JABstem

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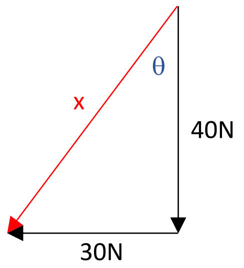
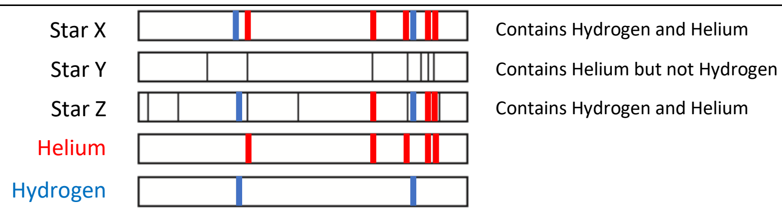
Past Papers Nat 5 Physics 2017 Marking Scheme

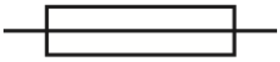
Grade Awarded	Mark Required (/100)	% candidates achieving grade
A	68+	31.7%
B	56+	21.5%
C	45+	20.0%
D	39+	9.4%
No award	<39	17.5%

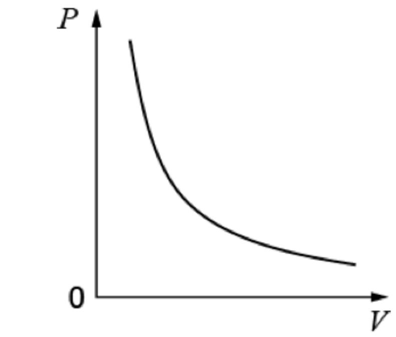
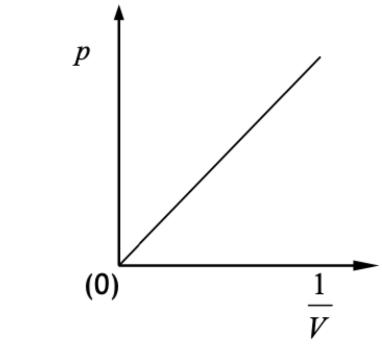
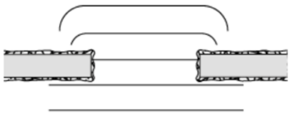
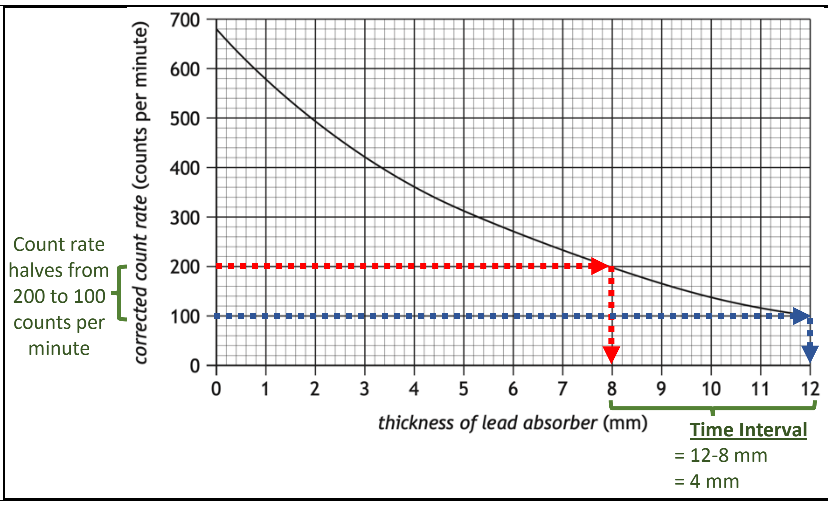
Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	11.9 /20	31.7 /60	13.5 /20

