Examiner only

1. *(a)* (i) State the difference between vector and scalar quantities.

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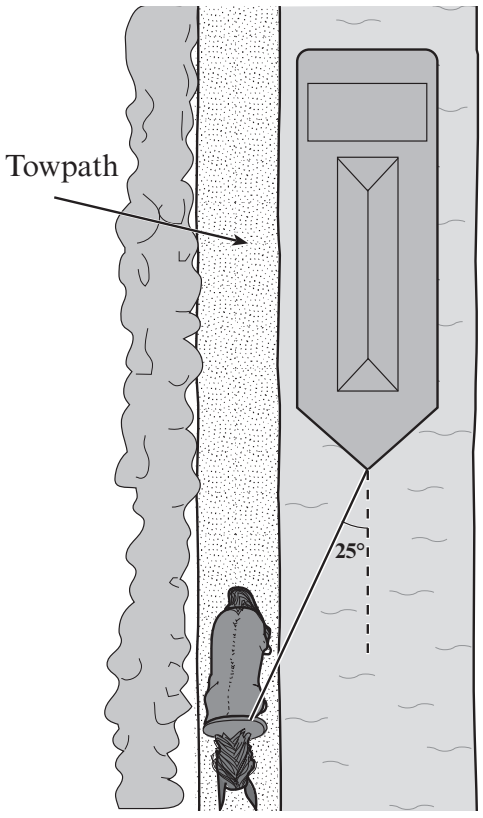
[1]

(ii) Place the following quantities in the correct column in the table below. [2]

distance *time* *velocity* *temperature* *force* *density*

Vector	Scalar

(b) A boat is pulled along a canal by a horse using a rope tied to the boat's bow. The rope makes an angle of 25° with the centre line of the canal as shown.



(i) Calculate the forward component of the force pulling the boat along the canal given that the tension in the rope is 1600 N. [2]

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(ii) Ignoring the effect of the mass of the rope, explain whether it is better to use a long rope or a short rope to pull the boat. [2]

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Examiner only

2. *(a)* State the conditions necessary for a body to remain in equilibrium. [2]

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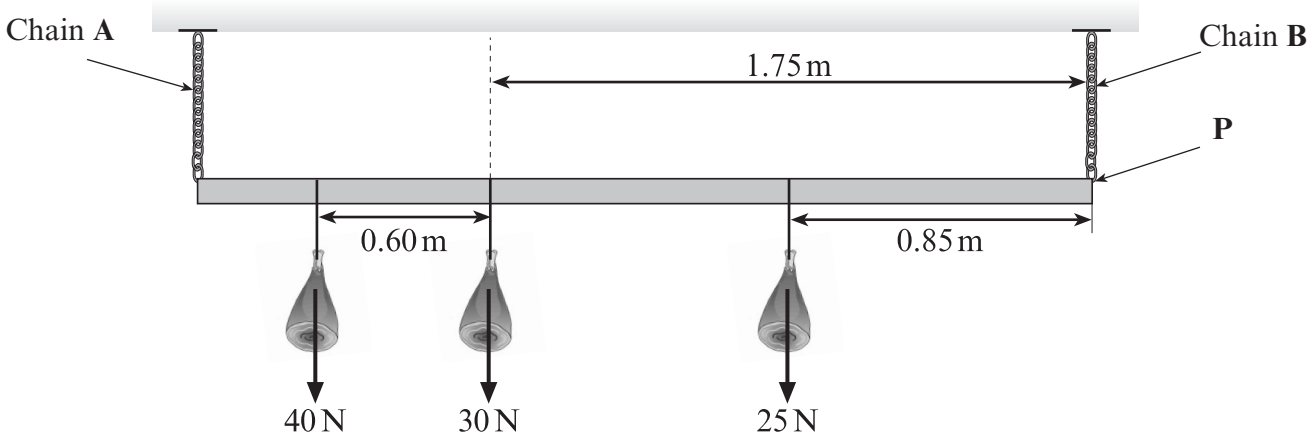
(b) The owner of a high-street butcher shop hangs joints of meat from a uniform metal bar as shown. The bar is 3.0 m long, weighs 20 N and is connected to the shop's ceiling by two light chains, **A** and **B**.



