Mark Scheme (Results)

Summer 2026

Pearson Edexcel International Advanced
Level In Physics
WPH15/01A

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Mark scheme notes

Underlying principle
The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. **It is not a set of model answers.**

1. Mark scheme format
1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the MS has specified specific words that must be present. Such words will be indicated by underlining e.g. 'resonance'
1.2 Bold lower case will be used for emphasis e.g. '**and**' when two pieces of information are needed for 1 mark.
1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".
1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties
2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.
2.2 This does not apply in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.
2.3 The mark will not be awarded for the same missing or incorrect unit only once within one clip in epen.
2.4 Occasionally, it may be decided not to insist on a unit e.g the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.
2.5 The mark scheme will indicate if no unit error is to be applied by placing brackets around the unit.

3. Significant figures
3.1 Use of too many significant figures in the theory questions will not prevent a mark being awarded if the answer given rounds to the answer in the MS.
3.2 Too few significant figures will mean that the final mark cannot be awarded in 'show that' questions where one more significant figure than the value in the question is needed for the candidate to demonstrate the validity of the given answer.
3.3 The use of one significant figure might be inappropriate in the context of the question e.g. reading a value off a graph. If this is the case, there will be a clear indication in the MS.
3.4 The use of $g = 10\ \text{m s}^{-2}$ or $10\ \text{N kg}^{-1}$ instead of $9.81\ \text{m s}^{-2}$ or $9.81\ \text{N kg}^{-1}$ will be penalised by one mark (but not more than once per clip). Accept $9.8\ \text{m s}^{-2}$ or $9.8\ \text{N kg}^{-1}$
3.5 In questions assessing practical skills, a specific number of significant figures will be required e.g. determining a constant from the gradient of a graph or in uncertainty calculations. The MS will clearly identify the number of significant figures required.

4. Calculations

4.1 **use of** the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.

4.2 If a 'show that' question is worth 2 marks, then both marks will be available for a reverse working. If the question is worth 3 marks then only 2 marks will be available.

4.3 The mark scheme will show a correctly worked answer for illustration only.

5. Quality of Written Expression

5.1 Questions that asses the ability to show a coherent and logically structured answer are marked with an asterisk.

5.2 Marks are awarded for indicative content and for how the answer is structured.

5.3 Linkage between ideas, and fully-sustained reasoning is expected.

Question Number	Answer	Mark
1	**The only correct answer is A (The energy released when the nucleus forms from individual nucleons)** B is not correct because binding energy is defined as the energy released when the nucleus forms from individual nucleons C is not correct because binding energy is defined as the energy released when the nucleus forms from individual nucleons D is not correct because binding energy is defined as the energy released when the nucleus forms from individual nucleons	**1**
2	**The only correct answer is B (Increase the counting time to 10 minutes)** A is not correct because this would change the calculated count rate C is not correct because this would increase the percentage uncertainty D is not correct because this would increase the percentage uncertainty	**1**
3	**The only correct answer is B (It emits no em-radiation)** A is not correct because dark matter is defined as matter that does not emit electromagnetic radiation C is not correct because dark matter is defined as matter that does not emit electromagnetic radiation D is not correct because dark matter is defined as matter that does not emit electromagnetic radiation	**1**
4	**The only correct answer is C ($\sqrt{2}\,A$)** A is not correct because $E_{\text{k,max}} = \frac{1}{2}m\omega^2A^2$ B is not correct because $E_{\text{k,max}} = \frac{1}{2}m\omega^2A^2$ D is not correct because $E_{\text{k,max}} = \frac{1}{2}m\omega^2A^2$	**1**
5	**The only correct answer is C** A is not correct because mass is moving fastest at the point where displacement from the equilibrium position is zero B is not correct because mass is moving fastest at the point where displacement from the equilibrium position is zero D is not correct because mass is moving fastest at the point where displacement from the equilibrium position is zero	**1**
6	**The only correct answer is B (2.5)** A is not correct because $g = \frac{GM}{r^2}$ C is not correct because $g = \frac{GM}{r^2}$ D is not correct because $g = \frac{GM}{r^2}$	**1**

