Candidate Name	Centre Number					Candidate Number				
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AS PHYSICS

AS UNIT 1
Motion, Energy and Matter

SPECIMEN PAPER

(1 hour 30 minutes)

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	12	
2.	11	
3.	14	
4.	9	
5.	15	
6.	11	
7.	8	
Total	80	

ADDITIONAL MATERIALS

In addition to this examination paper,
you will require a calculator and a **Data Booklet**.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Answer **all** questions.
Write your name, centre number and candidate number in the spaces at the top of this page.
Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question 5*(b).*

*Answer **all** questions.*

1. *(a)* When a net force F pushes a body of mass m through a distance D the body acquires a speed v. The following relationship is proposed:

$$F = \frac{mv^2}{2D}$$

Show that the equation is correct as far as units are concerned. [3]

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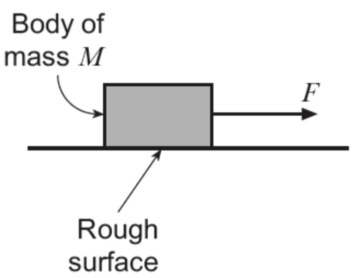
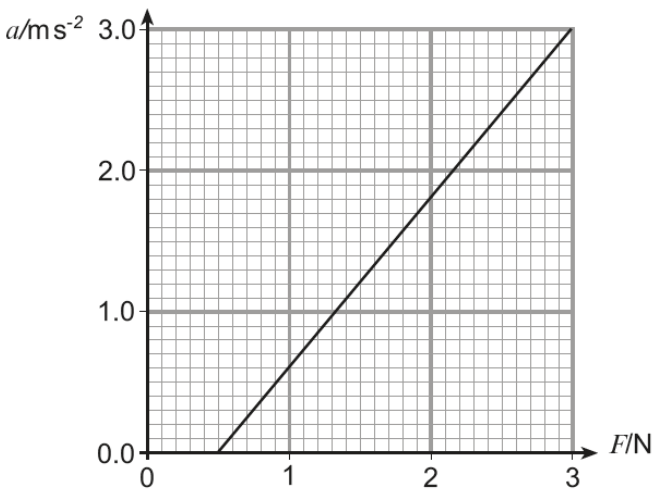
(b) A body of mass M is placed on a rough surface and a horizontal force, F, is applied to it as shown. Data-logging apparatus is used to determine the acceleration of the body for different values of F. The results are shown in the graph.





(i) Explain why the acceleration of the body is 0 when the applied force, F, is less than 0.5 N. [2]

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(ii) Use the graph to determine the value of M. [3]

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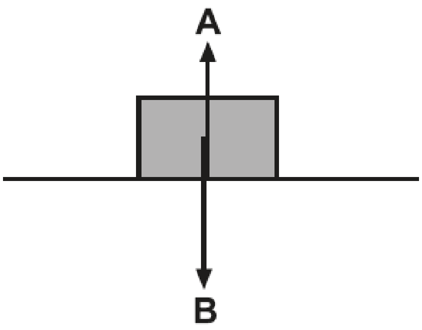
(c) (i) Label forces (A) and (B) acting on the body. [2]



(A) ....
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(B) ....
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(ii) State the Newton third law reaction to force (B) and the body upon which it acts. [2]

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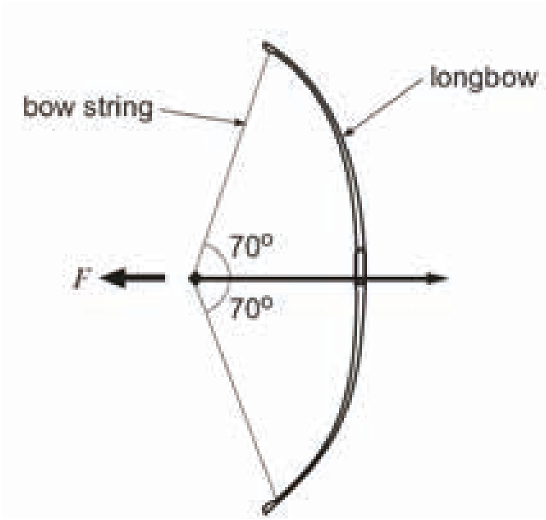
2. *(a)* The medieval longbow used by the Llantrisant bowmen was a devastatingly effective weapon. Assuming that a horizontal force F of 800 N is needed to draw back the bow string, show that the tension T in the string is approximately 1 170 N. [2]



