JABstem
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Past Papers
Nat 5
Physics
2019
Marking Scheme

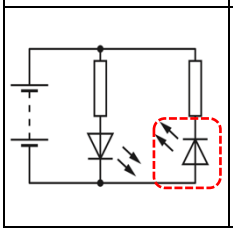
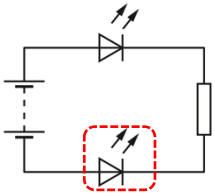
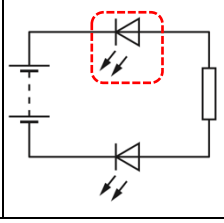
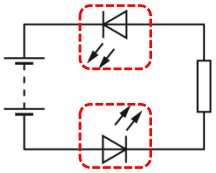
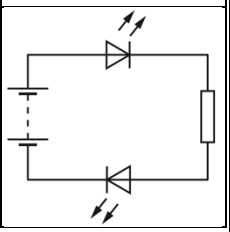
Grade Awarded	Mark Required		% candidates achieving grade
	/125	%	
A	86+	68.8%	31.8%
B	72+	57.6%	22.5%
C	58+	46.4%	20.3%
D	44+	35.2%	14.7%
No award	<44	<35.2%	10.7%

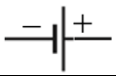
Section:	Multiple Choice	Extended Answer	Assignment
Average Mark:	15.5 /25	40.3 /75	17.3 /25

2019 Nat5 Physics Marking Scheme

<table>
<tr><th>Question</th><th>Answer</th><th>Physics Covered</th></tr>
<tr><td>1</td><td>A</td><td>
<table>
<tr><td>Vector Quantity</td><td>force</td><td>velocity</td><td>displacement</td><td>acceleration</td><td>weight</td></tr>
<tr><td>Scalar Quantity</td><td>energy</td><td>speed</td><td>distance</td><td>time</td><td>mass</td></tr>
</table>
</td></tr>
<tr><td>2</td><td>B</td><td>$a = 2.0\ m\ s^{-2}$ $v = ?$ $u = 6.0\ m\ s^{-1}$ $t = 4.0\ s$
$a = \frac{v - u}{t}$
$2.0 = \frac{v - 6.0}{4.0}$
$8.0 = v - 6.0$
$v = 8.0 + 6.0$
$v = 14.0\ m\ s^{-1}$</td></tr>
<tr><td>3</td><td>E</td><td>The greatest acceleration on the journey will have the steepest gradient on the graph
$\therefore$ Section ST is the greatest acceleration.</td></tr>
<tr><td>4</td><td>C</td><td>$d = ?$ $v = 8.0\ m\ s^{-1}$ $t = 2.0\ s$
$d = v \times t$
$d = 8.0 \times 2.0$
$d = 16.0\ m$
Distance from river bank = distance ball kicked – width of river = 16.0m – 3.0m = 13.0m</td></tr>
<tr><td>5</td><td>C</td><td>
<table>
<tr><td>Statement I - Incorrect</td><td>Statement II - Incorrect</td><td>Statement III - Correct</td></tr>
<tr><td>Sirius A is the closest to Earth but is the oldest star</td><td>There is no relationship between age of star and approximate surface temperature</td><td>There is no relationship between age of star and approximate surface temperature</td></tr>
</table>
</td></tr>
<tr><td>6</td><td>B</td><td>☒A Geostationary satellites have an orbital period of 24 hours to stay above same point on Earth
☑B Geostationary satellites orbital altitude of 36000km and have an orbital period of 24 hours
☒C Geostationary satellites have an orbital period of 24 hours to stay above same point on Earth
☒D Geostationary satellites orbit the earth at an altitude of 36000 km
☒E Geostationary satellites orbit the earth at an altitude of 36000 km</td></tr>
<tr><td>7</td><td>C</td><td>$W = 240N$ $g_{earth} = 9.8N\ kg^{-1}$ $m = ?$
$m = \frac{W}{g} = \frac{240\ N}{9.8\ N\ kg^{-1}} = 24.5\ kg$
$W = ?$ $g_{mars} = 3.7N\ kg^{-1}$ $m = 24.5\ kg$
$W = m \times g = 24.5kg \times 3.7\ N\ kg^{-1} = 91\ N$</td></tr>
<tr><td>8</td><td>C</td><td>$Q = ?$ $I = 2.0\ A$ $t = 5\ minutes = 5x60\ s$
$Q = I \quad t$
$Q = 2.0 \times 5x60$
$Q = 600\ C$</td></tr>
<tr><td>9</td><td>D</td><td>From graph: if temperature = 50°C then Resistance = 2.0 kΩ = 2000 Ω
In Question: if temperature = 50°C then Current = 0.004 A
$V = I \quad R$
$V = 0.004 \times 2000$
$V = 8\ V$</td></tr>
</table>