7	**The only correct answer is B (5, 3.2)** A is not correct because period is 4 × (time to return to equilibrium position) C is not correct because amplitude is twice the displacement from the equilibrium position and period is 4 × (time to return to equilibrium position) D is not correct because amplitude is twice the displacement from the equilibrium position	**1**
8	**The only correct answer is D (The resultant force always acts in the opposite direction to the displacement)** A is not correct because the resultant force sometimes acts in the opposite direction to the velocity B is not correct because the resultant force sometimes acts in the same direction as the velocity C is not correct because the resultant force never acts in the same direction to the displacement	**1**
9	**The only correct answer is B ($\frac{g}{2}$)** A is not correct because $g = \frac{GM}{r^2}$ **and** $\rho = \frac{m}{V}$ C is not correct because $g = \frac{GM}{r^2}$ **and** $\rho = \frac{m}{V}$ D is not correct because $g = \frac{GM}{r^2}$ **and** $\rho = \frac{m}{V}$	**1**
10	**The only correct answer is A (W → X and temperature increases)** B is not correct because the temperature increases C is not correct because the temperature decreases D is not correct because the temperature decreases	**1**

Question Number	Acceptable Answer		Additional Guidance	Mark
11	Use of $I = \frac{L}{4\pi d^2}$ $L = 6.4 \times 10^{33}$ W	**(1)** **(1)**	Example of calculation $L = 4\pi d^2 I = 4\pi(2.93 \times 10^{18}\ \text{m})^2 \times 5.92 \times 10^{-5}\ \text{W m}^{-2}$ $L = 6.39 \times 10^{33}$ W	**2**

(Total for Question 11 = 2 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
12	Energy transferred from hot liquid = energy transferred to juice [This may be implicit] **(1)** Use of $E = mc\Delta\theta$ **(1)** Final temperature $= 79$ °C **(1)**	Accept 352K Example of calculation 0.22 kg × 4190 J kg^{-1} °C^{-1}× (100 – θ) K = 0.075 kg × 3890 J kg^{-1} °C^{-1} × (θ – 11.5) K (θ – 11.5) K = $\frac{0.22\ \text{kg} \times 4190\ \text{J kg}^{-1}\ °\text{C}^{-1}}{0.075\ \text{kg} \times 3890\ \text{J kg}^{-1}\ °\text{C}^{-1}} \times (100 - \theta)$K ($\theta$ – 11.5) °C = (316 – 3.16 θ) °C $\therefore 4.16\,\vartheta = 327.5$ $\theta = \frac{327.5\ °\text{C}}{4.16} = 78.7$ °C	**3**

(Total for Question 12 = 3 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
13	λ_{max} = 0.39 (μm) [Allow 0.30 → 0.50 (μm)]	**(1)**		**4**
	Use of $\lambda_{max}\ T = 2.898 \times 10^{-3}$ m K	**(1)**		
	T = 7400 K [accept answer consistent with their stated value of λ_{max}]	**(1)**	Example of calculation	
	[Allow T = 7200 K → 7800 K consistent with their λ_{max}]		$T = \frac{2.898 \times 10^{-3}\ \text{m K}}{3.9 \times 10^{-7}\ \text{m}} = 7431\ \text{K}$	
	7400 (K) is closest to 7500 (K), so star is Virginis A **Or** calculated value compared with 6500, 7500 or 7800 **and** consistent conclusion.	**(1)**		
	OR			
	λ_{max} = 0.39 (μm) [Allow 0.30 → 0.50 (μm)]	**(1)**		
	Use of $\lambda_{max}\ T = 2.898 \times 10^{-3}$ m K	**(1)**	Example of calculation	
	calculates λ_{max} for all three stars in the table	**(1)**	$\lambda\text{max} = \frac{2.898 \times 10^{-3}\ \text{m K}}{6500\ K} = 4.458 \times 10^{-7}\ m$	
	Procyon A = 0.446μm, Virginis A = 0.386 μm, Altair = 0.372 μm compares to their λ_{max} from the graph, **and** consistent conclusion	**(1)**	$\lambda\text{max} = \frac{2.898 \times 10^{-3}\ \text{m K}}{7500\ K} = 3.864 \times 10^{-7}\ m$	
			$\lambda\text{max} = \frac{2.898 \times 10^{-3}\ \text{m K}}{7800\ K} = 3.7154 \times 10^{-7}\ m$	