(i) On the diagram, show the weight of the bar as an arrow acting through the centre of gravity and label it 20 N. [1]

(ii) Taking moments about point **P**, calculate the tension in chain **A**. [4]

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(iii) Hence calculate the tension in chain **B**. [2]

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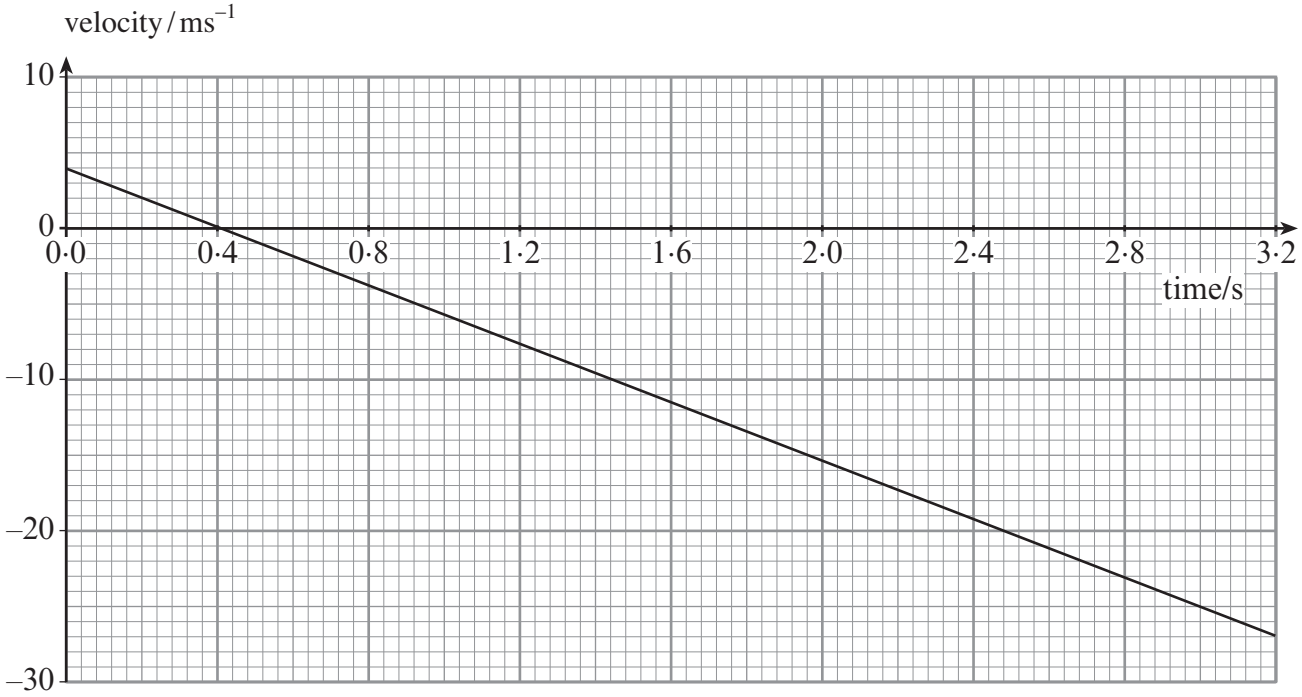
Examiner only

6. A stone is released from the basket of a hot-air balloon that is moving upwards. The velocity-time graph describes the vertical motion of the stone from the moment it is released to the time it lands on the ground at 3.2 s. Ignore air resistance throughout this question.



(a) Calculate the gradient of the graph and explain its significance. [2]

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(b) State the velocity at which the balloon was ascending at the moment the stone was released. [1]

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(c) Describe the motion of the stone between 0.0 s and 0.8 s. [3]

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Examiner only

(d) (i) Shade the part of the graph which represents the height of the stone above the ground at the moment of release. [1]

(ii) Hence, or otherwise, calculate the height of the stone above the ground at the moment of release. [2]

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(e) The balloon is also moving **horizontally** at a steady velocity when the stone is released. State whether the stone will land on the ground behind, directly beneath or in front of the moving basket. Explain your answer. [3]

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Examiner only

7. *(a)* (i) Define *work.* [2]

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(ii) Hence express the unit of work, J, in terms of the SI base units kg, m and s. [2]

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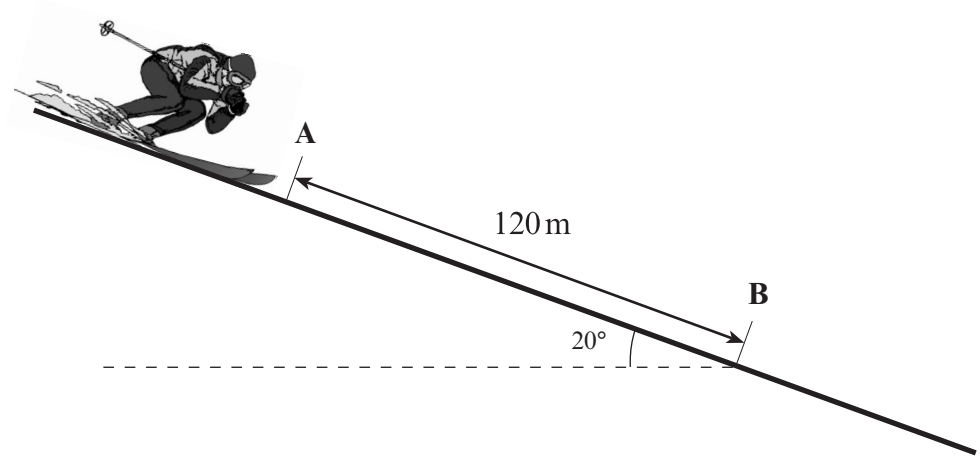
(b)



