| Class | Register Number | Name |
|---|---|---|
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南洋女子中学校

# NANYANG GIRLS' HIGH SCHOOL
## End-of-Year Examination 2017
## Secondary Three

**PHYSICS** **1 hour 45 minutes**

**Paper 2** Theory Paper **10:30 – 12:15**

**Monday** **9 October 2017**

No additional materials are required.

**READ THESE INSTRUCTIONS FIRST**

**Do not open this booklet until you are told to do so.**
Write your name, register number and class in the spaces at the top of this page and on any separate answer paper used.

Write in dark blue or black ink. You may use a pencil for any diagrams or graphs.
Do not use correction fluid or tape.

**Section A (40 marks)**
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

**Section B (30 marks)**
Answer **all** questions.
Question **11** has a choice of parts to answer: **11 *Either*** or **11 *Or*.**
Write your answers in the spaces provided on the question paper.

At the end of the examination, **circle** **11 Either** or **11 Or** in the grid on the right to indicate which question you have answered.

**INFORMATION FOR CANDIDATES**

The intended number of marks is given in the brackets [ ] at the end of each question or part question. You are advised to spend no longer than one hour on Section A and no longer than 45 minutes on Section B.

Candidates are reminded that **all** quantitative answers should include appropriate units. Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.
The use of an approved scientific calculator is expected, where appropriate.

The acceleration due to gravity (or gravitational field strength) *g* is taken to be 10 m $s^{-2}$ (or 10 N $kg^{-1}$) near the Earth's surface.

| Examiner's Use | |
|---|---|
| **Section A (40 marks)** | |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| **Section B (30 marks)** | |
| 9 | |
| 10 | |
| 11 Either | |
| 11 Or | |
| **Paper 2 (70 marks)** | |

| | |
|---|---|
| **Paper 1 (30 marks)** | |

| Overall |
|---|
| % |

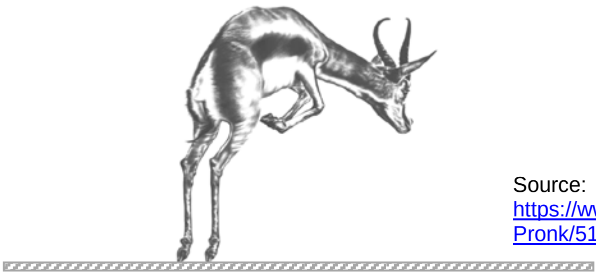
This document consists of **17** printed pages and 1 blank page.

**Setters:** AJL & CMH

**Section A (40 marks)**
Answer **all** questions.

**1** A springbok is a type of antelope. When it is startled, it will leap straight up into the air in a manner called a "pronk".

A springbok goes into a crouch (lowers its body) to perform a pronk. It then extends its legs forcefully, accelerating at 35 m $s^{-2}$ for 0.70 m vertically as its legs straighten. When its legs are fully extended (as shown in Fig. 1.1), it leaves the ground and rises into the air.



Source:
https://www.saatchiart.com/art/Drawing-Pronk/517846/2806964/view

**Fig. 1.1**

**(a)** Determine the speed at which the springbok just leaves the ground.

speed = ................................ [2]

**(b)** The springbok can jump to a large vertical height after leaving the ground.

Using the axes in Fig. 1.2, sketch a graph of speed against time for the springbok doing a "pronk", from the crouch to the highest point of its jump.
No calculation or labelling is needed. Neglect air resistance. [1]


**Fig. 1.2**

**2** A helicopter is sent out from a hospital to rescue someone in the sea. Its motion along the horizontal direction is shown by the velocity-time graph in Fig. 2.1.