2017 Nat5 Physics Marking Scheme

Question	Answer	% Correct	Physics Covered
1	A	59	The kinetic energy is at its greatest when velocity is at its greatest due to the equation $E_k = \frac{1}{2}mv^2$. • The mass of cyclist & cycle will be constant • the greater the velocity the greater the kinetic energy
2	D	57	Current in branch with lamp = $A_1 - A_2$ = 5.0A – 2.0A = 3.0A Q = ? I = 3.0A t = 30 s $Q = I \quad t$ $Q = 3.0 \times 30$ $Q = 90\ C$
3	A	71	☑A Voltage is constant & current decreases ∴ resistance must *increase* if $R = {}^{V}/_{I}$ ☒B Voltage is constant & current decreases ∴ resistance must *increase* if $R = {}^{V}/_{I}$ ☒C Current *decreases* from 0.4A to 0.2A between 0.05 s to 0.45s ☒D Current *decreases* from 0.4A to 0.2A between 0.05 s to 0.45s ☒E Current *decreases* from 0.4A to 0.2A between 0.05 s to 0.45s
4	E	60	☒A The *battery* supplies energy to the circuit ☒B The *variable resistor* increasing in resistance will decrease the voltage across R_1 ☒C The *motor* changes electrical energy into kinetic energy ☒D The transistor will only supply energy to the motor only when the transistor is switched on ☑E The *transistor* will switch on the motor when the voltage is correct
5	B	86	☒A The copper block should be insulated to give a more accurate value of specific heat capacity ☑B The thermometer is in the copper block and the block is insulated ☒C The copper block should be insulated to give a more accurate value of specific heat capacity ☒D The copper block should be insulated to give a more accurate value of specific heat capacity ☒E The reading on the thermometer will only be accurate if the thermometer is in the block when read
6	D	64	W = ? m = 1200kg g = 5.0 N kg^{-1} $W = m \times g$ $W = 1200 \times 5.0$ $W = 6000N$ P = ? F = 6000N A = 1.5 m^2 $P = \frac{F}{A} = \frac{6000}{1.5} = 4000\ Pa = 4.0\times10^3\ Pa$
7	B	63	Temperature Change in degrees Celsius = 60°C – (-15°C) = 75°C ∴ Temperature Change in Kelvin = 75K
8	E	62	**Statement I - Incorrect**: Transverse waves have the direction of vibration at right angles to the direction of wave travel **Statement II - Correct**: All electromagnetic waves are transverse and water waves are transverse **Statement III - Correct**: Sound waves are longitudinal
9	C	65	**Amplitude**: Amplitude = $\frac{2.6m}{2}$ = **1.3m** **Wavelength**: 4 wavelengths = 12m; 1 wavelength = **3m** **Frequency**: $f = \frac{N}{t} = \frac{4}{0.5s}$ = **8.0 Hz**
10	C	37	Total distance = 30km up to aeroplane and 30km back from aeroplane = 60km = 60,000m $t = \frac{d}{v} = \frac{60000\ m}{3.0\times10^8\ m\ s^{-1}} = 0.0002\ s = 2\times10^{-4}\ s$
11	B	71	☒A Gamma has higher frequency than X rays ☑B UV has shorter λ than visible and lower f than X-rays ☒C infrared has a longer wavelength than visible light ☒D microwaves have a longer wavelength than visible ☒E radio waves have a longer wavelength than visible EM Type: Gamma, X-Ray, Ultra-violet, Visible, Infra-Red, Microwave, Radio & TV Energy: High ↔ Low Frequency: High ↔ Low Wavelength: Low ↔ High

