Index Number		Name	

Anglo-Chinese School
(Independent)

FINAL EXAMINATION 2020
YEAR 3 INTEGRATED PROGRAMME

PHYSICS **PAPER 2**

Tuesday **6 October 2020** **1 hour 45 minutes**

Marks Awarded	
Section	**Marks**
A	
B	
Penalty	
Sig. Fig.	
Units	
TOTAL SCORE	

INSTRUCTIONS TO STUDENTS

Write your index number in the box provided on the top right corner of this page.

Do not open this booklet until you are told to do so.

Section A
Answer **all** questions in the spaces provided in the paper.

Section B
Answer **all** questions in the spaces provided in the paper.

INFORMATION FOR STUDENTS
Candidates are reminded that all quantitative answers should include appropriate units.
Candidates are advised to show their answers in a clear and orderly manner as more marks are awarded for sound use of physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.
Take g = 10 N kg^{-1} or 10 m s^{-2}

Calculators are allowed for this paper.
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There are **18** printed pages

Section A [50 Marks]

A1. **Fig. 1.1** shows a skydiver, of mass 75 kg, falling towards the Earth at constant velocity, a long time after jumping from an aeroplane.

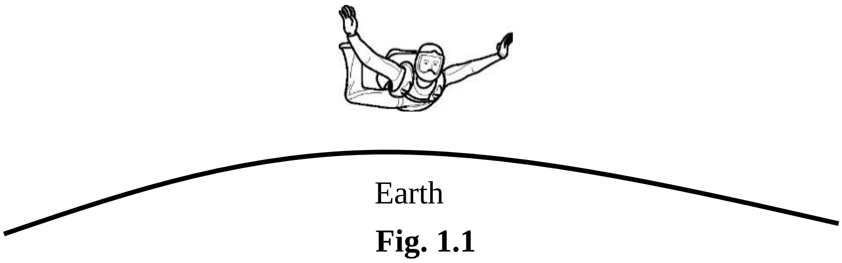

Fig. 1.1

At time $t = 0$, he receives a radio signal. He opens his parachute 12 s later.
Fig. 1.2 is the velocity-time graph for the skydiver.

