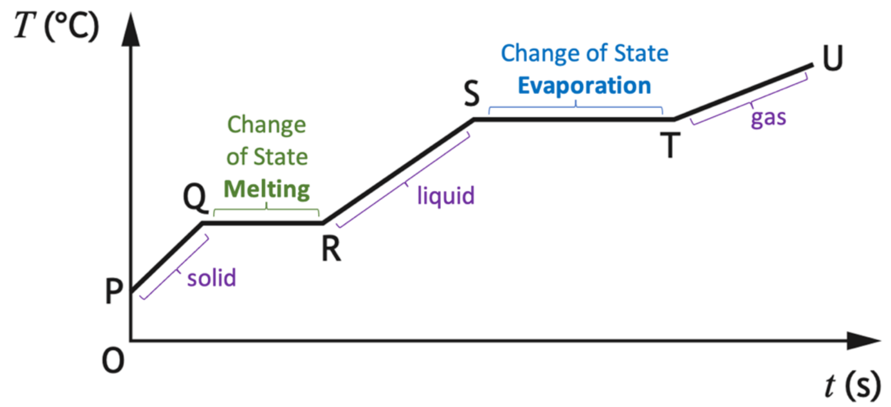
Marking Scheme

This marking scheme is for the intended National 5 Physics Exam in 2020 which was cancelled due to the Covid-19 pandemic. This paper was widely used in schools in 2021 to predict grades for students when the 2021 exams were cancelled. Some refer to this paper as the 2021 paper for this reason.
Whether this paper would have been the exact same paper presented to students had the exams gone ahead in 2020 is unknown but it fair to conclude that it would have been very close if not the same.
The grades awarded by SQA in 2020 and 2021 are in the table below.

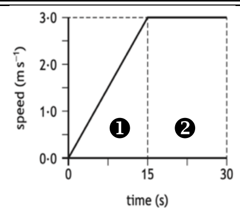
Grade Obtained	A	B	C	D	N/A
2020	40.3%	23.4%	22.2%	9.2%	4.8%
2021	43.4%	19.8%	18.1%	10.8%	7.8%

2020 Nat5 Physics Marking Scheme

Question	Answer	Physics Covered
1	A	Vector Quantity: **force**, velocity, displacement, acceleration, weight Scalar Quantity: mass, speed, distance, time, energy
2	D	Terminal velocity is reached when the weight in the downward direction is balanced in the opposite direction by air resistance/friction
3	B	F_{un} = 25 N – 15 N = 10 N m = 5.0 kg a = ? F = m a 10 = 5.0 x a a = 2 m s^{-2}
4	B	F = ? k = 12 N m^{-1} y = 0.110m - 0.080m = 0.030 m F = k y F = 12 x 0.030 F = 0.36 N
5	D	☒A The vertical velocity increases as gravitational field strength causes acceleration ☒B The horizontal velocity is constant and appears horizontal on v_h graph ☒C The horizontal velocity is constant and appears horizontal on v_h graph ☑D Horizontal velocity is contant and vertical velocity is increasing. ☒E The horizontal velocity is constant and appears horizontal on v_h graph
6	C	At 540km altitude on graph, gravitational field strength = 8.3 N kg^{-1} W = ? m = 78 kg g = 8.3 N kg^{-1} W = mg = 78 x 8.3 = 647N = 650N
7	C	Statement I - **Correct**: The orbital period of a geostationary satellite is 24 hours so satellite stays above the same location on Earth. Statement II - **Correct**: The orbital period of a geostationary satellite is 24 hours so satellite stays above the same location on Earth. Statement III - Incorrect: Geostationary satellites have a fixed altitude of 36000km so the satellite stays above same location on Earth
8	B	1 light year = 3.0×10^8 m s^{-1} x 1x365.25x24x60x60 = 9.5×10^{15} m No. of light years = $\frac{2.4\times10^{18}\text{ m}}{9.5\times10^{15}\text{ m}}$ = 2.5×10^2 light years
9	C	Line spectrum from star calcium helium hydrogen sodium  2 calcium lines missing from line spectrum of star 3 helium lines missing from line spectrum of star Both hydrogen lines in line spectrum of star All sodium lines in line spectrum of star
10	E	P = 48 W V = 12 V I = ? P = V I 48 = 12 x I I = 4 A Q = ? I = 4 A t = 5 minutes = 5x60 s Q = I t Q = 4 x 5x60 Q = 1200 C
11	D	Trace X – d.c. signal: • negative charges (electrons) flow in one direction only. • gives a constant trace on oscilloscope Trace Y – a.c. signal: • the direction of electrons in current changes back and forth at regular intervals • the size of the current varies with time and is not constant Trace Z – d.c. signal: • negative charges (electrons) flow in one direction only. • gives a constant trace on oscilloscope