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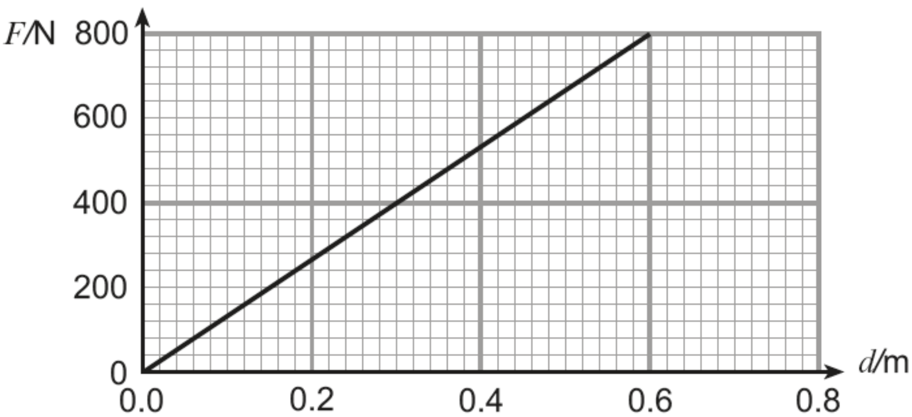
(b) (i) The graph shows the variation of F with d for the longbow, where d is the distance the centre of the string is pulled back. Calculate the energy stored in the bow when the tension in the string is 1 170 N. [2]



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(ii) Hence, **stating any assumptions you make**, show that the speed of the arrow as it leaves the bow is about 100 $m\,s^{-1}$. Take the mass of the arrow to be 50×10^{-3} kg. [3]

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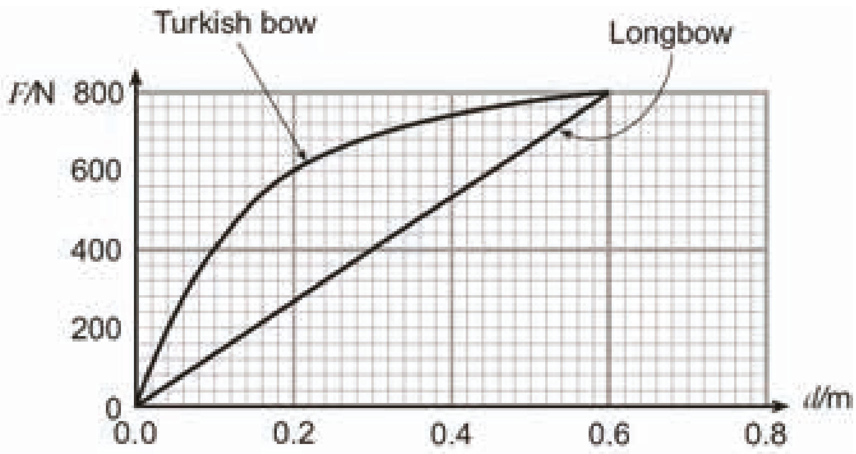
(c) The Turkish war-bow of the 15th and 16th centuries (pictured) was also a fearsome weapon, able to shoot lightweight arrows great distances. A copy of the graph on page 7 is shown below which has included on it a curve to represent the draw force versus ‘pull back distance’ for a typical Turkish bow.