10 — E

☒A	☒B	☒C	☒D	☑E
				

		
Diodes, LDRs and LEDs should be connected with the negative end connected to. Th negative end of a cell/battery	The negative end of a cell is the shorter line on the cell. This should be connected to the negative end of a diode, LDR or LED	LEDs circled are connected the wrong way in circuits above

11 — A

☑A As light decreases, resistance in LDR increases.
The voltage in the variable resistor decreases and the transistor switches on
☒B Increasing the light level will lower the resistance of LDR.
This will increase the voltage over the variable resistor and keep the lamp off.
☒C Increasing the resistance of R will increase the voltage of the variable resistor.
The lamp will stay off when the voltage over the variable resistor increases
☒D Reducing the supply voltage does not alter the ratio of voltages between LDR and variable resistor.
☒E Temperature will affect all parts of the circuit but the lamp will remain off

12 — D

Statement I - Incorrect	Statement II - **Correct**	Statement III - **Correct**
V_1 would <u>only</u> equal V_2 if the combined resistance in parallel of R_2 and R_3 equals the resistance of R_1	Voltage V_2 always equals V_3 as voltage in branches of a parallel circuit are always equal.	The V_s equals the total voltages over V_1 and the combined V_2 & V_3 parallel branches. As $V_2 = V_3$: $V_s = V_1 + V_2$ and $V_s = V_1 + V_3$

13 — B

☒A PQ: Solid rising in temperature until it reaches melting point
☑B QR: Change of State as it is horizontal: Melting from solid to liquid
☒C RS: Liquid rising in temperature until it reaches boiling point
☒D ST: Change of State as it is horizontal: Evaporating from liquid to gas
☒E TU: Gas rising in temperature

14 — B

p = 1470 Pa ρ = 990 kg m^{-3} g = 9.8 N kg^{-1} h = ?

$p = \rho \times g \times h$

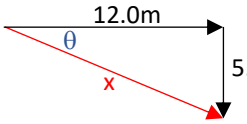
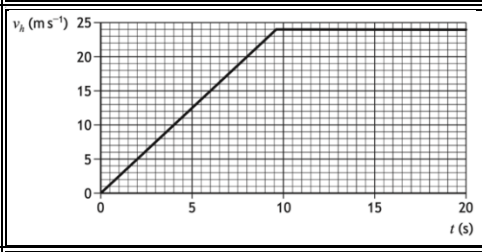
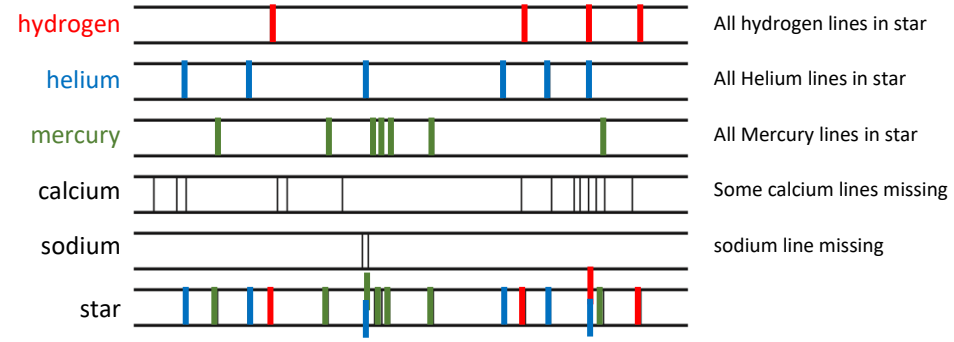
$1470 = 990 \times 9.8 \times h$