A skier of mass 70 kg descends a slope inclined at 20° to the horizontal as shown. The skier passes point **A** at a speed of 6 ms^{-1} and a second point **B** at a speed of 21 ms^{-1}. The distance between **A** and **B** is 120 m. Calculate, for the descent from **A** to **B**,

(i) the gravitational potential energy lost by the skier; [2]

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(ii) the kinetic energy gained by the skier. [3]

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Examiner only

(c) (i) State the principle of conservation of energy. [1]

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(ii) Discuss your answers to *(b)* (i) and (ii) in terms of this principle. [2]

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(d) Calculate the mean resistive force experienced by the skier between **A** and **B**. [4]

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QUESTION 8 IS ON PAGE 14

Examiner only

6. *(a)* In this question, stars may be assumed to radiate as *black bodies.* Define a *black body.* [1]

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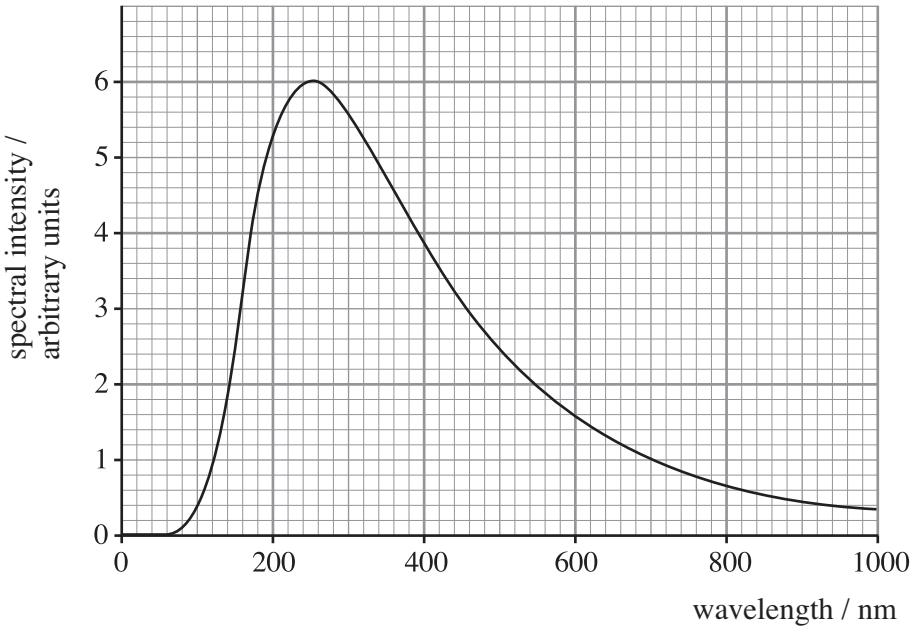
(b) The diagram shows the spectrum of *Rigel* (one of the brightest stars in the night sky).



Show that the surface temperature of Rigel is 10 000 K to one significant figure. [3]

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(c) The *power* emitted by Rigel is found to be 2.53×10^{31} W.

(i) Use Stefan's law to calculate the effective surface area of Rigel. [3]

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Examiner only

(ii) The **radius** of the **Sun** is 6.96×10^8 m. Supporting your explanation with a calculation, explain why Rigel is called a *giant* star. [2]

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(iii) Referring again to the spectrum given in part *(b),* discuss whether or not Rigel should be classed as a *red* giant. [3]

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QUESTION 7 IS ON PAGE 12

Examiner only

7. When two protons are accelerated to high kinetic energies and collide with each other, the following reaction may occur. [x is an 'unknown' particle.]

$$p + p \longrightarrow p + x + \pi^+$$

(a) The charge on a proton (p) is $+e$.

(i) What is the magnitude of the charge on the π^+ (a pion or π meson) ? [1]

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(ii) Deduce the charge of particle x. [1]

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(b) The π^+ is classed as a *meson*. How is the p classed? [1]

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(c) In the reaction, u quark number and d quark number are each conserved. [$\bar{u}$ is assigned u quark number -1 and $\bar{d}$ is assigned d quark number -1.]

Giving your reasoning, determine the quark make-up of particle x, and hence identify this particle. [4]

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(d) Explain how *lepton* conservation applies in this reaction. [1]

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(e) Discuss which of the forces, *weak, strong*, or *electromagnetic*, is likely to be responsible for the reaction. [2]

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U1HENS10

SOLIDS UNDER STRESS

a) Describe an experiment to calculate the Youngs Modulus of a material [10]
b) Derive a formula for the energy stored per unit volume in a material [5]