Use the graph to compare the effectiveness of the Turkish bow in relation to the longbow. Your answer could refer to the ease of use of each bow, the energy stored and the effect this has on the motion of an arrow.
Calculations are not required. [4]

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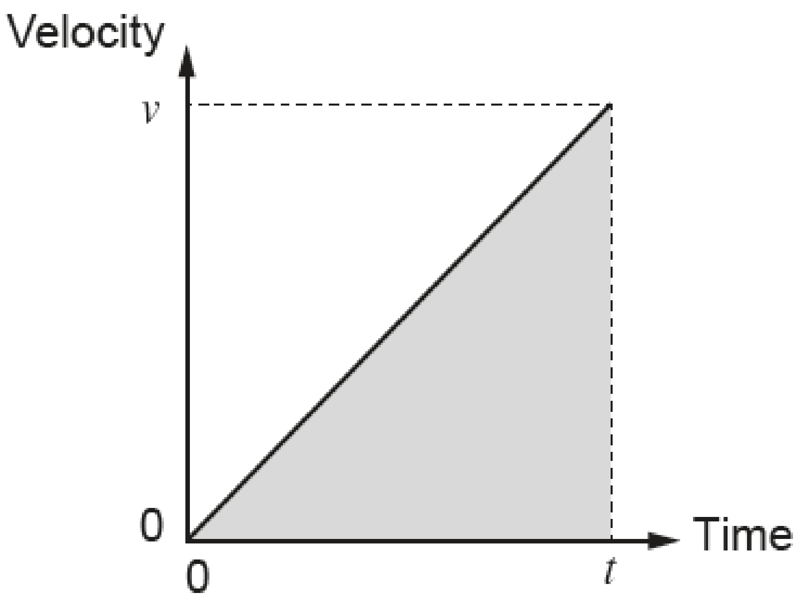
3. *(a)* A velocity-time graph is given for a body which is accelerating from rest in a straight line.



(i) Use the graph to show that, using the usual symbols: [3]

$$x = \tfrac{1}{2}at^2$$

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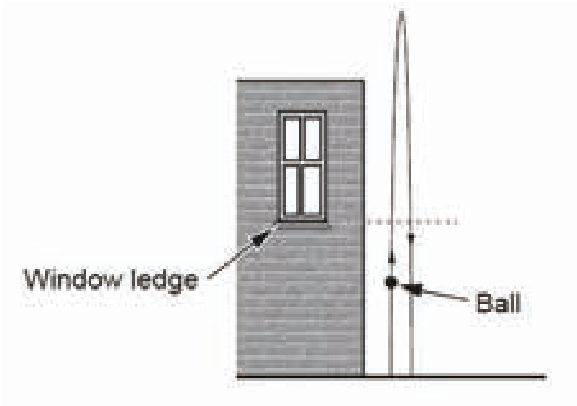
(ii) An actual car starts to accelerate uniformly but then air resistance increases and decreases its acceleration. Sketch a graph of the expected motion of the car **on the above graph.** [1]

(b) Iestyn throws a ball vertically upwards at Castell Coch and it passes a window ledge 0.3 s after being released. It passes the window ledge on its way back down, 1.6 s **later** (i.e. 1.9 s after being released). *Ignore the air resistance*.



(i) Determine the time of flight of the ball. [1]

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(ii) Calculate the initial velocity of the ball when it is released. [3]

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(iii) Calculate the height of the window ledge above the ground. [2]