(Total for Question 13 = 4 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
14(a)	Mass difference calculated Conversion to kg Use of $\Delta E = c^2 \Delta m$ Conversion of J to eV Energy released = 5.8 (MeV)	**(1)** **(1)** **(1)** **(1)** **(1)**	<u>Example of calculation</u> $\Delta \text{m} = (224.02021 - 220.01138 - 4.00260)\text{u}$ $= 6.23 \times 10^{-3}\text{u}$ $\Delta m = 6.2 \times 10^{-3}\text{u} \times 1.66 \times 10^{-27}\ \text{kg u}^{-1}$ $= 1.03 \times 10^{-29}\ \text{kg}$ $\Delta E = c^2 \Delta m = (3.00 \times 10^{8}\ \text{m s}^{-1})^2 \times 1.03 \times 10^{-29}\ \text{kg}$ $= 9.27 \times 10^{-13}\ \text{J}$ $\Delta E = \frac{9.27 \times 10^{-13}\ \text{J}}{1.6 \times 10^{-13}\text{J MeV}^{-1}} = 5.79\ \text{MeV}$	**5**
14(b)	Alpha radiation is highly ionising Radon gas can be breathed in **and** cause damage to living tissue	**(1)** **(1)**	Allow mutate/kill **Or** causes cancer for damage Allow DNA **Or** cells **Or** lungs for living tissue Do not allow skin for living tissue	**2**

(Total for Question 14 = 7 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
15(a)(i)	Same time period as velocity **and** constant amplitude Wave shifted a quarter cycle to the right [i.e. a positive sine wave, displacement is zero at time zero.]	**(1)** **(1)**		**2**
15(a)(ii)	T = 0.40 s from graph Use of $T = 2\pi\sqrt{\frac{m}{k}}$ (accept any value of T that could be read from the graph) stiffness = 31 N m^{-1}	**(1)** **(1)** **(1)**	<u>Example of calculation</u> $0.40\ \text{s} = 2\pi\sqrt{\frac{0.125\ \text{kg}}{k}}$ $k = 4\pi^2 \times \frac{0.125\ \text{kg}}{(0.40\ \text{s})^2} = 30.8\ \text{N m}^{-1}$	**3**
15(b)	When data has to be collected over a very short time interval When multiple data sets have to be collected simultaneously	**(1)** **(1)**	Allow When data has to be collected over a very long time interval	**2**

(Total for Question 15 = 7 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
16(a)	Use of $P = VI$ **and** $P = \frac{\Delta E}{\Delta t}$ Use of $\Delta E = mL$ specific latent heat $= 3.5 \times 10^5$ J kg^{-1}	**(1)** **(1)** **(1)**	Example of calculation $\Delta E = VIt = 24\text{ V} \times 2.3\text{ A} \times 750\text{ s} = 4.14 \times 10^4\text{ J}$ $L = \frac{4.14 \times 10^4\text{ J}}{(270 - 150) \times 10^{-3}\text{kg}} = 3.45 \times 10^5\text{ J kg}^{-1}$	**3**
16(b)	Some melted water stayed in the funnel **Or** Recorded mass of water may be too small **Or** Measured Current/p.d. is too large **Or** Calculated power is too large	**(1)**		**1**

(Total for Question 16 = 4 marks)