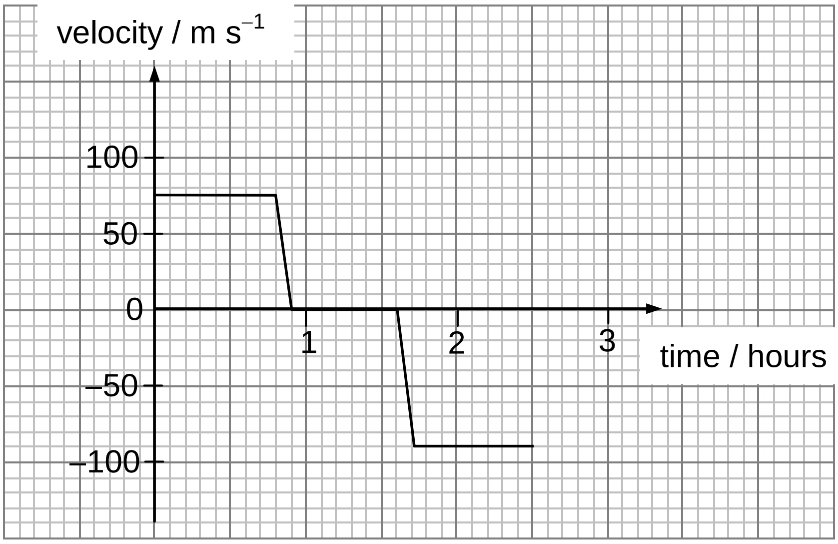



**Fig. 2.1**

**(a)** Describe clearly the horizontal motion of the helicopter from 0 to 2.5 hours shown in Fig. 2.1.

……………………………………………………………………………………………

……………………………………………………………………………………………

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…………………………………………………………………………………………..[3]

**(b)** Determine the displacement of the helicopter from 0 to 1.5 hours.

displacement = …………………………… [2]

**3** Fig. 3.1 shows three blocks connected by inextensible strings on a frictionless surface. The masses of the blocks are 24 kg, 14 kg and 12 kg respectively.
A force of 20 N is pulling the system to the right such that the blocks move together.

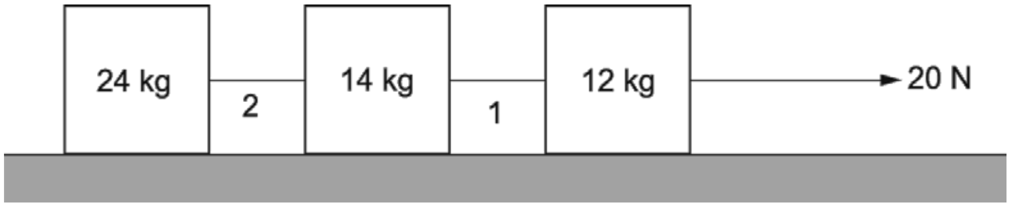


**Fig. 3.1**

**(a)** Calculate the acceleration of the blocks.

acceleration = …………………………… [2]

**(b)** Determine the tension in string 1.

tension = …………………………… [2]

**(c)** Compare the tension in strings 1 and 2. Explain your reasoning clearly.

………………………………………………………………………………………

………………………………………………………………………………………

……………………………………………………………………………………..[2]

**4** In Sentosa, visitors can enjoy rides on luge carts (see Fig. 4.1) downslope along a trail.

Source:
http://www.maritour.com/wp-content/uploads/2016/02/SINGAPORE-LUGE-SENTOSA.jpg

**Fig. 4.1**

**(a)** Fig. 4.2 shows a simplified diagram of the luge cart.
Draw and label all the forces acting on the luge cart. Neglect air resistance. [2]

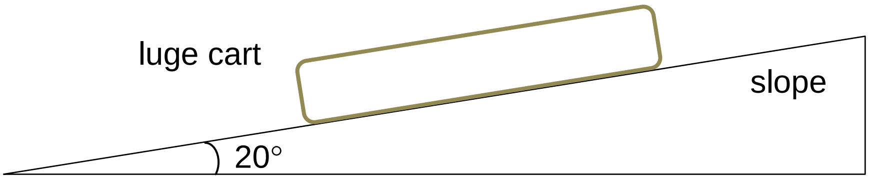


**Fig. 4.2**

**(b)** Explain what "moves" a luge cart down a slope.

…………………………………………………………………………………………………

……………………………………………………………………………………………...[1]

**(c)** A luge cart moves down a slope at 20° to the horizontal as shown in Fig. 4.2.
The cart is moving in a straight line with constant speed.

