Section A [8 marks]

Answer **ALL** questions. Record your choices in the table on the cover page.

1 A car accelerates uniformly along a straight level road for 20 s.

The energy in the kinetic store of the car increases from 1.6 MJ to 2.5 MJ.

What is the power output of the car?

A 45 kW **B** 80 kW **C** 125 kW **D** 205 kW

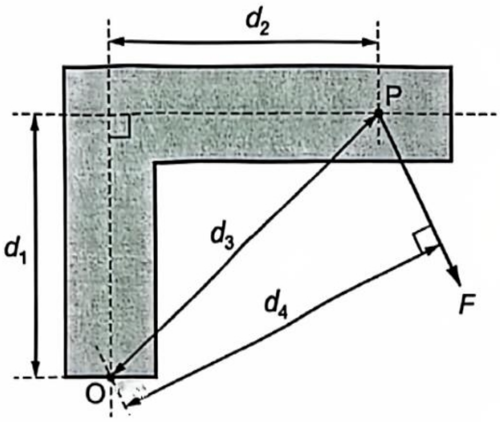
2 A lift of mass 420 kg moves vertically upwards at a constant speed of 0.20 m/s.

The input power of the lift is 1200 W. The gravitational field strength *g* is 10 N/kg.

What is the efficiency of the lift?

A 7.0 % **B** 14 % **C** 30 % **D** 70 %

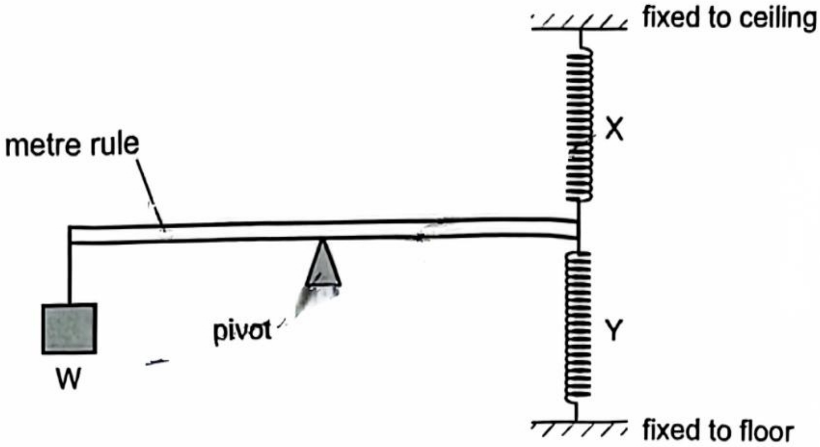
3 A force *F* causes a moment about point O on an L-shaped bar. The force *F* acts at point P.



What is the moment of *F* about O?

A Fd_1 **B** Fd_2 **C** Fd_3 **D** Fd_4

4 Two stretched springs X and Y are attached to one end of a metre rule as shown. A weight W is hung from the other end. A pivot is at the centre of the rule.



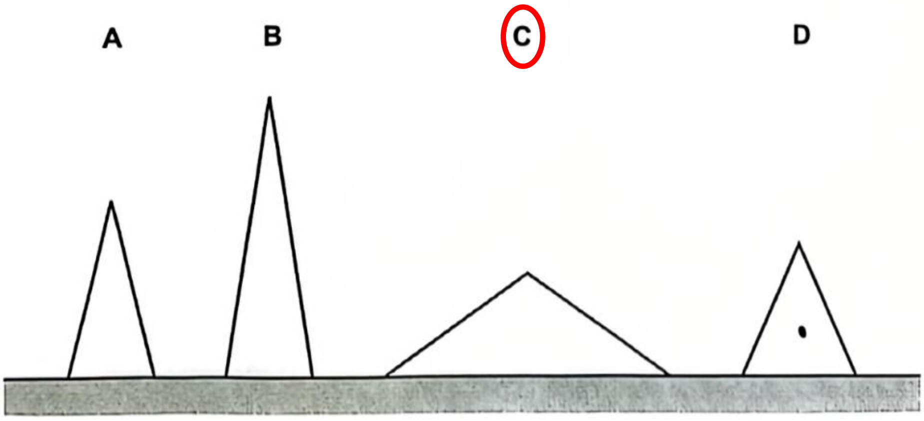
The pivot is moved away from weight W.

How does the extension of each spring change?

	spring X	spring Y
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

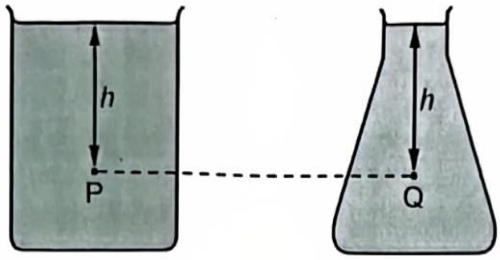
5 Four solid uniform cones have equal weight. They are placed on a bench as shown in the scale diagram.

Which cone is the most stable?