Question Number	Acceptable Answer	Additional Guidance	Mark
17(a)	Top line correct **(1)** Bottom line correct **(1)**	Example of equation $^{40}_{19}\text{K} \rightarrow {}^{40}_{20}\text{Ca} + {}^{0}_{-1}\beta^{-} + {}^{0}_{0}\bar{\nu}$	**2**
17(b)(i)	Use of $\lambda = \frac{\ln 2}{t_{1/2}}$ **(1)** Use of $\frac{\Delta N}{\Delta t} = (-)\lambda N$ **(1)** initial number of atoms = 1.08×10^{22} **(1)** .	Example of calculation $\lambda = \frac{\ln 2}{(1.25\times10^{9}\times3.15\times10^{7})\text{s}} = 1.76 \times 10^{-17}\text{s}^{-1}$ $1.90 \times 10^{5}\ \text{Bq} = 1.76 \times 10^{-17}\text{s}^{-1} \times N$ $\therefore N = \frac{1.90 \times 10^{5}\ \text{Bq}}{1.76 \times 10^{-17}\text{s}^{-1}} = 1.08 \times 10^{22}$	**3**
17(b)(ii)	Use of $A = A_0 e^{-\lambda t}$ **(1)** t = 4.8 ×10^7 year **(1)** **Or** A = 1.90×10^5 Bq [valid calculation needed] 4.8×10^7 (year) > 75 (year) so claim is false. **(1)** **Or** 1.90×10^5 (Bq) > 1.85×10^5 (Bq) so claim is false **Or** comparison of calculated value with value in question **and** consistent conclusion [ecf λ from (i)]	Example of calculation $1.85 \times 10^{5}\ \text{Bq} = 1.90 \times 10^{5}\ \text{Bq} \times \text{e}^{-1.76\times10^{-17}\text{s}^{-1}\,t}$ $t = \frac{\ln\left(\frac{1.85 \times 10^{5}\ \text{Bq}}{1.90 \times 10^{5}\ \text{Bq}}\right)}{-1.76 \times 10^{-17}\text{s}^{-1}} = 1.52 \times 10^{15}\ \text{s}$ $t = \frac{1.52 \times 10^{15}\ \text{s}}{3.15 \times 10^{7}\ \text{s year}^{-1}} = 4.81 \times 10^{7}\ \text{year}$	**3**

(Total for Question 17 = 8 mark

<table>
<tr><th>Question Number</th><th>Acceptable Answer</th><th>Additional Guidance</th><th>Mark</th></tr>
<tr><td>18(a)</td><td>Use of circumference = $2\pi r$ (1)
Use of $V = \frac{4}{3}\pi r^3$ (1)
Conversion of temperature to kelvin (1)
Use of $pV=NkT$ (1)
Pressure is 140 kPa (1)

35 kPa is not in the range 45 kPa – 52 kPa so ball does not meet FIBA rules (1)
Or 140 kPa is not in the range 150 kPa – 157 kPa
Or comparison of calculated value with range and consistent conclusion</td><td><u>Example of calculation</u>
$r = \frac{0.75\ \text{m}}{2\pi} = 0.119\ \text{m}$
$V = \frac{4}{3}\pi \times (0.119\ \text{m})^3 = 7.12 \times 10^{-3}\ \text{m}^3$
$p = \frac{2.5 \times 10^{23} \times 1.38 \times 10^{-23}\ \text{J K}^{-1} \times (273 + 16.0)\ \text{K}}{7.12 \times 10^{-3}\ \text{m}^3}$
$= 1.40 \times 10^5\ \text{Pa}$
Excess pressure $= (1.40 - 1.05) \times 10^5\ \text{Pa}$
Excess pressure $= 3.50 \times 10^4\ \text{Pa} = 35\ \text{kPa}$</td><td>6</td></tr>
<tr><td>*18(b)</td><td>This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning.
Total marks awarded is the sum of marks for indicative content and the marks for structure and lines of reasoning.