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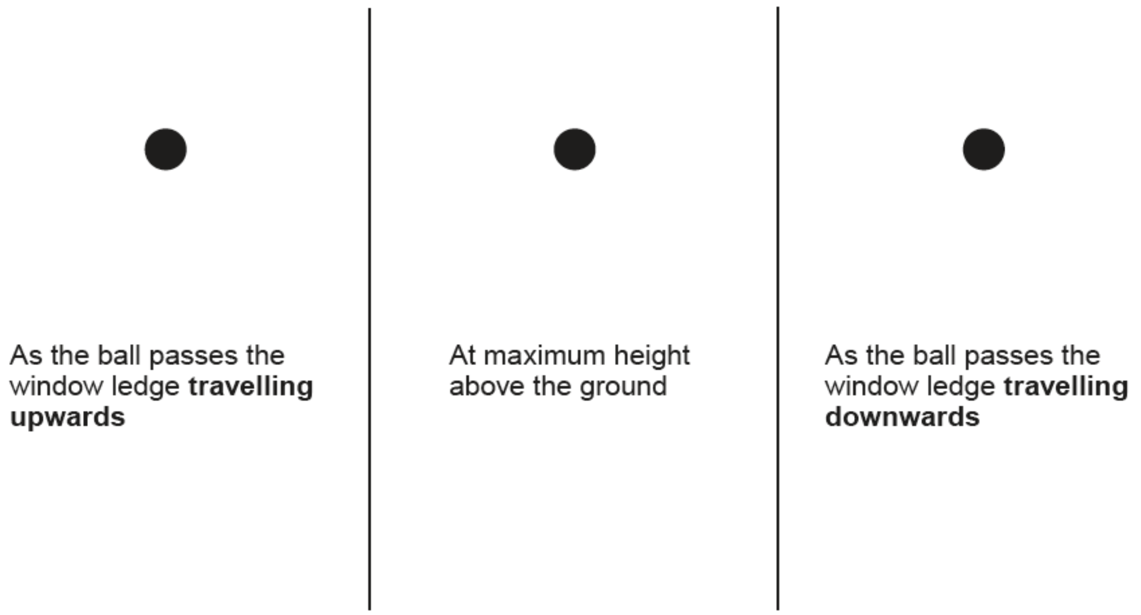
(c) In reality, air resistance also acts on the ball. In the spaces provided draw **three** free body diagrams showing the forces acting on the ball at the positions indicated. **Label** these forces. [4]



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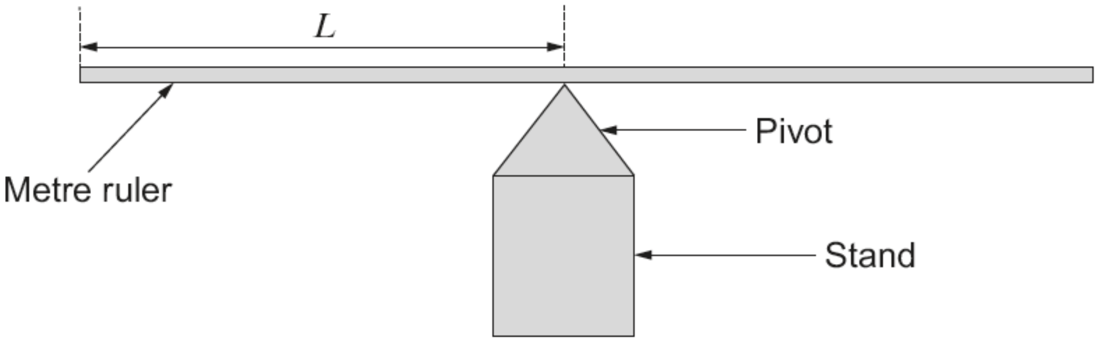
4. *(a)* A student uses the following apparatus to determine the mass of a small metal ball bearing.

- A metre ruler
- A tall pivot and stand
- A 0.2 N weight
- A test tube, into which the ball bearing can be placed

The apparatus is set up as shown.



(i) The ruler is adjusted until it is balanced at its Centre of Gravity. State what is meant by '*Centre of Gravity*'. [1]