Draw and label a vector diagram (not to scale) below to show the addition of all the forces identified in part (a). [2]

**(d)** If the mass of the luge cart is 25 kg, calculate the frictional force acting on the cart.

frictional force = …………………………… [2]

**5** A toy is constructed with two heavy spheres J and K, a plastic rod and some wire as shown in Fig. 5.1. The toy is placed on a support where it remains balanced.

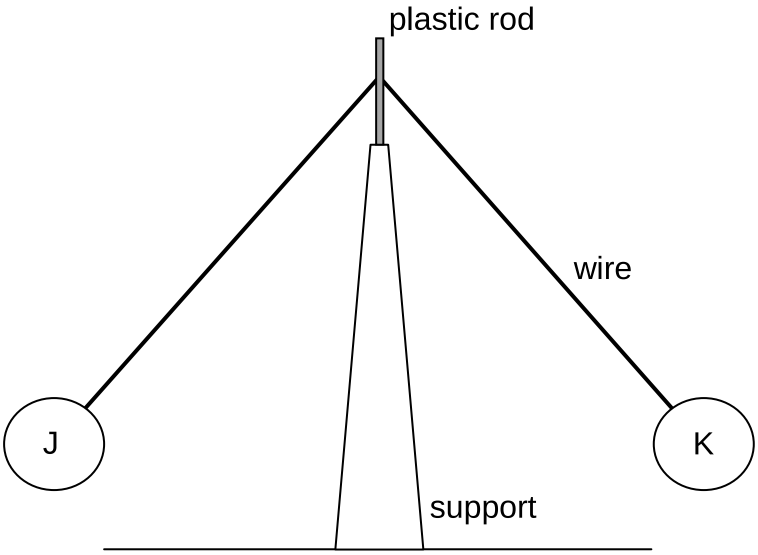


**Fig. 5.1**

**(a)** Define *centre of gravity*.

…………………………………………………………………………………………

…………………………………………………………………………………………[1]

**(b)** The plastic rod and the wire have negligible weight. Mark on Fig. 5.1 the centre of gravity of the toy with a cross "x". [1]

**(c)** Explain why the toy does not topple when sphere K is pushed towards the left.

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………[2]

**6** A car crusher is used to reduce the dimensions of cars before they are sent for recycling. The car crusher makes use of a hydraulic system to set up the large force required to crush a car. Fig. 6.1 shows a simple hydraulic system.

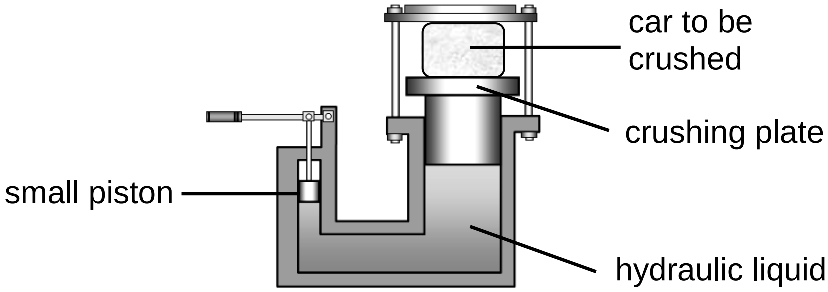


**Fig. 6.1**

**(a)** State two properties of the hydraulic liquid that allow hydraulic systems to work.

**1.** ……………………………………………………………………………………….

……………………………………………………………………………………… [1]

**2.** ……………………………………………………………………………………….

……………………………………………………………………………………… [1]

**(b)** A typical crushing plate has an area of 13.0 $m^2$. If the force required to crush a car is 155 kN, calculate the pressure that must be set up at the small piston.

pressure = ……………………………. [2]

**7** The Taipei 101 in Taiwan is a 101-storey skyscraper. The skyscraper is the home of the world's fastest elevator. The elevators transport visitors from the ground floor to the Observation Deck on the 89$^{th}$ floor, 380 m above the ground.

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

…………………………………………………………………………………………

…………………………………………………………………………………………..[1]

**(b)** Electrical energy is supplied to the elevator's motor as the elevator moves upwards. Describe the energy changes as the elevator moves from ground level until it reaches the Observation Deck. Assume there are no passengers in the elevator.