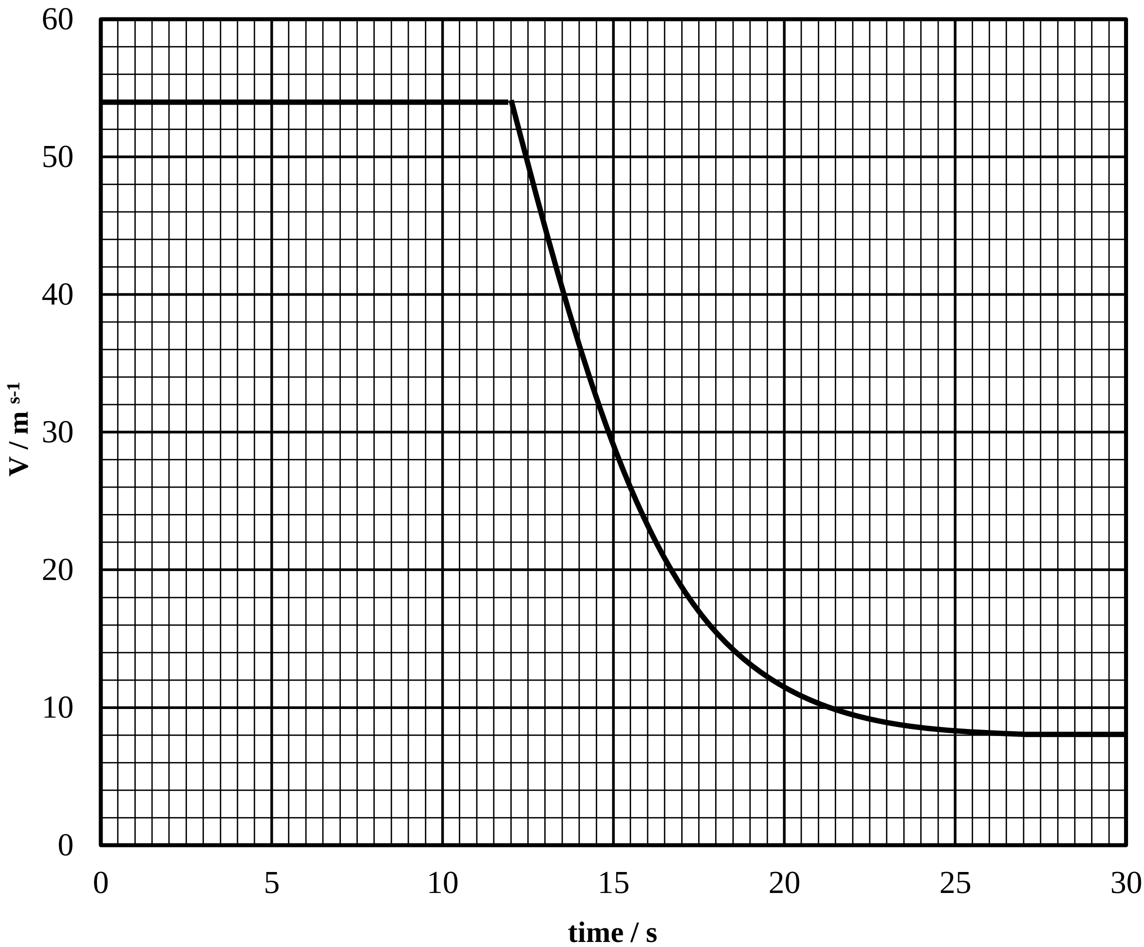

Fig. 1.2

(a) State the difference between *speed* and *velocity*. [1]

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(b) The gravitational field strength g is 10 N kg^{-1}.

(i) Calculate the weight of the skydiver. [1]

(ii) State the size of the air resistance acting on the skydiver between $t = 0$ and $t = 12$ s. [1]

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(c) For the period between $t = 0$ and $t = 12$ s, determine

(i) the magnitude of the velocity of the skydiver, [1]

(ii) the displacement of the skydiver. [1]

(d) State

(i) what happens to the air resistance as the skydiver opens his parachute. [1]

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(ii) the effect on the motion of the skydiver of opening the parachute. [1]

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(e) By $t = 15$ s, his parachute is fully opened.
State what happened to the air resistance after $t = 15$ s. [1]

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A2.

(a) State Newton's second law of motion. [1]

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(b) A car of mass 900 kg tows a trailer in a straight line along a horizontal road, as shown in **Fig. 2.1**.

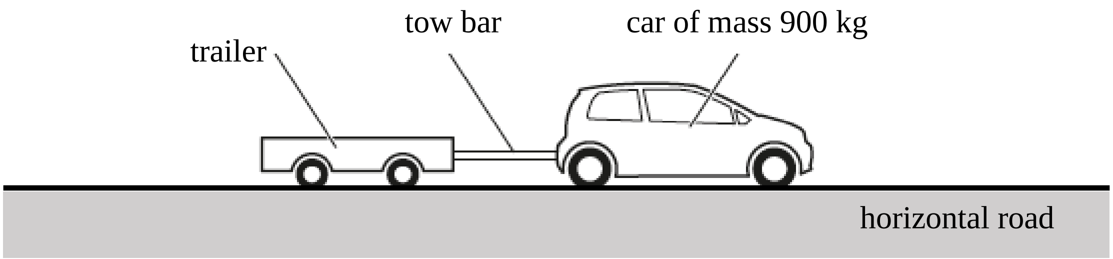


Fig. 2.1

The car and the trailer are connected by a horizontal tow-bar.
The variation with time t of the velocity v of the car for a part of its journey is shown in **Fig. 2.2**.