$h = 0.15$ m

15 — E

☒A The number of collisions between particles and tyre decides the pressure in tyre
☒B The tyre does not shrink so the force does not act over a smaller area
☒C Increasing the average spacing between particles does not necessarily increase force or frequency of collision of air particles with the tyre to increase pressure.
☒D Expansion of the tyre is not necessarily linked to an increase in collisions by air particles with the tyre with greater frequency or greater force.
☑E Increase in pressure is caused by an increased kinetic energy of particles hitting the surface of the tyres more frequently and with more force.

16	D	Pressure: Constant $V_1 = 0.3\ m^3$ $T_1 = 20^oC = 293\ K$ $V_2 = ?$ $T_2 = 50^oC = 323\ K$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{0.3}{293} = \frac{V_2}{323}$ $V_2 = \frac{0.3 \times 323}{293}$ $V_2 = 0.33\ m^3$
17	B	Amplitude: Amplitude = $\frac{6m}{2}$ = **3m** Wavelength: 3 wavelengths = 24m; 1 wavelength = **8m**
18	C	The to work out the frequency of a wave, both the wavelength and the speed of the wave are required. The question does not give an indication of the speed of the wave. Frequency can also be worked out from the period of the wave where T = 8ms = 0.08s $T = \frac{1}{f}$ $0.08 = \frac{1}{f}$ f = 12.5 Hz
19	D	☒A No curvature on the ends of the waves after the wall ☒B Curvature starts too early. Should only start in the areas where wall blocked wave ☒C Wavelength should be same before and after the wall ☑D Wavelength the same and curvature in the areas where the wall blocked wave ☒E Wavelength should be same before and after the wall
20	A	Angle of incidence = angle between normal and ray inside glass block = 90^o-55^o = 35^o Angle of Refraction = angle between normal and ray before glass block = 90^o-30^o = 60^o
21	B	☒A alpha particles deflect towards the negative plate and gamma rays go straight ☑B alpha particles deflect towards the negative plate and gamma rays go straight ☒C alpha particles deflect towards the negative plate ☒D alpha particles deflect towards the negative plate and gamma rays go straight ☒E gamma rays do not deflect in an electric field
22	A	$A = \frac{N}{t} = \frac{1800}{3x60} = 10\ Bq$
23	E	$\dot{H} = 5.0\ mSv\ h^{-1}$ H = ? t = 8 h x 6 x 12 = 576h $\dot{H} = \frac{H}{T}$ $5 = \frac{H}{576}$ H = 5 x 576 = 2880 mSv
24	D	☒A alpha particle tracers inside body would not be detectable outside the body ☒B beta particle tracers inside body would not be detectable outside the body ☒C The tracer half-life is too long to be used safely in the patient ☑D A short half life and a gamma emitter are the ost suitable to be used as a tracer ☒E The tracer half-life is too long to be used safely in the patient
25	B	56 MBq → 28 MBq → 14 MBq → 7 MBq → 3.5 MBq 4 half-lives = 40 hours 1 half-life = 10 hours