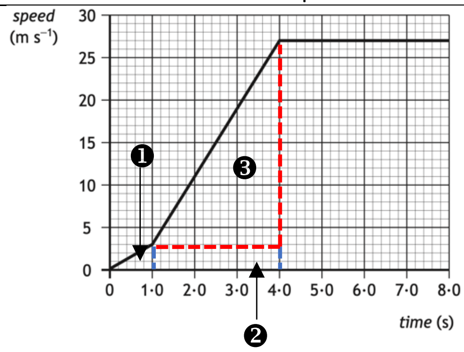
12	A	85	☑A Q is the angle of incidence and S is the angle of refraction as both are measure from the normal ☒B The angle of incidence must be outside the glass so cannot be S ☒C P is not the angle of incidence and R is not the angle of refraction as they are not measured from the normal ☒D The angle of incidence must be outside the glass so cannot be R ☒E Q is the angle of incidence but R is not the angle of refraction as the angle is measured from the normal
13	B	56	Total Equivalent Dose = Equivalent does for Alpha Radiation + Equivalent Dose for Gamma Radiation = $D\,w_R$ + $D\,w_R$ = (15 μGy x 20) + (20 μGy x 1) = 300 μSv + 20 μSv = 320 μSv
14	C	31	**Magnitude of force**  $x=\sqrt{(40)^2+(30)^2}$ $x=\sqrt{1600+900}$ $x=\sqrt{2500}$ $x=50$ N **Bearing of Force** $\tan\theta = \frac{opp}{adj} = \frac{30}{40}$ 0.75 ∴ θ = 37° Bearing = 180° + 37° = 217
15	C	40	☒A A ball falling freely would increase in velocity due to acceleration due to gravity ☒B A rocket accelerating upwards would have an increasing velocity not a decreasing velocity ☑C A ball thrown into the air would decrease in velocity, come to a stop (zero) and reverse direction ☒D A ball falling to Earth would increase in velocity due to gravity ☒E Graph shows a reversal of direction when the lone goes below zero on x-axis
16	E	46	☒A acceleration is the same at any point as the gravitational field strength is the same. ☒B the average velocity from Y is less through light gates as trolley has not accelerated for as long as from X ☒C acceleration is the same at any point as the gravitational field strength is the same. ☒D acceleration is the same at any point as the gravitational field strength is the same. ☑E Acceleration increases and average velocity is less when released from Y.
17	D	60	☒A As Mars has a lower gravitational field strength than Earth, weight of rocket will be less on mars ☒B As Mars has a lower gravitational field strength than Earth, weight of rocket will be less on mars ☒C As Mars has a lower gravitational field strength than Earth, weight of rocket will be less on mars ☑D Rocket has less weight on Mars and unbalanced force is greater on Mars. ☒E Rocket is identical in its thrust but the rocket has less weight ∴ unbalanced force will be greater
18	B	60	Statement I - Incorrect: The greater the altitude the *longer* the orbital period Statement II - **Correct**: A satellite has constant vertical velocity due to gravity being constant Statement III - Incorrect: Satellites will have a constant velocity to maintain their orbit.
19	B	39	In 1s heat transfer is 1130 J ∴ in 120s the heat transfer is 1130x120 = 135600 J E = 135600 J m = ? $l = 22.6\times10^5$ J kg^{-1} $E = m \times l$ $22.6\times10^5 = m \times 22.6\times10^5$ $m = 0.06\text{kg} = 6.0\times10^{-2}$ kg
20	D	76	

<table>
<tr><th>Question</th><th>Answer</th><th>Physics Covered</th></tr>
<tr><td>1a(i)</td><td></td><td>A fuse protects a circuit from too much current flowing and the fuse will blow when a specified current is exceeded.</td></tr>
<tr><td>1a(ii)</td><td>One answer from:</td><td><table><tr><td>stops too
large a current</td><td>prevents
wiring overheating</td><td>protect wiring
(from damage)</td></tr></table></td></tr>
<tr><td>1a(iii)</td><td>3A Fuse</td><td><table><tr><td>Power Rating</td><td>Up to 720W</td><td>Over 720W</td></tr><tr><td>Fuse Selected</td><td>3A</td><td>13A</td></tr></table></td></tr>
<tr><td>1b</td><td>One answer from:</td><td>direction of $\left\{\begin{array}{c}\text{electron (flow)}\\ \text{charge (flow)}\end{array}\right\}$ (continually) changing $\left\{\begin{array}{l}\text{back and forth}\\ \text{to and fro}\end{array}\right.$</td></tr>
<tr><td>2a(i)</td><td>7.50 V</td><td>When switch S1 is closed, $R_T = R_1 + R_2 = 15.0\Omega + 25.0\Omega = 40.0\ \Omega$ (1 mark)
V = 12.0 V I = ? R = 40.0 Ω
$V = IR$ (1 mark if written here or below)
$12.0 = I \times 40.0$ (part of Substitution mark)
$I = 0.300\ \text{A}$
Voltage Across Motor = ? I = 0.300 A R = 25.0 Ω
$V = IR$ (1 mark if written here or below)
$V = 0.300 \times 40.0$ (part of Substitution mark)
$V = 7.50\ \text{V}$ (1 mark)</td></tr>
<tr><td>2a(ii)</td><td>2.25W</td><td>P = ? V = 7.5 V R = 25.0 Ω
$P = \frac{V^2}{R} = \frac{(7.5)^2}{25.0} = \frac{56.25}{25.0} = 2.25\ \text{W}$
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>2b(i)</td><td>10.5 Ω</td><td>$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ (1 mark)
$\frac{1}{R_T} = \frac{1}{15.0} + \frac{1}{35.0}$ (1 mark)
$R_T = 10.5\ \Omega$ (1 mark)</td></tr>
<tr><td>2b(ii)</td><td>Answer to include:</td><td><table><tr><td>1 mark</td><td>(power dissipated is) $\left\{\begin{array}{l}\text{greater}\\ \text{increased}\\ \text{higher}\end{array}\right.$</td></tr><tr><td>1 mark</td><td>$\left.\begin{array}{c}\text{combined}\\ \text{parallel}\\ \text{total}\end{array}\right\}$ resistance less</td></tr><tr><td>1 mark</td><td>voltage across motor is $\left\{\begin{array}{l}\text{greater}\\ \text{increased}\end{array}\right.$ <u>or</u> Current in motor is $\left\{\begin{array}{l}\text{greater}\\ \text{increased}\end{array}\right.$</td></tr></table></td></tr>
<tr><td>3a</td><td>$2.5\text{x}10^5$ Pa</td><td>Temperature: Constant $p_1 = 1.0\text{x}10^5$ Pa $V_1 = 4.0\text{x}10^{-4}\ \text{m}^3$
p_2 = ? $V_2 = 1.6\text{x}10^{-4}\ \text{m}^3$
(1 mark) $p_1V_1 = p_2V_2$
(1 mark) $1.0\text{x}10^5 \text{ x } 4.0\text{x}10^{-4} = p_2 \text{ x } 1.6\text{x}10^{-4}$
$\frac{1.0\text{x}10^5 \text{ x } 4.0\text{x}10^{-4}}{1.6\text{x}10^{-4}} = p_2$
(1 mark) $2.5\text{x}10^5\ \text{Pa} = p_2$</td></tr>
<tr><td>3b</td><td>Answer to include:</td><td><table><tr><td>1 mark</td><td>(individual) particles collide with container walls more frequently (than before)</td></tr><tr><td>1 mark</td><td>(overall) force (on walls) is greater</td></tr><tr><td>1 mark</td><td>pressure increases</td></tr></table></td></tr>
</table>