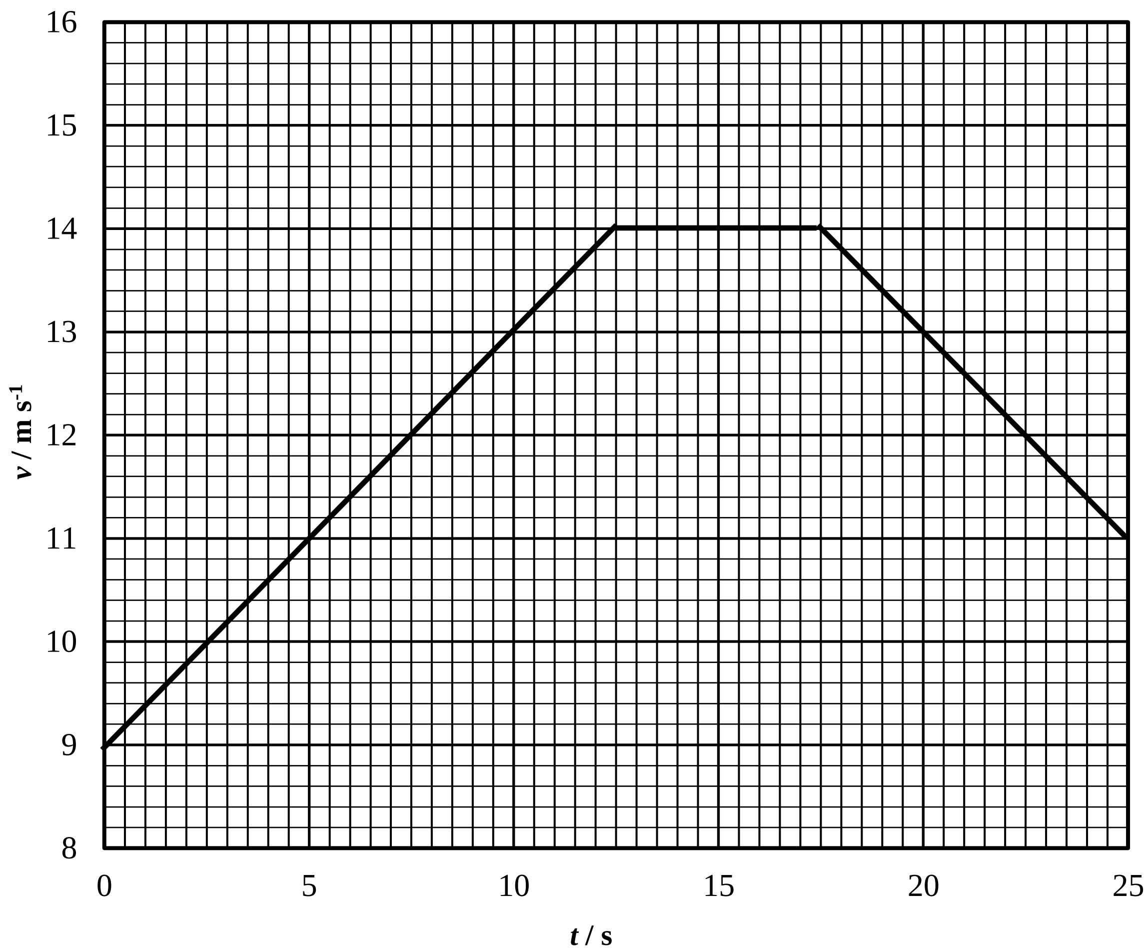


Fig. 2.2

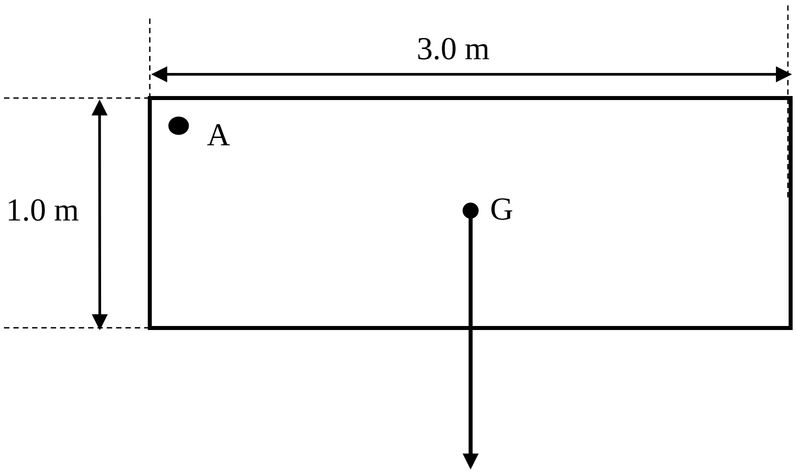
At time t = 10 s, the resistive force acting on the car due to air resistance and friction is 520 N. The tension in the tow-bar is 420 N.
For the car at time t = 10 s:

(i) Use **Fig. 2.2** to calculate the acceleration. [2]

(ii) use your answer in **(i)** to calculate the resultant force acting on the car [1]

(iii) show that a horizontal force of 1300 N is exerted on the car by its engine. [2]

A3. **Fig. 3.1** shows a uniform lamina of length 3.0 m by 1.0 m and thickness 0.02 m freely suspended at pivot A and being displaced to the current position. The centre of gravity of the sheet is at point G. The density of the sheet is 690 kg m^{-3}.



centre of gravity

Fig. 3.1

(a) Determine the mass of the sheet. [2]

(b) State what is meant by *center of gravity*. [1]

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(c) The sheet is released from its current position. State the direction of the resulting moment. [1]

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(d) The sheet eventually stops with G directly below A. Explain why the sheet stops at this position. [1]

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A4. A uniform beam AB of length 6.0 m is placed on a horizontal surface and then tilted at an angle of 30 ° to the horizontal, as shown in **Fig. 4.1**.

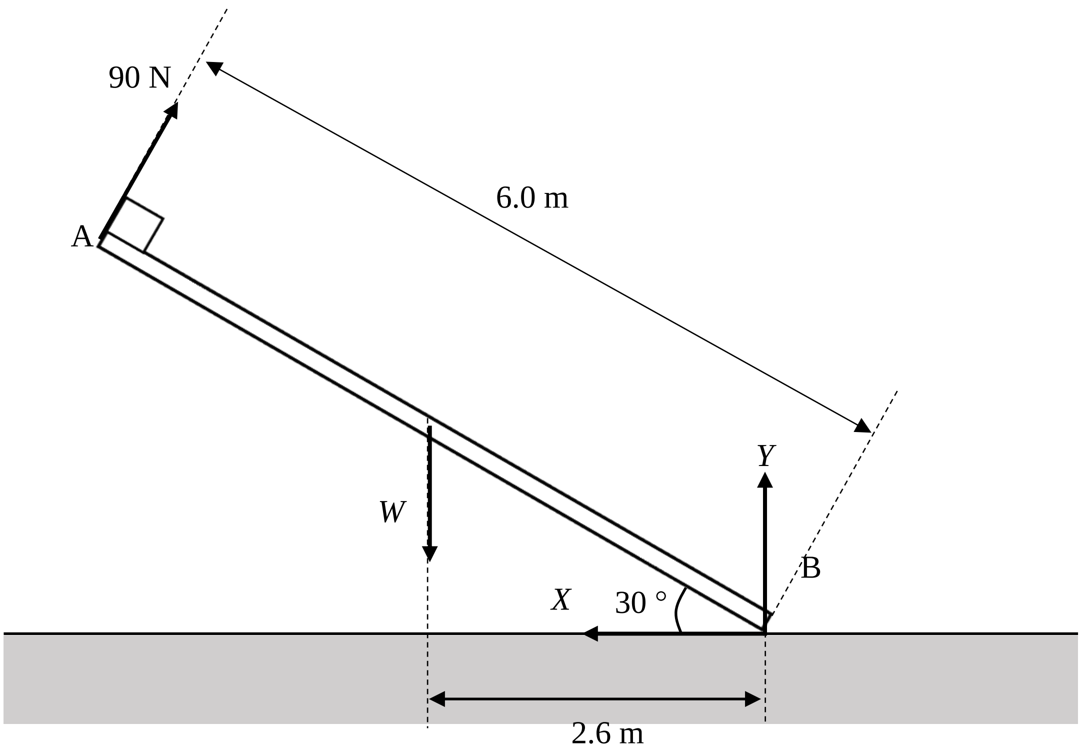

Fig. 4.1

The beam is held in equilibrium by four forces that all act in the same plane. A force of 90 N acts perpendicular to the beam at end A. The weight *W* of the beam acts at its centre of gravity. A vertical force *Y* and a horizontal force *X* both act at end B of the beam.