…………………………………………………………………………………………

…………………………………………………………………………………………..[1]

**(c)** For a maximum load of 1250 kg, the elevator takes 25 s to go from ground level to the Observation Deck.

Calculate

**(i)** the gain in gravitational potential energy of this maximum load,

gain in gravitational potential energy = ……………………………. [2]

**(ii)** the useful power output of the elevator motor needed to deliver this maximum load.

power = ……………………………. [1]

**(d)** The actual energy supplied by the elevator motor is greater than the gravitational energy gained by the load. Explain why this does not contradict the principle of conservation of energy.

…………………………………………………………………………………………

…………………………………………………………………………………………..[1]

**8** Fig. 8.1 shows a stick PQ in front of a mirror M. The point P' is the mirror image of the end P of the stick. The diagram is drawn to scale.

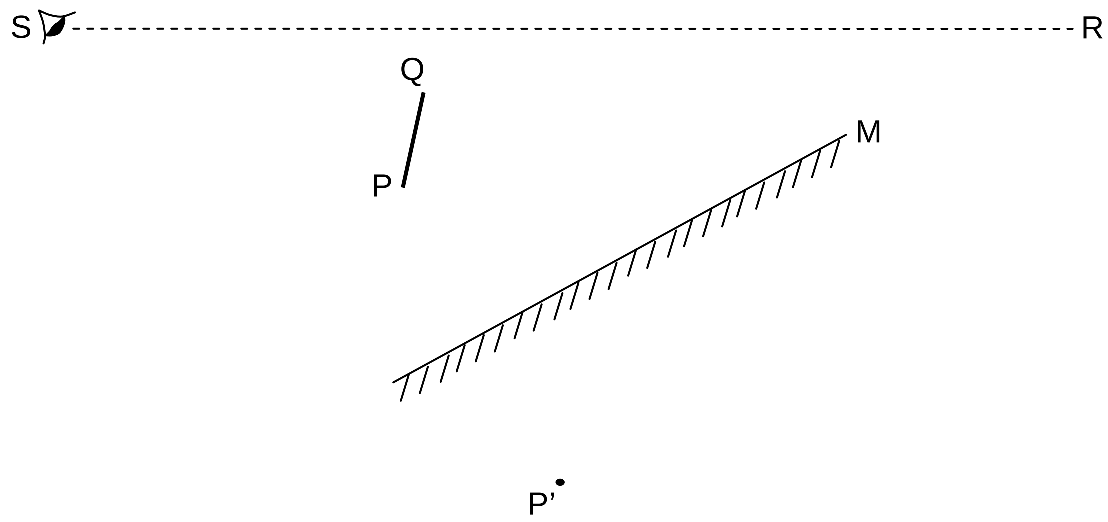


**Fig. 8.1**

Answer parts **(a)** to **(d)** on Fig. 8.1 above.

**(a)** Locate the position of the mirror image of end Q of the stick and hence draw the mirror image of the entire stick. Show clearly how the image was obtained. [1]

**(b)** Draw a light ray from P to show how a student at S is able to see the image P'. [2]

**(c)** Mark the angle of reflection for the ray drawn in **(b)** and label it *r*. [1]

**(d)** The student next moves along the dotted line from S towards R.

Determine the furthest position of the student (nearest to R) just before she completely loses sight of the image P'. Label this position F. [1]

## Section B (30 marks)

Answer questions **9, 10** and **only** one **of the alternative questions in** Question **11**.

**9** A vertical take-off aeroplane with a weight of 52 500 N lifts off vertically from the deck of an aircraft carrier as shown in Fig. 9.1.

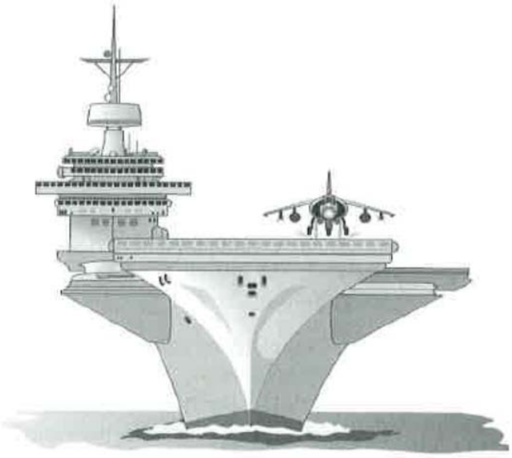

**Fig. 9.1**

The aeroplane has a vertical acceleration of 2.0 m $s^{-2}$.
Neglect air resistance.