3c	One graph from:	<u>1 mark</u> axes labelled **p** and **V** (axes can be transposed) <u>1 mark</u> correct shape (curved)  <u>1 mark</u> graph of **p** against $^1/_V$ (or **V** against $^1/_p$) <u>1 mark</u> labelled with straight line through the origin 
4a(i)	0.40 Hz	$T = \frac{1}{f}$ (1 mark) $2.5 = \frac{1}{f}$ (1 mark) $f = 0.40$ Hz (1 mark)
4a(ii)	One answer from:	measure the time for more waves to pass count the number of waves in a longer period of time repeat (the measurement) and average
4b	3.2 m s^{-1}	v = ? f =0.4 Hz λ= 8.0m $v = f \times \lambda$ (1 mark) $v = 0.40 \times 8.0$ (1 mark) $v = 3.2$ m s^{-1} (1 mark)
4c		1 mark: diffraction of waves into 'shadow' regions behind walls 1 mark: straight sections in middle and consistent wavelengths before and after gap
4d	energy decreases/lost	The amplitude of a wave is proportional to the energy of the wave. As the wave loses energy the amplitude of the wave decreases.
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	background count (rate)	The background count rate must be subtracted from the activity count to exclude the contribution of background radiation from the activity.
6b(i)	4·4 mm	 Take any halving of the corrected count rate on the y-axis. Work out the thickness on the x-axis for this halving.

<table>
<tr><td>6b(ii)</td><td>13.2mm</td><td>$^1/_8$th of initial Corrected Count Rate = 3 half-thicknesses used (1 mark)

1 half-thickness = 4.4mm ∴ 3 half-thicknesses = 3 x 4.4 = 13.2mm (1 mark)</td></tr>
<tr><td>6b(iii)</td><td>Greater</td><td>Aluminium is used to prevent beta radiation passing through but will allow gamma radiation through. Thicker aluminium will be needed to stop the same quantity of radiation that lead would stop.</td></tr>
<tr><td>6c</td><td>8000 h</td><td>$\dot{H}$ = 2.5x10^{-6} Sv h^{-1} H = 20mSv = 20x10^{-3} Sv t = 15min = 15x60s = 900s
$$\dot{H} = \frac{H}{t}$$ (1 mark)
$$2.5\times10^{-6} = \frac{20\times10^{-3}}{t}$$ (1 mark)
$$t = 8000\ h$$ (1 mark)</td></tr>
<tr><td>7a</td><td>80000 decays per unit time
or
80000 decays per second</td><td>80kBq = 80000 Bq