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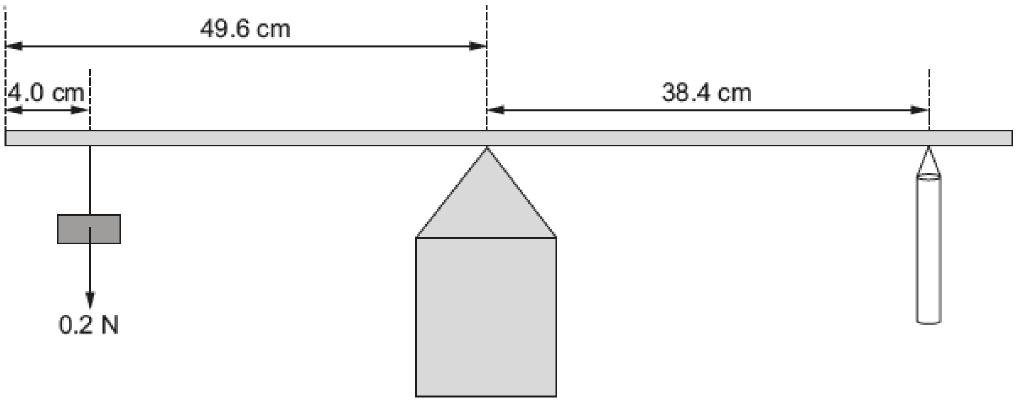
(ii) The length L at balance is found to be 49.6 cm. With the ruler at balance the 0.2 N weight is suspended 4.0 cm from the left hand end and the empty test tube is suspended a distance of 38.4 cm from the pivot so as to keep the ruler balanced. This is shown below.



The ball bearing is placed inside the test tube and the above procedure is repeated, keeping the 0.2 N weight a distance of 4.0 cm from the left hand end. The ruler is again balanced, this time with the test tube containing the ball bearing suspended a distance of 24.5 cm from the pivot.

Show, in clear steps, that the **mass** of the ball bearing is approximately 14 grams. [4]

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(b) The student measures the diameter of the ball bearing to be 1.50 cm. Use this information and the information in the table to determine the material of the ball bearing. Justify your answer. [4]

Material	**Density / kg m^{-3}**
Aluminium	2 800
Iron	7 950
Copper	8 900
Lead	11 300

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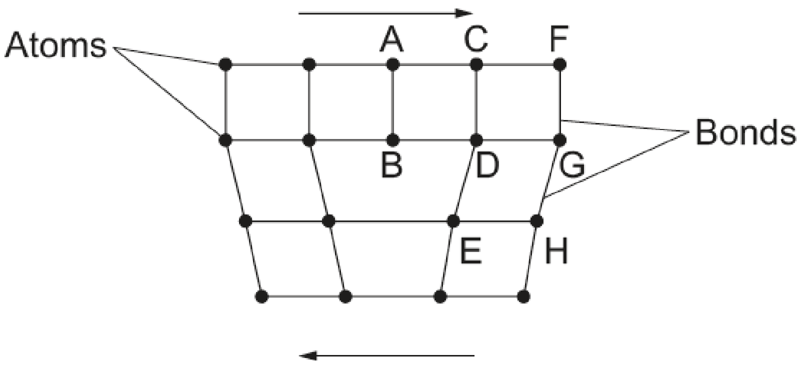
5. *(a)* Sketch a typical stress-strain graph for the stretching to breaking point of a malleable metal such as copper. Label on your graph:

(i) the elastic limit;
(ii) the yield point;
(iii) the region of plastic deformation. [4]

(b) The diagram shows the arrangement of atoms in a metal crystal in the region of a dislocation.



Explain how plastic deformation takes place in ductile metals when forces are applied as shown by the arrows. Explain how the addition of a foreign atom affects this process. [6 QER]

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(c) A student obtains the following values and uses them to determine the tensile stress in a metal wire:

Tension in wire = 122 ± 2 N

Cross-sectional area = 0.64 ± 0.08 (× 10^{-6}) m^2

(i) Determine the tensile stress in the wire. [1]

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(ii) By considering the uncertainties in the measurements, determine the maximum and minimum possible values of the tensile stress. [2]

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(d) The student repeats this experiment with a much thicker wire and using a force of approximately 1 000 times greater. Evaluate the associated benefits and risks of this additional experiment. [2]