**(a)** Calculate the net force needed to produce the acceleration.

net force = …………………………… [1]

**(b)** On Fig. 9.2, draw and label the forces acting on this plane when it is accelerating vertically.

[1]

**Fig. 9.2**

**(c)** Calculate the magnitude of the thrust produced by the engines when the plane take off vertically.

thrust = ……………………………. [2]

**(d)** On the return journey to the aircraft carrier, the weight of the plane has reduced to 50 000 N. The plane is descending vertically at 3.0 m s$^{-1}$ when it is at a height of 18 m above the deck.

**(i)** Calculate the deceleration required to bring the plane smoothly from the height of 18 m to rest on the deck of the ship.

deceleration = ……………………………. [2]

**(ii)** Calculate the thrust that the engines of the plane must produce to ensure that it lands smoothly on the deck of the ship.

thrust = ……………………………. [2]

**(iii)** Hence, calculate the work done by the engines in landing the plane from 18 m to the deck of the ship.

work done = ……………………………. [2]

**10** A 20.0 cm tall empty metal cylinder has a 15.0 cm long ruler placed across its diameter at the bottom as shown in Fig. 10.1. A girl looks over the edge of the cylinder with one eye along a line at an angle 30° to the vertical.

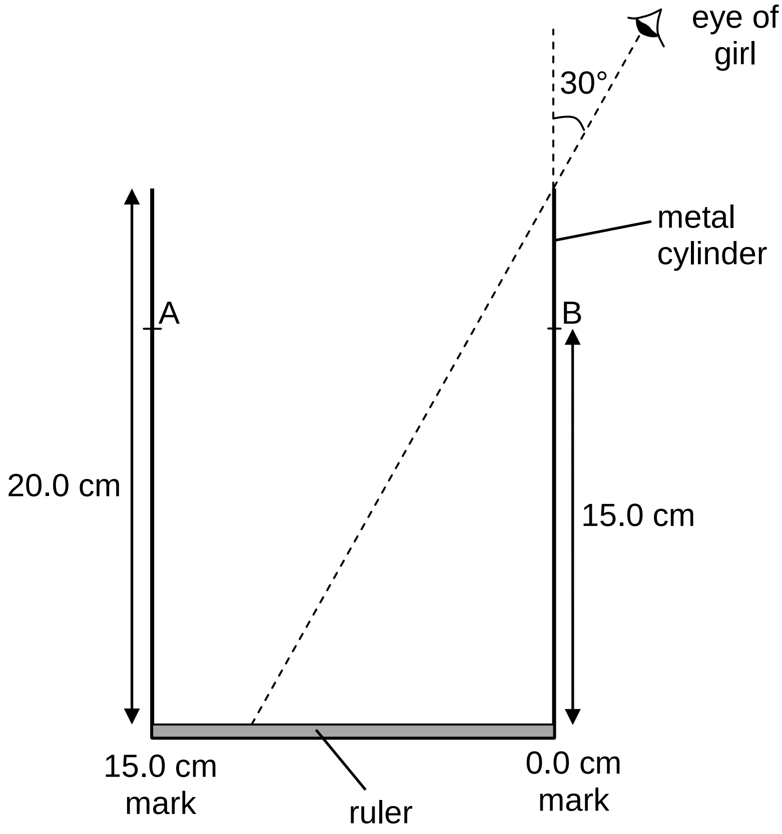


**Fig. 10.1**

**(a)** Determine the smallest reading she can see on the ruler.

smallest reading seen = ……………………………. [1]

**(b)** Water is poured into the cylinder until the water level reaches AB, at a height of 15.0 cm, as shown in Fig. 10.1. The girl keeps her eye in the same position as before.