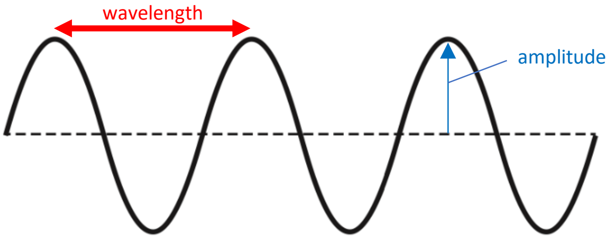
<table>
<tr><td>12</td><td>E</td><td>
<table>
<tr><th>Statement I - Correct</th><th>Statement II - Correct</th><th>Statement III - Correct</th></tr>
<tr><td>Resistance is equal to the gradient of the line on an V-A graph.
• Resistor X gives steepest gradient on graph so Resistor X has greatest resistance.</td><td>
</td><td>$\text{Gradient} = \frac{\Delta\text{voltage}}{\Delta\text{current}}$
$\text{Gradient} = \frac{1.0 - 0.0}{4.0 - 0.0}$
$\text{Gradient} = \frac{1.0}{4.0}$
Gradient = 0.25 Ω</td></tr>
</table>
</td></tr>
<tr><td>13</td><td>A</td><td>☑A This circuit will give readings of current and voltage to calculate R = $^V/_I$
☒B Voltmeter is incorrectly fitted to circuit (voltmeters are linked in parallel)
☒C Ammeter is incorrectly fitted to circuit (ammeters are linked in series)
☒D Ammeter is giving the current before it splits into either branch ∴ too big
☒E Ammeter and voltmeter are incorrectly fitted to circuit</td></tr>
<tr><td>14</td><td>B</td><td>
</td></tr>
<tr><td>15</td><td>B</td><td>E = 9.0x10^4 J   m = ?   l = 22.6x10^5 J kg^{-1}
E = m x l
9.0x10^4 = m x 22.6x10^5
m = 0.04kg</td></tr>
<tr><td>16</td><td>D</td><td>Area = l x b = 0.2m x 0.10m = 0.02 m^2
P = ?   F = 28 N   A = 0.02 m^2
$P = \frac{F}{A} = \frac{28}{0.02} = 1400\ \text{Pa}$</td></tr>
<tr><td>17</td><td>E</td><td>☒A As there is no increase in temperature the air particles do not move faster
☒B Decrease in volume increases pressure leading to air particles hitting walls more often
☒C As there is no decrease in temperature the air particles do not move slower
☒D An increase in temperature for the particles to gain kinetic energy
☑E Decrease in volume increases pressure leading to air particles hitting walls more often</td></tr>
<tr><td>18</td><td>A</td><td>Temperature Change in degrees Celsius = 64°C – 22°C = 42°C
∴ Temperature Change in Kelvin = 42K</td></tr>
<tr><td>19</td><td>A</td><td>
<table>
<tr><th>Frequency of Waves</th><th>Period of Waves</th></tr>
<tr><td>5 water waves in 10s:
$f = \frac{N}{t} = \frac{5}{10} = \mathbf{0.5\ Hz}$</td><td>Frequency = 0.5Hz
$T = \frac{1}{f} = \frac{1}{0.5} = \mathbf{2s}$</td></tr>
</table>
</td></tr>
<tr><td>20</td><td>C</td><td>☒A Speed decreases as red light enters a more dense. Medium (glass block)
☒B Wavelength decreases as red light enters a more dense medium (glass block)
☑C Both wavelength and speed of light decrease as it enters a more dense medium
☒D Wavelength decreases as red light enters a more dense medium (glass block)
☒E Wavelength decreases as red light enters a more dense medium (glass block)</td></tr>
</table>