(a) State the name of force *X*. [1]

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(b)

(i) Show that the perpendicular distance measured from the line of action of force *W* to end B is approximately 2.6 m. [2]

(ii) By taking moments about end B, calculate the weight *W* of the beam. [2]

A5. A small coin of mass m is initially at rest. It is dropped from the top of a building of height 360 m above ground level. The coin has a speed v as it hits the ground. The gravitational field strength g is equal to 10 N kg^{-1}.

(a) Determine the speed of the coin as it hits the ground. You may ignore air resistance. [3]

(b) When air resistance is negligible, a heavier coin hits the ground at the same speed as a lighter coin when they are both dropped from the same height.

(i) Explain why. [1]

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(ii) When air resistance acts, coins of different masses do not hit the ground at the same speed when they are dropped from the same height.
Explain why. [2]

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A6. A mercury barometer is setup at sea level as shown in **Fig. 6.1.**

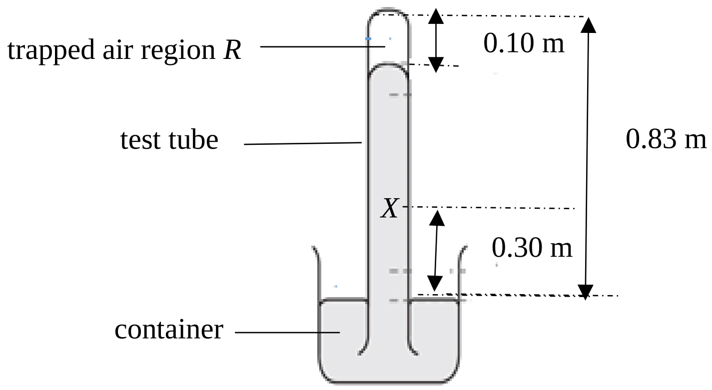

Fig.6.1

(a) Some air is trapped in region *R* of the tube. Using ideas about the molecules, explain how the trapped air exerts a gas pressure on the mercury below it. [2]

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(b) If the trapped air exerts a pressure of 18 mm Hg on the mercury below it, calculate the atmospheric pressure in mm Hg and Pascal (Pa).The density of the mercury is 13 600 kg m^{-3}.

(i) in mm Hg [1]

(ii) in Pa [2]

(c) Calcuate the total pressure at point *X* in Pascal. [2]

(d) State the effect on the pressure in region *R*, using the terms *increases, decreases or remains same*,when an additional 100 g of mercury is added into the container. [1]

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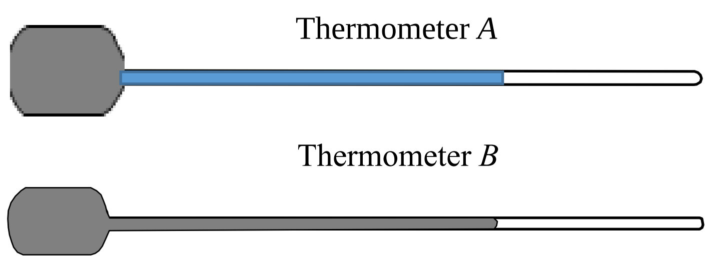
A7. Two thermometers *A* and *B* are constructed with *identical* bores of same length and cross-sectional area. Bulb *A* has a volume twice that of bulb *B*.



(a) State and explain which thermometer has greater sensitivity. [2]

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(b) Suggest a modification for themometer *A* to increase the range by keeping volume of the bulb constant. [1]

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(c) Thermometer *A* is placed in hot water.

(i) State the mode of transfer of thermal energy through the glass wall of the bulb to the mecury in the bulb. [1]

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(ii) Using the kinetic theory of matter, explain how thermal energy is transferred through the glass wall of bulb to the mecury. [2]

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A8. A student conducted an experiment to investigate the cooling nature of a black surface and a white surface using two identical conatiners *X* and *Y*. *X* is white on the outside surafce whereas *Y* is black on the outside surface. The two containers are filled with the same amount of hot water at the same temperature of 80ºC. Both the containers are left uncovered and are allowed to cool down under the same physical conditions.