**(i)** On Fig. 10.1, draw a horizontal line AB to show the water level. The refractive index of water is 1.33. A light ray from a point on the ruler travels in water till it reaches AB and bends towards the eye of the girl. Calculate the angle of incidence of this ray (in water) if the angle of refraction in air is 30°.

angle of incidence = ……………………………. [2]

**(ii)** Use the angle of incidence calculated in part **(i)** to draw on Fig. 10.1 the path of a light ray from a point on the ruler to AB, and to the eye of the girl. [1]

**(iii)** Hence, calculate the smallest reading that she can now see on the ruler, with water inside the cylinder.

smallest reading seen = ……………………………. [2]

**(c)** If instead of water, a clear liquid of a higher optical density is poured to the same level AB, describe how the smallest reading seen by the girl changes. Explain your answer clearly.

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…………………………………………………………………………………………..[3]

**(d)** The change in the smallest reading seen is due to refraction of light as light travels between two transparent medium with different refractive indices.

State one condition when refraction will not occur for a ray of light travelling between these two medium.

……………………………………………………………………………………………

…………………………………………………………………………………………..[1]

**11 EITHER**

Passenger airliners cruise at heights where the external atmospheric pressure is much lower than the normal atmospheric pressure at sea level. At these heights, the aircraft cabin is pressurised for passengers to breathe air comfortably, so there is a large difference between the air pressure inside and outside the aircraft.

An engineer designing a system for maintaining the air pressure within the cabin of a translantic aircraft starts by recording the pressure outside the aircraft as it makes its descent from an altitude of 9500 m.

The descent is in three stages as shown in Fig. 11.1.

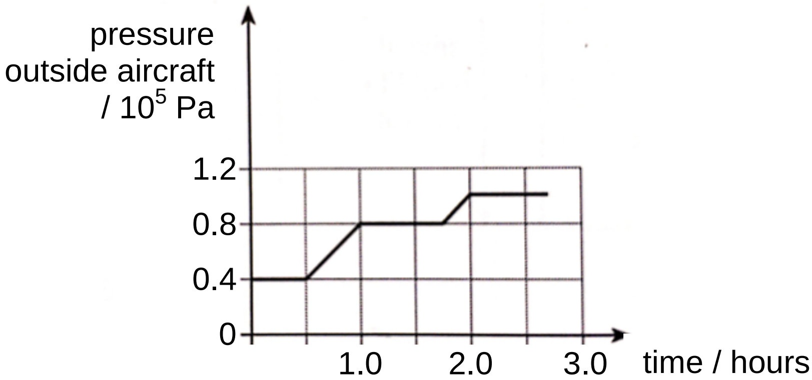


**Fig. 11.1**

**(a)** **(i)** From Fig. 11.1, determine the change in pressure outside the aircraft from 9500 m till it lands at a destination airport at sea level.

change in pressure = ................................ [1]

**(ii)** Assuming the density of air remains the same during the descent, estimate the density of the air outside the aircraft.

density of air = ................................ [2]

**(b)** **(i)** When the aircraft is cruising at 9500 m, calculate the force exerted by the air pressure outside the aircraft on a cabin window of area 0.65 $m^2$.

force = ……………………………. [2]

**(ii)** At 9500 m, if the air pressure inside the aircraft cabin is 90 kPa, determine the net force on the cabin window in part **(i)**.

net force = ……………………………. [2]

**(c)** Suggest a reason why the pressure inside the aircraft's cabin is reduced (kept lower than atmospheric pressure at sea level) when the aircraft is cruising at 9500 m.

……………………………………………………………………………………………

……………………………………………………………………………………………

…………………………………………………………………………………………..[2]

**(d)** Explain why the pressure in the cabin of the aircraft must be returned to 101 kPa before the aircraft lands.

……………………………………………………………………………………………

…………………………………………………………………………………………..[1]

**11 OR**

A metal tank containing compressed air has a safety valve shown in Fig. 11.2 below. The safety valve opens when the pressure of the compressed air exceeds a pre-set value.

The safety valve is attached to the lever at a position 4.0 cm from the pivot and a steel spring is attached 5.5 cm from the safety valve. The centre of gravity of the lever is 6.0 cm from the pivot and the lever has a weight of 2.8 N.