6 Two glass containers filled with different liquids are placed next to each other.

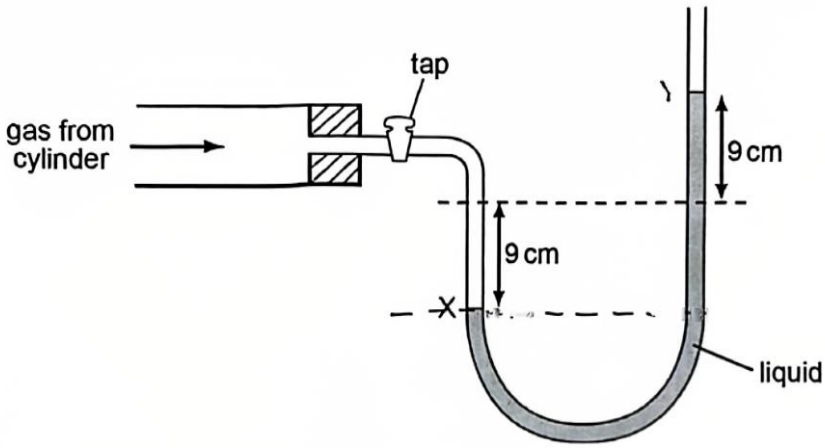
Point P is a distance h below the surface of the liquid in one container. Point Q is a distance h below the surface of the liquid in the other container.



Why is the pressure at P different from the pressure at Q?

A The atmospheric pressure is different at P and Q.
B The densities of the liquids are different.
C The gravitational field strength is different at P and Q.
D The shapes of the containers are different.

7 The diagram shows the levels X and Y in a liquid manometer when the gas tap is opened.



What is the pressure of the gas in the cylinder?

A 9 cm of liquid above atmospheric pressure
B 9 cm of liquid below atmospheric pressure
C 18 cm of liquid above atmospheric pressure
D 18 cm of liquid below atmospheric pressure

8 A rectangular block of weight 240 N and dimensions 2.0 m × 3.0 m × 5.0 m is placed on level ground.

What is the least pressure the block can exert on the ground?

A 16 Pa **B** 24 Pa **C** 40 Pa **D** 80 Pa

Section B [22 marks]

Answer **ALL** questions. Write your answers in the spaces provided.

1 Fig. 1.1 shows a hydraulic press.

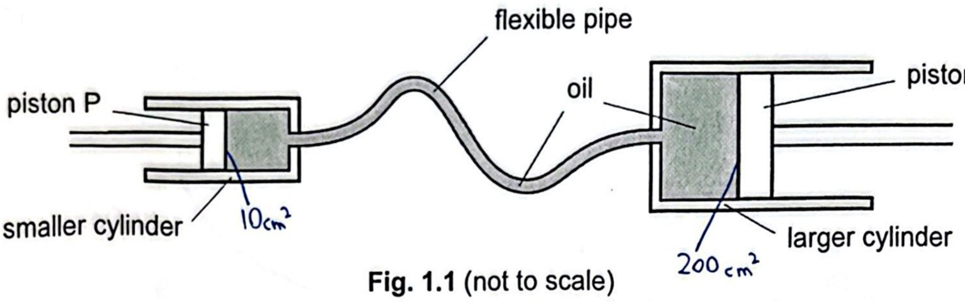


Fig. 1.1 (not to scale)

Two cylinders and the flexible pipe that joins them contain oil. Two pistons keep the oil in the cylinders.

The cross-sectional area of the smaller cylinder is 10 cm^2.
The cross-sectional area of the larger cylinder is 200 cm^2.

Piston P exerts a force of 3.0×10^2 N on the oil.

(a) Calculate the pressure, in N/cm^2, exerted by piston P on the oil.

$$P = \frac{F}{A}$$
$$= \frac{3.0 \times 10^2 \text{ N}}{10 \text{ cm}^2}$$
$$= 30 \text{ N/cm}^2$$

pressure = ...30...... N/cm^2 [2]

(b) Explain how the hydraulic press is able to produce a force on piston Q that is larger than 3.0×10^2 N. Force is never transmitted

pressure is transmitted

The pressure exerted by piston P on the oil remains the same throughout the oil and is exerted on piston Q, since piston Q has a larger area than piston P, a larger force will be exerted on piston Q to keep the same pressure. [2]

(c) Piston P moves a distance of 5.0 cm into the cylinder.

Calculate the distance that piston Q moves. Give your answer to 2 significant figures.

$F_1 d_1 = F_2 d_2$

$30 = \frac{F_2}{200}$

$F_2 = 6000$

$(3.0 \times 10^2)(5.0) = (6000)(d_2)$

$d_2 = 0.25\,cm$

distance = ...0.25 cm.......... [2]

[Total: 6]

2 (a) State the *principle of conservation of energy*.

Energy cannot be created or destroyed, but energy can be transferred from one store to another. The total energy in a (isolated) system remains constant. [2]

(b) Fig. 2.1 shows a lead ball of mass 4.0 kg placed on a trolley.

The trolley is released from rest at the top of a smooth, curved slide. It moves down the slide through a vertical height of 2.0 m and is eventually stopped by a wooden board.