21	C	☒A red light bends towards normal when it enters a more dense medium (glass) ☒B red light bends towards normal when it enters a more dense medium (glass) ☑C red light has bent towards the normal as the glass block is a more dense medium ☒D The red light bends towards the normal but not touching the normal ☒E The beam appears to have reflected not refracted as it enters glass at the normal
22	D	☒A X cannot be alpha as X bends towards + plate and alpha would deflect away ☒B X cannot be alpha as X bends towards + plate and alpha would deflect away ☒C Y cannot be alpha as Y would be attracted to – plate but X is undeflected ☑D X (α) bends towards – plate, Z (β) bends towards + plate and Y (γ) undeflected ☒E Y cannot be alpha as X would be attracted to the – plate but X is undeflected
23	A	Ionising describes the process where atoms *lose* electrons and become *positively* charged or atoms *gain* electrons and become *negatively* charged
24	D	The source releases alpha and gamma radiation but not beta. • piece of paper reduces the emitted radiation $\therefore$ **alpha radiation present** • 1cm of aluminium gives same result as piece of paper $\therefore$ beta radiation not present • 5cm of lead reduces the emitted radiation $\therefore$ **gamma radiation present**
25	A	D = ? E = 90 μJ = 90x10^{-6} J m = 2.0 kg $D = \frac{E}{m} = \frac{90\times10^{-6}}{2} = 45\times10^{-6}$ Gy = 45 μGy

Question	Answer	Physics Covered
1a(i)	300s	d = 870m v = 2.9 m s^{-1} t = ? $d = v \times t$ (1 mark) $870 = 2.9 \times t$ (1 mark) $t = 300$ s (1 mark)
1a(ii)	2.9 m s^{-1} EAST or 2.9 m s^{-1} 090	Average speed = 2.9 m s^{-1} is a scalar quantity with no direction Average velocity = 2.9 m s^{-1} is a vector quantity when the direction EAST or 090 is added
1b(i)	0.20 m s^{-2}	a = ? v = 3.0 m s^{-1} u = 0.0 m s^{-1} t = 15 s $a = \frac{v - u}{t}$ (1 mark) $= \frac{3.0 - 0.0}{15}$ (1 mark) $= 0.20$ m s^{-2} (1 mark)
1b(ii)	68m	 Area ❶: Distance = area under graph = ½ x 15 x 3.0 = 22.5m Area ❷: Distance = area under graph = 15 x 3.0 = 45m **Total Distance** = 22.5 + 45 = 67.5m = 68m
1c	048	$\tan\theta = \frac{opp}{adj} = \frac{2.6}{2.9} = 0.897 \quad \therefore \theta = 42^o$ Bearing = 90° – 42° = 048
2a(i)	To reduce friction	The force of the moving air upwards lifts the vehicle up enough so that there is no friction between the linear air track and the vehicle.
2a(ii)	Answer to include:	1 mark: length/width of card 1 mark: time for card to pass through the (light) gate 1 mark: time taken for card to reach (light) gate
2b	Answer to include:	1 mark: 1.8 m s^{-2} 1 mark: acceleration value is not in the same proportion to the accelerating force
2c	(gravitational) potential ↓ kinetic	Energy is stored as gravitational potential energy when it is higher up. When released the gravitational potential energy ids converted into kinetic energy as it falls.
3a	Working showing 0.45 Hz	f = ? N = 27 t = 1 minute = 60 s $f = \frac{N}{t}$ (1 mark) $= \frac{27}{60}$ (1 mark) $= 0.45$ Hz
3b(i)	1.1x10^5 J	P = 95 W E = ? t = 1200 s $P = \frac{E}{t} \therefore 95 = \frac{E}{1200} \therefore E = 95 \times 1200 = 1.1 \times 10^5$ J
3b(ii)	One answer from:	Energy will also have been generated as { heat / sound
3c	160 N	E_w = 208 J F = ? d = 1.3m $E_w = F \quad d$ (1 mark) $208 = F \times 1.3$ (1 mark) $F = 160$ N (1 mark)
4a	Answer to include:	A <u>natural</u> satellite of a { planet / dwarf planet
4b	Hydra Longest orbital period	For a moon in a fixed orbit, the further the moon from the planet greater the orbital period. The mass and diameter of the moon are irrelevant.
4c	Answer to include:	1 mark: It received a { gravitational boost / slingshot / catapult } from Jupiter 1 mark: causes an increase in its speed/kinetic energy