(a) In the axis given below, draw the cooling curves for both containers *X* and *Y* until the hot water in both containers reaches a room temperature of 20ºC. Label the graphs as *X* and *Y* for the white container *X* and the black container *Y* respectively [2]

(b) Explain why the decrease in temperature for both containers are different in the first few seconds compared to the last few seconds before reaching room temperature . [2]

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(c) Explain why the evaporation of a liquid causes cooling. [2]

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Section B [30 Marks]

B9. **Fig. 9.1** shows a man of mass 90 kg bungee jumping off a bridge and falls 20.0 m before the elastic cord attached to his feet starts to exert any force on him.

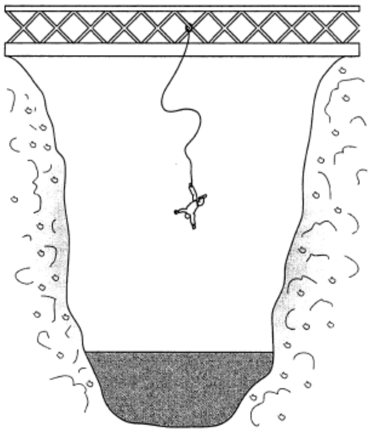

Fig. 9.1

The man possesses maximum kinetic energy when he has fallen 42.5 m from the bridge. Assume that the effect of air resistance on the man is negligible.

A force-extension graph of the elastic cord after 20.0 m is shown in **Fig. 9.2**