W= Fd

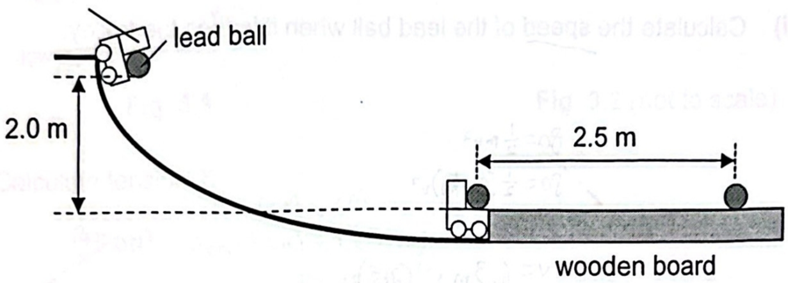


Fig. 2.1 (not to scale)

The lead ball leaves the trolley and travels a horizontal distance of 2.5 m along the wooden board before coming to a rest.

(i) The gravitational field strength g is 10 N/kg.

Calculate the decrease in the gravitational potential energy of the lead ball.

Decrease in GPE $= mgh$

$= (4.0 kg)(10 N/kg)(2.0 m)$

$= 80 J$

decrease in gravitational potential energy = 80 J [2]

(ii) On Fig. 2.2, sketch a graph to show how the ball's kinetic energy varies with its height above the wooden board. Indicate the maximum kinetic energy of the ball on the vertical axis.

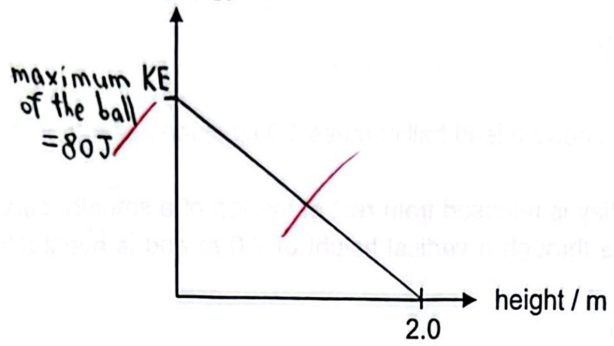


Fig. 2.2

[2]

(iii) Calculate the speed of the lead ball when it leaves the trolley.

$80 = \frac{1}{2}mv^2$

$80 = \frac{1}{2}(4.0kg)v^2$

$v^2 = 40$

$v = 6.3 m s^{-1}$ (2s.f.)

speed = ...$6.3 m s^{-1}$...... [2]

(iv) Calculate the average frictional force between the lead ball and the wooden board.

$80 = F(2.5m)$

$F = 32N$

average frictional force = ...32N...... [2]

[Total: 10]

3 Fig. 3.1 shows the lower jawbone and the chewing muscle in a person's head. The jawbone pivots about a joint just in front of the ear.

Fig. 3.2 shows a model of the jawbone and the forces acting on it. The front teeth of the jawbone exert a biting force of 45.0 N. The tension T in the chewing muscle acts upwards on the jawbone, keeping it horizontal. The weight of the lower jawbone is assumed to be neligible.

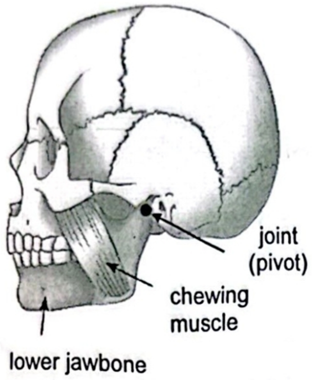


Fig. 3.1

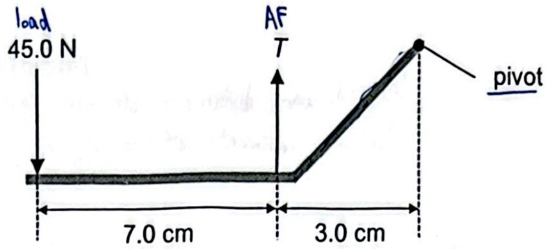


Fig. 3.2 (not to scale)

(a) Calculate tension T.

ACM = CM

$(45.0N)(7.0cm+3.0cm) = T(3.0cm)$

$T = 150N$

$T =$ ......150N...... [2]

(b) Determine the magnitude and direction of the force that the ~~socket~~ joint (pivot) exerts on the lower jawbone.

ACM = CM

$(150N)(7.0cm) = F(10.0cm)$

$F = 105N$

$= 110N$ (2s.f.)

total upwards force = total downwards force

$45.0 + R = 150$

$R = 150 - 45.0$

$= 105.0N$

magnitude of force = ...110N......

direction of force = ...downwards...... [2]

(c) Explain why the back teeth can generate a stronger biting force.

The back teeth is closer ~~to~~ the pivot, as the distance between the force and the pivot decreases, the force will increase so the back teeth can generate a stronger biting force than the front teeth which is further away from the pivot. [2]

x for same ? clockwise moment of tension T

[Total: 6]

End of Paper

Perpendicular distance of back teeth from pivot is shorter [1] and the clockwise moment of tension T about the same pivot is constant [1].