Question	Answer	Physics Covered
1a(i)	13m	Displacement East = 16.0m - 4.0m =12.0m. Displacement South = 11.0m - 6.0m = 5.0m  $x = \sqrt{(12.0)^2 + (5.0)^2}$ $x = \sqrt{144 + 25}$ $x = \sqrt{169}$ $x = 13$ m
1a(ii)	113	$\tan\theta = \frac{\text{opp}}{\text{adj}} = \frac{5.0}{12.0} = 0.417 \quad \therefore \ \theta = 23^o$ Bearing = 90° + 23° = 113
1b	0.40m s^{-1} at bearing 113	s = 13m $\bar{v}$ = ? t = 32.5s s = $\bar{v}$ t (1 mark) 13 = $\bar{v}$ x 32.5 (1 mark) $\bar{v}$ = 0.40 m s^{-1} (1 mark)
1c	2.9 s	Distance travelled = 16.0 + 11.0 + 4.0 + 6.0 = 37.0m d = 37.0 m $\bar{v}$ = 1.25 m s^{-1} t = ? d = $\bar{v}$ t (1 mark) 37.0 = 1.25 x t (1 mark) t = 29.6 s Difference in time = 32.5s – 29.6s = 2.9 s (1 mark)
1d	Answer to include:	(The forces are) equal (in size) and opposite (in direction)
2a(i)	2.5 m s^{-2}	a = ? v = 20 m s^{-1} u = 0 m s^{-1} t = 8 s $a = \frac{v - u}{t} = \frac{20 - 0}{8} = 2.5$ m s^{-2} (1 mark) (1 mark) (1 mark)
2a(ii)	370 kg	F = 925 N m = ? a = 2.5 m s^{-2} F = m a (1 mark) 925 = m x a (1 mark) m = 370 kg (1 mark)
2a(iii)A	275 N	F = 1200 – 925 = 275 N
2a(iii)B	One answer from:	streamlined (shape) | has wheels | aerodynamic | Or other suitable answer
2b	80 m	 Distance = area under graph = ½ x 8 x 20 = 80 m
3	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.
4a	Hydrogen Helium Mercury (all three required for 1 mark)	

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4b(i) — The distance light travels in one year

A light year is the distance electromagnetic radiation like light travels in one year.
A light year has a distance: $d = 3.0\times10^{8}\ m\ s^{-1} \times 1\times365.25\times24\times60\times60\ s = 9.5\times10^{15}\ m$

4b(ii) — 9.2×10^{17} m

$d = v \times t$ (1 mark)

$d = 3\times10^{8} \times 97 \times 365.25 \times 24 \times 60 \times 60$ (1 mark)

$d = 9.2\times10^{17}\ m$ (1 mark)

4c(i) — One answer from:

No atmosphere to absorb light	full range of EM waves can be observed	can be used in daytime or cloudy weather	no light pollution

4c(ii) — One answer from:

GPS	weather forecasting	communications	scientific discovery

5a(i) — Graph showing:

1 mark	1 mark	1 mark
suitable scales, labels and units	all points plotted accurately to ± half a division	best fit curve

5a(ii) — Answer to include:

1 mark	(Resistance of wire) increases (as the length of wire increases)
1 mark	Current decreases (as the length of wire increases).

5a(iii) — 0.55 A

5a(iv) — Repeat (and average)

Repeating an experiment allows and average to be worked out. This reduces the chance of a rogue result changing the results to a different conclusion.

5b — Answer to include:

1 mark	Resistance will be less (than 5.2Ω)		
1 mark	The wire now has shorter length (between X and Y)	or	Two wires are connected in parallel

6a(i) — 0.025 A

$R_T = R_1 + R_2 + R_3$

$R_T = 180 + 180 + 120$ (1 mark)

$R_T = 480\ \Omega$

V = 12 V I = ? R = 480 Ω

$V = I \times R$ (1 mark)

$12 = I \times 480$ (1 mark)

$I = 0.025\ A$ (1 mark)

6a(ii) — 0.075 W

P = ? I = 0.025 A R = 120 Ω

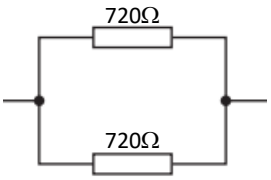
$P = I^2 \times R$ (1 mark)

$P = (0.025)^2 \times 120$ (1 mark)

$P = 0.075\ W$ (1 mark)

6b(i) — 480 Ω

Combining Parallel Resistors:



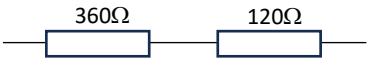
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$ (1 mark)

$\frac{1}{R_T} = \frac{1}{720} + \frac{1}{720}$ (1 mark)

$\frac{1}{R_T} = \frac{2}{720}$

$R_T = 360\ \Omega$

Combining Series Resistors:



$R_T = 360\Omega + 120\Omega = \mathbf{480\ \Omega}$ (1 mark) (1 mark)

6b(ii) — Answer to include:

1 mark	(Power will be) the same
1 mark	Current will be the same (in the 120 Ω resistor)

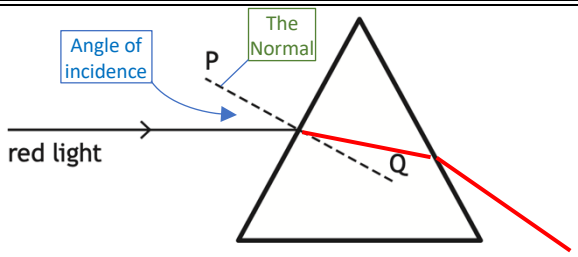
7a — Working showing: 91000 J

P = 3.5 kW = 3500 W E = ? t = 26s

$P = \frac{E}{t}$ (1 mark)

<table>
<tr><td></td><td></td><td>$3500 = \frac{E}{26}$ (1 mark)
$E = 91000$ J</td></tr>
<tr><td>7b(i)</td><td>83600 J</td><td>E_h = ? c = 4180 m = 0.25 kg $\Delta T = 100^0C - 20^oC = 80^oC$
E = c x m x ΔT (1 mark)
E = 4180 x 0.25 x 80 (1 mark)
E = 83600 J (1 mark)</td></tr>
<tr><td>7b(ii)</td><td>0.0033 kg</td><td>$E_h = 91000 - 83600$ (1 mark)
$E_h = 7400$ J
E = 7400 J m = ? l = 22.6×10^5 J kg^{-1}
E = m x l
7400 = m x 22.6×10^5
m = 0.0033 kg</td></tr>
<tr><td>7b(iii)</td><td>One answer from:</td><td>Heat energy lost to the surroundings. <u>or</u> Some of the heat (energy) is used to heat the dispenser.</td></tr>
<tr><td>8a</td><td>Diagram showing:</td><td>1 mark (including arrow)
Thrust

1 mark for arrow and one from:
Weight
Force of Gravity
Pull of gravity
Gravitational Pull</td></tr>
<tr><td>8b</td><td>783 N</td><td>P = 1.74×10^5 Pa F = ? A = 4.50×10^{-3} m^2
$P = \frac{F}{A}$ (1 mark)
$1.74 \times 10^5 = \frac{F}{4.50 \times 10^{-3}}$ (1 mark)
F = 783 N (1 mark)</td></tr>
<tr><td>8c(i)</td><td>1.5×10^5 Pa</td><td>p_1 = 1.74×10^5 Pa $V_1 = 7.5 \times 10^{-4}$ m^3
p_2 = ? $V_2 = 7.5 \times 10^{-4}$ m^3 + 1.2×10^{-4} m^3 = 8.7×10^{-4} m^3 (1mark)
(1 mark) $p_1V_1 = p_2V_2$
(1 mark) $1.74 \times 10^5 \times 7.5 \times 10^{-4} = p_2 \times 8.7 \times 10^{-4}$
$\frac{1.74 \times 10^5 \times 7.5 \times 10^{-4}}{8.7 \times 10^{-4}} = p_2$
(1 mark) 1.5×10^5 Pa = p_2</td></tr>
<tr><td>8c(ii)</td><td>Answer to include:</td><td>1 mark (individual) particles collide with container/walls less frequently (than before)
1 mark (overall) force (on walls) is less
1 mark pressure decreases</td></tr>
</table>