<table><tr><th>IC points</th><th>IC mark</th><th>Max linkage mark</th><th>Max final mark</th></tr><tr><td>6</td><td>4</td><td>2</td><td>6</td></tr><tr><td>5</td><td>3</td><td>2</td><td>5</td></tr><tr><td>4</td><td>3</td><td>1</td><td>4</td></tr></table></td><td>Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning.
The following table shows how the marks should be awarded for indicative content.
<table><tr><th>Number of indicative points seen in answer</th><th>Number of marks awarded for indicative points</th></tr><tr><td>6</td><td>4</td></tr><tr><td>5-4</td><td>3</td></tr><tr><td>3-2</td><td>2</td></tr><tr><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td></tr></table></td><td></td></tr>
</table>

3	2	1	3
2	2	0	2
1	1	0	1
0	0	0	0

Indicative content

IC1 As the temperature of the air decreases the average/mean kinetic energy of the molecules decreases

IC2 (So) the (root mean square) velocity/speed of the molecules decreases
Or the (average) momentum of the molecules decreases

IC3 The change of momentum of a molecule during a collision with the ball decreases

IC4 The rate of collision (of molecules) with the ball decreases

IC5 (So) the rate of change of momentum decreases and so the force (on the ball) decreases

IC6 (Hence) pressure exerted by the gas decreases, since $P = F/A$

	Number of marks awarded for structure and lines of reasoning
Answer shows a coherent and logical structure with linkage and fully sustained lines of reasoning demonstrated throughout	2
Answer is partially structured with some linkages and lines of reasoning	1
Answer has no linkage between points and is unstructured	0

6

(Total for Question 18 = 12 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
19(a)(i)	Use of $V = \frac{-GM}{r}$ gravitational potential = (−) 5.53 × 10^7 (J kg^{-1})	**(1)** **(1)**	Example of calculation $V = \frac{-6.67\times10^{-11}\ \text{N m}^2\ \text{kg}^{-2}\times5.98\times10^{24}\ \text{kg}}{(6.36\times10^6+8.50\times10^5)\ \text{m}} = -5.532\times10^7\ \text{J kg}^{-1}$	**2**
19(a)(ii)	calculation of energy change using $m \times \Delta V$ increase in gravitational potential energy = 1.1 × 10^9 J [ecf from i]	**(1)** **(1)**	Use of show that value gives 1.12 × 10^9 J Example of calculation $\Delta E = 145\ \text{kg} \times (-5.53\times10^7 + 6.27\times10^7)\text{J kg}^{-1} = 1.07\times10^9$	**2**
19(b)	Equate $F = \frac{GMm}{r^2}$ with $F = m\omega^2 r$ Use of $\omega = \frac{2\pi}{T}$ radius of geostationary orbit = 4.2 × 10^7 m **Or** period of satellite orbit = 23.3 hours **Or** ω =7.5 x 10^{-5} rad s^{-1} **Or** v = 3.10 m s^{-1} 4.2 × 10^7 (m) ≈ 4.1 × 10^7 (m), so the satellite is a geostationary satellite **Or** 23.3 (hours) ≈ 24 (hours) so the satellite is a geostationary satellite **Or** 83.8 x 10^3 (s) ≈ 86.4 x 10^3 (s) so the satellite is a geostationary satellite **Or** 7.5 x 10^{-5} (rad s^{-1}) ≈ 7.27×10^{-5} (rad s^{-1}) so the satellite is a geostationary satellite **Or** 3.10 (m s^{-1}) ≈ 3.07 x 10^3 (m s^{-1}) so the satellite is a geostationary satellite **Or** comparison of calculated value with given value **and** consistent conclusion	**(1)** **(1)** **(1)** **(1)**	Allow reasonable statements such as "not quite geostationary" for "is geostationary". Example of calculation $\omega = \frac{2\pi}{(24\times60\times60)\ \text{s}} = 7.27\times10^{-5}\ \text{rad s}^{-1}$ $\frac{GMm}{r^2} = m\omega^2 r$ $\therefore r = \sqrt[3]{\frac{GM}{\omega^2}} = \sqrt[3]{\frac{6.67\times10^{-11}\ \text{N m}^2\ \text{kg}^{-1}\times5.98\times10^{24}\ \text{kg}}{(7.27\times10^{-5}\text{rad s}^{-1})^2}}$ $= 4.23\times10^7$ m	**4**