A Becquerel is a nuclei decay per second/unit time</td></tr>
<tr><td>7b(i)</td><td>Answer to include:</td><td><table><tr><td>1 mark</td><td>neutrons can go on to</td><td>cause further fission reactions
split more uranium nuclei</td></tr><tr><td>1 mark</td><td colspan="2">causing a chain reaction <u>or</u> this process repeats</td></tr></table></td></tr>
<tr><td>7b(ii)</td><td>1.6x10^9 W</td><td>Energy = 3.0x10^{21} x 3.2x10^{-11} (1 mark) = 9.6x10^{10} J
P = ? E = 9.6x10^{10} J t = 1 minute = 60 s
$$P = \frac{E}{t} = \frac{9.6\times10^{10}}{60} = 1.6\times10^{9}\ W$$
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>7c</td><td>Any suitable use including:</td><td><table><tr><td>treating cancer</td><td>tracers</td><td>sterilisation</td><td>smoke detectors</td><td>measuring thickness of paper</td></tr></table></td></tr>
<tr><td>8a</td><td>0 m</td><td>The distance travelled by 4 laps of track by motorbike = 4x380m = 1720m
However, displacement = 0m as the start and end positions are the same after four laps.</td></tr>
<tr><td>8b(i)</td><td>46.5 m</td><td>

<table><tr><td>Area ❶</td><td>Area ❷</td><td>Area ❸</td></tr><tr><td>Distance = area under graph</td><td>Distance = area under graph</td><td>Distance = area under graph</td></tr><tr><td>= $\frac{1}{2}$ x 1.0 x 3</td><td>= 3.0 x 3</td><td>= $\frac{1}{2}$ x 3.0 x 24</td></tr><tr><td>= 1.5</td><td>= 9.0</td><td>= 36.0</td></tr><tr><td colspan="3">Total distance = 1.5 + 9.0 + 36.0 = 46.5 m</td></tr></table></td></tr>
<tr><td>8b(ii)</td><td>8 m s^{-2}</td><td>Greatest Acceleration in first 8.0s is steepest gradient (1.0s to 4.0s)
a = ? v = 27 m s^{-1} u = 3 m s^{-1} t = 3.0 s
$$a = \frac{v - u}{t} = \frac{27 - 3}{3.0} = 8\ m\ s^{-2}$$
(1 mark) (1 mark) (1 mark)</td></tr>
<tr><td>8c</td><td>19 m s^{-1}</td><td>d = 4x380m = 1520 m $\bar{v}$ = ? t = 79s
$d = \bar{v}\ t$ (1 mark)
$1520 = \bar{v} \times 79$ (1 mark)
$\bar{v} = 19\ m\ s^{-1}$ (1 mark)</td></tr>
<tr><td>9a</td><td>Answer to include:</td><td>(The forces are) equal (in size) <u>and</u> opposite (in direction)</td></tr>
</table>

9b	120 kg	W = 1176 N m = ? g = 9.8 N kg^{-1} $W = m\ g$ (1 mark) $1176 = m \times 9.8$ (1 mark) $m = 120$ kg (1 mark)
9c	1.4 m s^{-2}	F = 1344 N – 1176 N = 168 N F = 168 N m = 120 kg a = ? $F = m\ a$ (1 mark) $168 = 120 \times a$ (1 mark) $a = 1.4$ m s^{-2} (1 mark)
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	Q	☒ Graph P: Ball must start with zero velocity just before the ball is hit by the racket ☑ Graph Q: Ball increases in velocity from zero when the ball is hit by the racket. ☒ Graph R: Ball must start with zero velocity just before the ball is hit by the racket
11b	Answer to include:	1 mark: equal (to) (this mark must be attained to achieve second mark) 1 mark: vertical/downward acceleration is the same
11c	220 N	E_w = 5.5 kJ = 5500 J F = ? d = 25m $E_w = F\ d$ (1 mark) $5500 = F \times 25$ (1 mark) $F = 220$ N (1 mark)
12a(i)	3.0x10^{8} m s^{-1}	All electromagnetic waves travel at 3.0x10^{8} m s^{-1}
12a(ii)	7.4x10^{16} m	$d = v \times t$ (1 mark) $d = 3\times10^{8} \times 7.8 \times 365.25 \times 24 \times 60 \times 60$ (1 mark) $d = 7.4\times10^{16}$ m (1 mark)
12b(i)	One answer from:	Photographic film; photodiode; charge coupled device/CCD; LDR; retina (of the eye); phototransistor
12b(ii)	Equal (to)	All electromagnetic waves travel at 3.0x10^{8} m s^{-1} so radio waves and light waves will arrive at the same time.

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