<table>
<tr><td>9a</td><td>2.0 m</td><td>ν = 3x10^{8}m s^{-1} f = 153MHz = 153x10^6 Hz λ = ?
ν = f x λ (1mark)
3x10^8 = 153x10^6 x λ (1mark)
λ = 2.0m (1mark)</td></tr>
<tr><td>9b</td><td>Answer to include:</td><td><table><tr><td>1 mark</td><td>The speed of light is (much) greater than the speed of sound</td></tr><tr><td>1 mark</td><td>The sound takes more time to travel (the 100 m)</td></tr></table></td></tr>
<tr><td>9c(i)</td><td>6.0 m s^{-1}</td><td>E_k = 4.5x10^5 J m = 25000 kg v = ?
$E_k = \frac{1}{2}$ m v^2 (1 mark)
4.5x10^5 = $\frac{1}{2}$ x 25000 x v^2 (1 mark)
$v^2 = \sqrt{36}$
v = 6.0 m s^{-1} (1 mark)</td></tr>
<tr><td>9c(ii)</td><td>One answer from:</td><td>Energy lost (as heat and sound) due to { friction / air resistance }</td></tr>
<tr><td>10a</td><td>Electromagnetic radiation</td><td>Also accepted: electromagnetic waves or electromagnetic spectrum</td></tr>
<tr><td>10b</td><td>Frequency is less/lower</td><td><table><tr><th>EM Type</th><th>Gamma</th><th>X-Ray</th><th>Ultra-violet</th><th>Visible</th><th>Infra-Red</th><th>Microwave</th><th>Radio & TV</th></tr><tr><td>Energy</td><td>High</td><td colspan="6">←</td><td>Low</td></tr><tr><td>Frequency</td><td>High</td><td colspan="6">←</td><td>Low</td></tr><tr><td>Wavelength</td><td>Low</td><td colspan="6">←</td><td>High</td></tr></table></td></tr>
<tr><td>10c(i)A</td><td>(Black bulb) Thermometer</td><td>Black bulb thermometer will show an increase in temperature as infra-red radiation is absorbed by the thermometer.</td></tr>
<tr><td>10c(i)B</td><td>radioactive waste</td><td>Radiation released by radioactive waste is a source of radiation in the environment</td></tr>
<tr><td>10c(ii)</td><td>One answer from:</td><td><table><tr><td>Treating skin conditions/jaundice</td><td>Produces vitamin D</td><td>Disinfection of hospital instruments</td></tr><tr><td>Checking security markings on banknotes</td><td>Tanning Sun-beds</td><td>To ‘cure’ or harden composite material for fillings or nail gel/polish</td></tr></table></td></tr>
<tr><td>11a(i)
11a(ii)
11a(iii)</td><td>Line as shown in diagram:
(the) normal
Angle if incidence as shown in diagram:</td><td> 
</td></tr>
<tr><td>11b</td><td>Answer to include:</td><td><table><tr><td>1 mark</td><td>wavelength is the same</td></tr><tr><td>1 mark</td><td>the blocks are made of the same material.</td></tr></table></td></tr>
<tr><td>12a</td><td>Answer to include:</td><td><table><tr><td>1 mark</td><td>1 mark</td><td>1 mark</td></tr><tr><td>Measure the count in a set time</td><td>Repeat at regular intervals</td><td>Measure and subtract background count</td></tr></table></td></tr>
<tr><td>12b</td><td>Carry out experiment over longer time period</td><td>The initial corrected count rate is 250 counts per minute and has yet to reach the first halving at 125 counts per minute. The graph would need to extrapolated to get top 125 counts per minute and this could lead to error if not correctly drawn. Leaving for even longer might allow. Multiple halving to give more half-life values which would confirm the reliability of the results achieved.</td></tr>
<tr><td>12c(i)</td><td>1.5 x10^{-8} Gy</td><td>D = ? E = 1.2 μJ = 1.2x10^{-6} J m = 80.0kg
$D = \frac{E}{m}$ (1 mark)
$D = \frac{1.2x10^{-6}}{85}$ (1 mark)
D = 1.5 x10^{-8} Gy (1 mark)</td></tr>
</table>

<table>
<tr><td>12c(ii)</td><td>3</td><td>H = 4.5 x10^{-8} Sv D = 1.5 x10^{-8} Gy w_R = ?
H = D x W_R (1 mark)
4.5 x10^{-8} = 1.5 x10^{-8} x W_R (1 mark)
W_R = 3 (1 mark)</td></tr>
<tr><td>12d</td><td>Answer to include:</td><td>1 mark Photographic film blackened/darkened/fogged
1 mark Film behind different windows affected by different types of radiation</td></tr>
<tr><td>13</td><td>Open Ended Question:</td><td><table><tr><th>1 mark</th><th>2 marks</th><th>3 marks</th></tr><tr><td>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.</td><td>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.</td><td>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.</td></tr></table></td></tr>
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