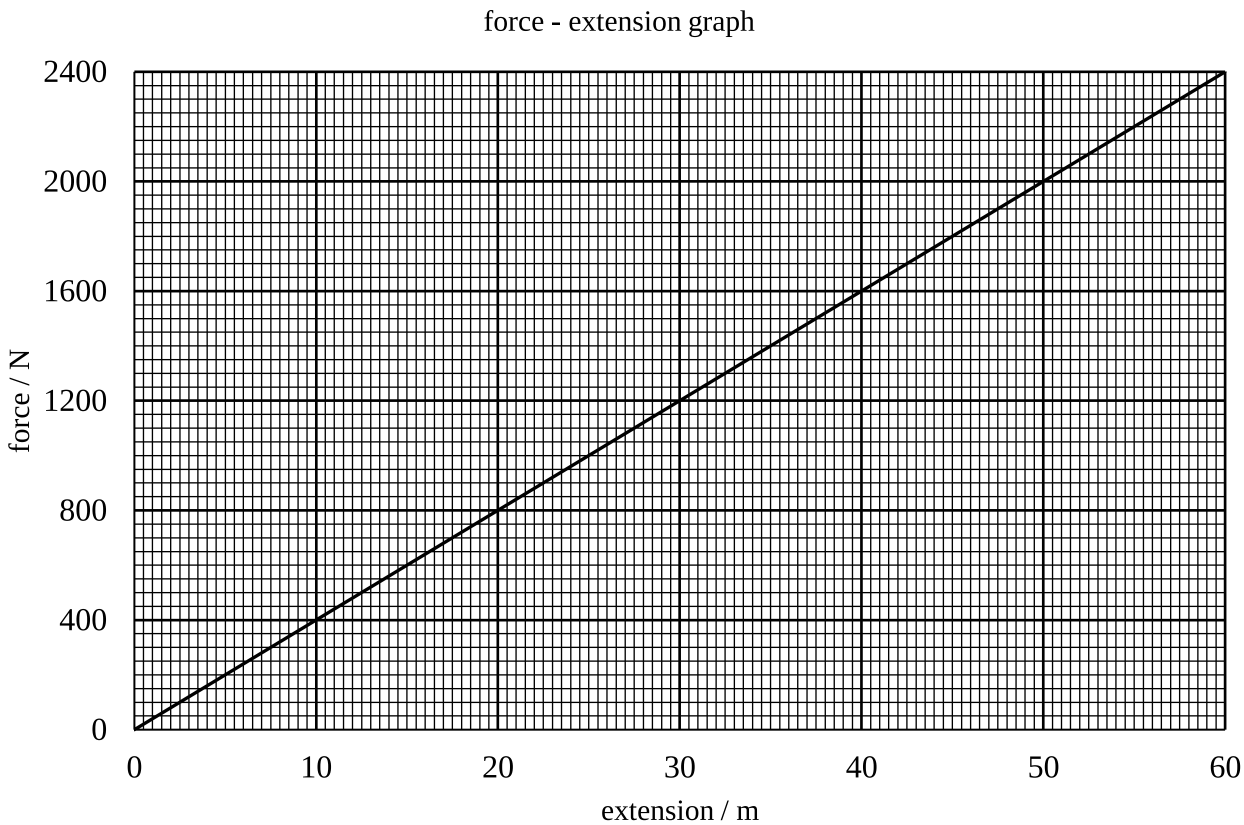

Fig. 9.2

(a) Using information from the previous page and **Fig. 9.2**, draw free-body diagrams, indicating all the forces, with magnitude, acting on the man when the man has fallen ***(the box illustrated represents the man)***

(i) 20.0 m from the bridge, [1]

(ii) 42.5 m from the bridge, [2]

(iii) 80.0 m from the bridge. [2]

(b) The bungee jumper continues to fall till the 80 m mark. At this point, the speed of the jumper is zero. The gravitational potential energy is now taken to be zero.

(i) Complete the energy changes, with either, *zero, maximum, increasing* or *decreasing*, of the bungee jumper at the 20 m, 45 m and 80 m mark. [2]

Distance fallen / m	20	45	80
Gravitational Potential Energy / J	decreasing	decreasing	zero
Kinetic Energy / J	increasing		zero
Elastic Potential Energy / J			

(ii) Explain, in terms of forces, at 80 m, why the jumper will accelerate upwards. [1]

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(iii) Continually, the bungee jumper will experience a series of accelerations and decelerations before coming to rest at the near bottom of the bridge. Using principle of conservation of energy, state the different forms of energy changes and explain why this principle is not violated. [2]

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B10. The table below shows the physical properties of a substance *X* at a standard room temperature of 25 °C and atmospheric pressure of 1.0×10^5 Pa.

Mass/g	Melting point /°C	Boiling point /°C	Specific heat capacity of a liquid / J kg^{-1} $°C^{-1}$	Specific latent heat of vaporisation. /J kg^{-1}
100 g	-39.0	357.0	140	2.95×10^5

(a) What is the state of substance *X* at -27.0 °C? [1]

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(b) State what is meant by the *specific latent heat of vaporisation* is 2.95×10^5 J kg^{-1} [1]

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(c) Calculate the thermal energy needed to raise the temperature of substance *X* from -27.0 °C to 10.0 °C. [2]

(d) Calculate the total amount of thermal energy needed to change substance *X* from its room temperature to gaseous state. [3]

(e) Some amount of substance *X* is collected in a container at its gaseous state. The container is wrapped with a cooling pad. Using the idea of kinetic model of molecules, explain what will happen to the pressure of gas *X*. [3]

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B11. **Fig. B11.1** shows a top view of full-scale drawing of a narrow beam of light *PQR* from a ray box being directed at the surface *AB* of an irregular shaped glass block *ABCDEF*. The glass block is fixed onto a circular turntable that rotates about its centre.