4d(i)	1.20×10^{11} J	$E_k = \frac{1}{2}mv^2$ (1 mark) $= \frac{1}{2} \times 454 \times (23.0\times10^3)^2$ (1 mark) $= 1.20\times10^{11}$ J (1 mark)
4d(ii)	Answer to include:	1 mark: There is no friction / air resistance / opposing force 1 mark: Therefore there is no unbalanced force
4e	4.8×10^{12}m	d = ? $\quad v = 3.0\times10^8$ m s^{-1} $\quad$ t = 4.4hours = 4.4x60x60 s $d = v \times t$ (1 mark) $d = 3.0\times10^8 \times 4.4\times60\times60$ (1 mark) $d = 4.8\times10^{12}$m (1 mark)
5	Answer to include:	**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.
6a(i)	One answer from:	To reduce / limit the current (in the LED) Also accepted: To reduce the voltage across the LED | To protect/prevent damage to the LED
6a(ii)	330 Ω	$V_s = V_R + V_1 + V_2 + V_3$ $12 = V_R + 1.8 + 1.8 + 1.8$ (1 mark) $V_R = 6.6$ V $V_R = 6.6$ V $\quad$ I = 0.020 A $\quad$ R = ? $V_R = I R$ (1 mark) $6.6 = 0.020 \times R$ (1 mark) $R = 330\ \Omega$ (1 mark)
6a(iii)	One answer from:	The green and blue LEDs have different voltages / currents (than the red LEDs)
6b	Answer to include:	1 mark: same brightness 1 mark: same voltage across the red LEDs <u>or</u> the three branches are connected in parallel, so voltage across them does not change
7a	0.85 V (which is greater than switch on voltage 0.7 V)	V_s =5.0 V $\quad V_2$ = ? $\quad R_1 = 16.6$ kΩ = 16600Ω $\quad R_2 = 3.4$ kΩ = 3400Ω $V_2 = \frac{R_2}{R_1 + R_2} \times V_s$ $V_2 = \frac{3400}{16600 + 3400} \times 5.0$ $V_2 = 0.85$ V
7b(i)	The control circuit operates at 5 V the floodlight at 230 V	The purpose of a relay switch is that the switch circuit has a much lower voltage than the circuit it is switching on. This reduces the risk of a serious electric shock when switching on the machine on remotely.
7b(ii)	2.5 A	P = 575 W $\quad$ I = ? $\quad$ V = 230 V $P = I V$ (1 mark) $575 = I \times 230$ (1 mark) $I = 2.5$ A (1 mark)
7b(iii)	3A	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.