(Total for Question 19 = 8 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
20(a)(i)	A (stellar) object of known luminosity	**(1)**		**1**
20(a)(ii)	A standard candle is located (in a star cluster) The intensity of the standard candle is measured. The inverse square law is used to calculate the distance to the standard candle	**(1)** **(1)** **(1)**	allow radiation flux for intensity	**3**
20(b)	λ value read from graph [393.0 (nm) or 396.5 (nm)] Use of $\Delta\lambda/\lambda = v/c$ for either spectral line $v = (-)3.05\times10^5$ m s^{-1} 393.4 nm line **Or** $v = (-)3.02\times10^5$ m s^{-1} 396.9 nm line **Or** $v = (-)3.04\times10^5$ m s^{-1} mean of 393.4 nm and 396.9 nm line Andromeda is moving towards the Earth [dependent on a negative velocity or on the logic of the wavelength is decreased (so blue shift)]	**(1)** **(1)** **(1)** **(1)**	Do not accept $\Delta\lambda = 396.9 - 393.4$ Example of calculation $v = \frac{(393.0 - 393.4)\times10^{-9}\text{ nm}}{393.4\times10^{-9}\text{ nm}} \times 3.0\times10^8\text{ m s}^{-1}$ $= -3.05\times10^5\text{ m s}^{-1}$ $v = \frac{(396.5 - 396.9)\times10^{-9}\text{ nm}}{396.9\times10^{-9}\text{ nm}} \times 3.0\times10^8\text{ m s}^{-1}$ $= -3.02\times10^5\text{ m s}^{-1}$	**4**
20(c)	Determine the red shift Calculate the (recessional) velocity Use Hubble's Law to calculate distance	**(1)** **(1)** **(1)**	Accept calculate $\Delta\lambda/\lambda$ or $\Delta f/f$ Accept Use $d = \frac{v}{H_0}$ to calculate distance	**3**

(Total for Question 20 = 11 marks)

Question Number	Acceptable Answer		Additional Guidance	Mark
21(a)	As the group of stars ages, main sequence stars evolve into red giants	**(1)**		**4**
	Then red giants evolve into white dwarf stars	**(1)**		
	Z is at the earliest stage, as diagram only has main sequence stars	**(1)**		
	X is at the latest stage, as diagram has red giants **and** white dwarf stars	**(1)**		
21(b)	Mass difference calculated	**(1)**		**2**
	$\Delta E = 3.26$ MeV	**(1)**	Example of calculation $\Delta m = [(2.80839 + 0.93957) - (2 \times 1.87561)]$ GeV/c^2 $\Delta m = -0.00326$ GeV/c^2 $\therefore \Delta E = 3.26$ MeV	
21(c)(i)	Use of $L = \sigma A T^4$	**(1)**	Example of calculation	**4**
	Use of $A = 4\pi r^2$	**(1)**	$\frac{L_{\text{final}}}{L_{\text{initial}}} = \left(\frac{r_{\text{final}}}{r_{\text{initial}}}\right)^2 \times \left(\frac{T_{\text{final}}}{T_{\text{initial}}}\right)^4$	
	Ratio of luminosities	**(1)**	$\frac{L_{\text{final}}}{L_{\text{initial}}} = \left(\frac{1.26 \times 10^{11}\ \text{m}}{6.96 \times 10^{8}\ \text{m}}\right)^2 \times \left(\frac{3000\ \text{K}}{5800\ \text{K}}\right)^4 = 2346$	
	$\frac{L_{\text{final}}}{L_{\text{initial}}} = 2350$	**(1)**		
21(c)(ii)	The wavelength at which peak intensity occurs will shift to a longer wavelength.	**(1)**	Accept shift to a lower frequency Accept shift towards the IR-region of the spectrum	**4**
	Because $\lambda_{\text{max}} T$ is constant and T decreases	**(1)**		
	The intensity of radiation will increase	**(1)**		
	Or The luminosity of the Sun will increase			
	Because $L \propto AT^4$ and the increase in A much greater than the decrease in T	**(1)**		

(Total for Question 21 = 14 marks)
TOTAL FOR PAPER = 90 MARKS