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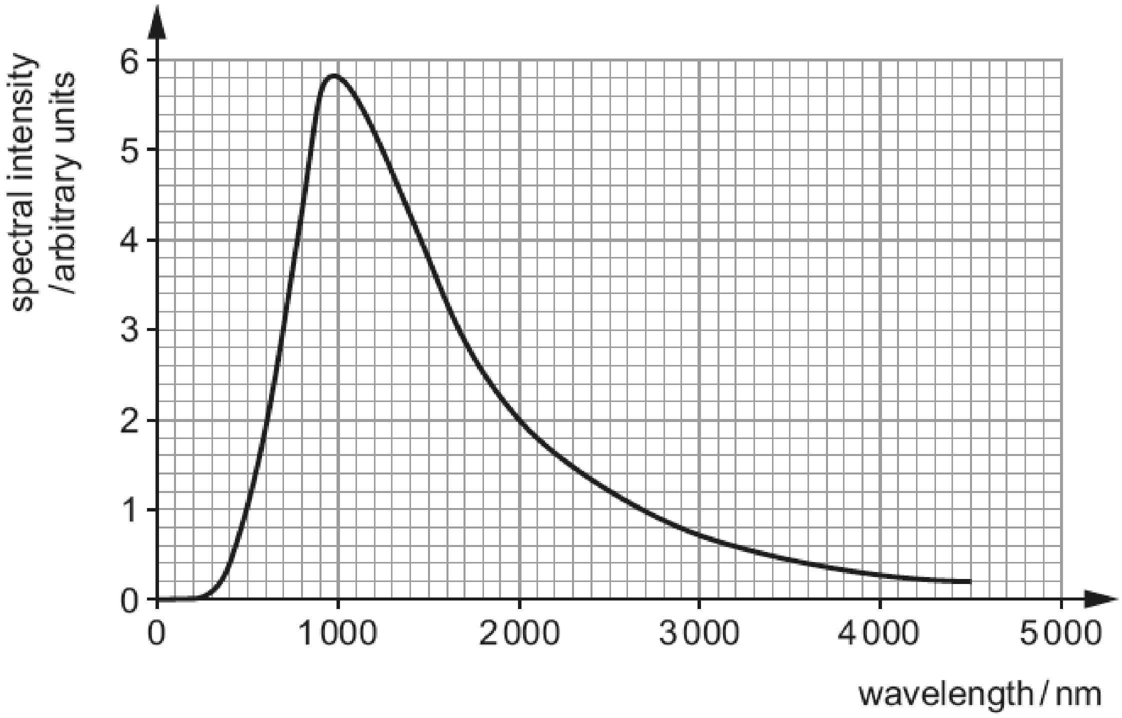
6. The nearest star to the Sun is a ‘red dwarf’, *Proxima Centauri*. The graph shows its spectrum.



(a) Use the data to show clearly that the temperature of the star is about 3 000 K. [3]

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(b) The range of visible wavelengths is 400 nm – 700 nm.

(i) Explain why you would expect *Proxima Centauri* to be ‘red’. [1]

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(ii) Name the region of the electromagnetic spectrum containing most of the power radiated. [1]

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(iii) Astrophysicists believe that *Proxima Centauri* will become hotter in the distant future. Estimate the temperature it would have to reach in order for the intensity of its radiation to be roughly the same at each end of the **visible** region of the spectrum (so the star appears white). Show your working clearly. [3]

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(c) Use Stefan's law to calculate the total power of electromagnetic radiation emitted from *Proxima Centauri* (at its present temperature) if its effective radius is 1.01×10^8 m. [3]

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7. (a) An electron and a positron can annihilate (destroy) each other, in this interaction:

$$e^- + e^+ \rightarrow \gamma + \gamma$$

(i) Explain how lepton number is conserved in this interaction. [2]

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(ii) State which force (strong, weak or electromagnetic) is involved in this interaction, giving a reason for your answer. [1]

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(b) A proton and an antiproton can annihilate each other, in this **strong** interaction:

$$p + \bar{p} \rightarrow \pi^+ + x$$

By applying conservation rules, suggest the identity of particle x. [2]

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(c) The π^+ is unstable. It can decay, thus:

$$\pi^+ \rightarrow y + \nu_e$$

(i) Identify y. [1]

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(ii) Which force is involved? [1]

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(d) Show below, as an equation, how the π^- might decay. [1]

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