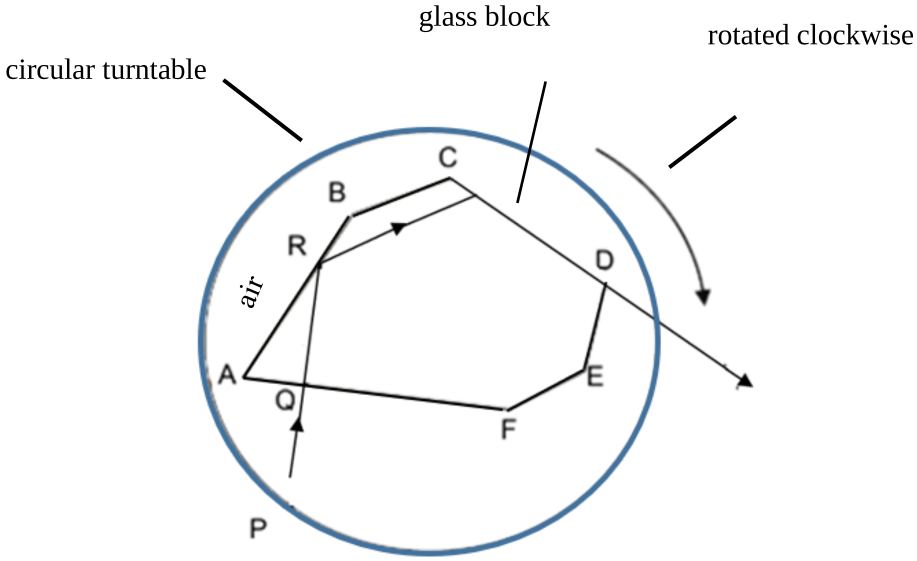

Fig. B11.1 Top view

(a) **(i)** Explain in words what is meant by *critical angle*. [1]

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(ii) State the relationship between refractive index of the medium and its critical angle. [1]

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(b) With reference to **Fig. B11.1**, measure and record the critical angle of the glass block. [1]

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(c) Use the answer in **(b)** to calculate the refractive index of the glass block. [2]

(d) Explain why the light ray does not exit the glass block at surface *AB*. [1]

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(e) The turntable is rotated 20° in the clockwise direction as shown in **Fig. B11.1.** The light ray *PQ* is now found to bend after passing through surface *AF*.

Calculate the angle of refraction at surface *AF*. [2]

(f) The outer surface of the glass block is coated with a transparent material *X* which has a refractive index greater than that the glass block. A narrow beam of light ray *PQ* from a ray box is directed at surface *AF* as shown in **Fig. B11.2.**

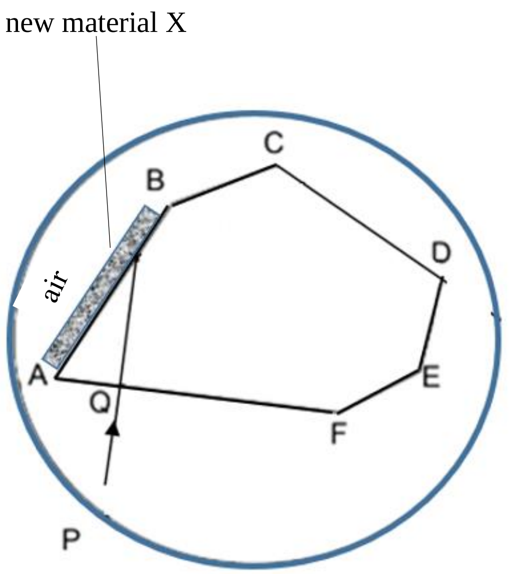

Fig. B11.2

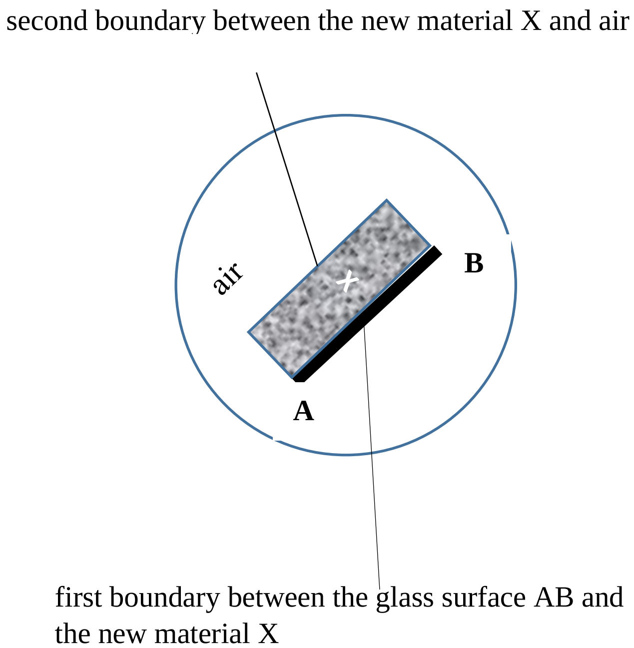

Fig. B11.3

Fig. B11.3 shows the magnified top view of the boundaries. State and explain what will happen to the light ray *PQ* at the first boundary after it hits glass surface *AB*. [2]

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