8a	4.6×10^5 J	E_h = ? $c = 810\ J\ kg^{-1}\ {}^oC^{-1}$ $m = 2.5\ kg$ $\Delta T = 250^0C - 22^oC = 228^oC$ $E = c \times m \times \Delta T$ (1 mark) $E = 810 \times 2.5 \times 228$ (1 mark) $E = 4.6\times10^5\ J$ (1 mark)
8b(i)	58.0 Ω	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ (1 mark) $\frac{1}{R_T} = \frac{1}{174} + \frac{1}{174} + \frac{1}{174}$ (1 mark) $\frac{1}{R_T} = \frac{3}{174}$ $R_T = 58.0\ \Omega$ (1 mark)
8b(ii)	910 W	P = ? V = 230 V R = 58.0 Ω $P = \frac{V^2}{R} = \frac{(230)^2}{58.0} = \frac{52900}{58.0} = 910\ W$ (1 mark) (1 mark) (1 mark)
8c	Answer to include:	1 mark: greater time 1 mark: specific heat capacity of oil is greater than clay brick
9a	Working showing 2.0×10^7 Pa	Temperature: Constant $p_1 = 2.5\times10^5$ Pa V_1 = 960 litres p_2 = ? (2.0×10^7 Pa) V_2 = 12 litres (1 mark) $p_1V_1 = p_2V_2$ $2.5\times10^5 \times 960 = p_2 \times 12$ (1 mark) $\frac{2.5\times10^5 \times 960}{12} = p_2$ $2.0\times10^7\ Pa = p_2$
9b(i)	280 K	Volume: Constant $p_1 = 2.0\times10^7$ Pa $T_1 = 21^oC = 294$ K $p_2 = 1.9\times10^7$ Pa T_2 = ? (1 mark) $\frac{p_1}{T_1} = \frac{p_2}{T_2}$ (1 mark) $\frac{2.0\times10^7}{294} = \frac{1.9\times10^7}{T_2}$ $T_2 = \frac{1.9\times10^7 \times 294}{2.0\times10^7}$ (1 mark) T_2 = 280 K
9b(ii)	Answer to include:	1 mark: (The decrease in temperature) decreases the kinetic energy of the gas particles/the particles move slower 1 mark: The particles hit the walls of the container less often/frequently 1 mark: The particles hit the walls of the container with less force
10	Answer to include:	**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.

11a(i)	Amplitude labelled as shown in diagram	
11a(ii)	wavelength labelled as shown in diagram	
11b	1.4m	$v = 340\ m\ s^{-1}$ f = 250Hz λ = ? $v = f \times \lambda$ (1 mark) $340 = 250 \times \lambda$ (1 mark) $\lambda = 1.4\ m$ (1 mark)
11c(i)	Graph showing:	1 mark: Suitable scales, labels and units 1 mark: All points plotted accurately to ± half a division 1 mark: Best fit curve
11c(ii)	800 Hz	Must be consistent with the line the candidate has drawn. ± half a division tolerance If the candidate has not shown a curve or line in (c)(i) this mark cannot be given. If the candidate has used a non-linear scale in (c)(i) this mark cannot be given.
11c(iii)	Repeat measurement and average	Also accepted: Increase the range of lengths; Increase the number of different lengths.
12a	Activity decreases too much with the time (to still be suitable)	With a half-life of 22 hours, at least 7 half-lives will have passed in the week after the solution was prepared. The solution would have less than 1% remaining. 100% Day 0 → 50% Day 1 → 25% Day 2 → 12.5% Day 3 → 6.25% Day 4 → 3.13% Day 5 → 1.56% Day 6 → 0.78% Day 7
12b(i)	Any suitable source	
12b(ii)	330 decays	A = 5.5 Bq N = ? t = 1 minute = 60s $A = \frac{N}{t}$ (1 mark) $5.5 = \frac{N}{60}$ (1 mark) N = 330 decays (1 mark)
12b(iii)	One answer from:	Move the Geiger-Müller tube closer to the tissue sample Place shielding around apparatus
13a(i)	fission	Induced Nuclear Fission is the process where neutrons are absorbed by a nucleus causing it to split into two smaller nuclei and some more neutrons are sent out to split further nuclei in a chain reaction.
13a(ii)	Answer to include:	1 mark: Neutrons produced in 1st reaction can go on to { cause further reactions / split more nuclei } 1mark: This process repeats or a chain reaction occurs
13b	96 years	$1 \rightarrow \frac{1}{2} \rightarrow \frac{1}{4} \rightarrow \frac{1}{8}$ 3 half-lives to decrease activity to $^1/_8$ of original value 1 half-life = 32 years ∴ 3 half-lives = 3x32 years = 96 years
13c(i)	1×10^{-5} Sv	Total Equivalent Dose = Equivalent Dose from Slow Neutrons + Equivalent Dose for Gamma Radiation $= D\,w_R + D\,w_R$ $= (2.2\times10^{-6} \times 3) + (3.4\times10^{-6} \times 1)$ $= 6.6\times10^{-6}\ Sv + 3.4\times10^{-6}\ Sv$ $= 1.0\times10^{-5}\ Sv$
13c(ii)	2000 Shifts	$N = \frac{20\times10^{-3}}{1.0\times10^{-5}}$ N = 2000 Shifts