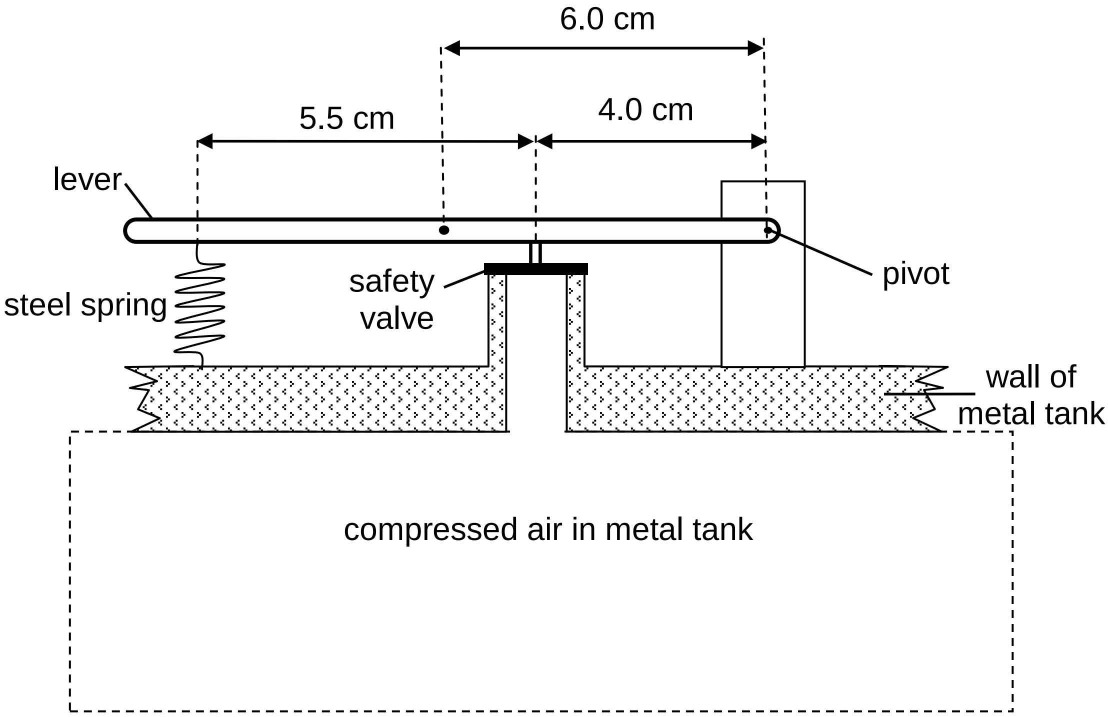


**Fig. 11.2**

**(a)** Define *the moment of a force*.

………………………………………………………………………………………………

………………………………………………………………………………………………

………………………………………………………………………………………………[1]

**(b)** Mark and label in Fig. 11.2, the forces acting on the lever due to gravity, the spring and the safety valve. [2]

**(c)** Calculate the moment due to the weight of the lever about the pivot.

moment = …………………………… [1]

**(d)** The tension in the steel spring is 3.8 N. Calculate the force acting on the safety valve.

force = ………………. [3]

**(e)** In a maintenance exercise, the lever in Fig. 11.2 is replaced by a longer lever. The two options for fixing the new lever are shown in Fig. 11.3 and Fig. 11.4 below.

In both options, assume that the new lever is uniform and its weight is the same as the original lever's weight. The pivot position, the positions of the safety valve and the steel spring on the tank, remain unchanged.

The new lever is drawn in dotted lines and slightly displaced from its actual position to allow you to compare it to the position of the original lever.

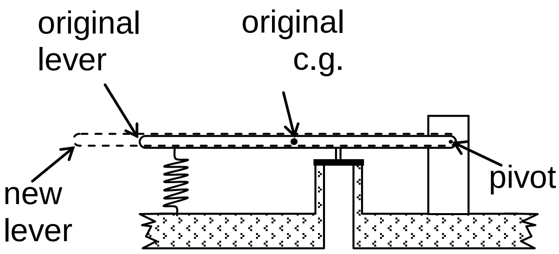


**Fig. 11.3**

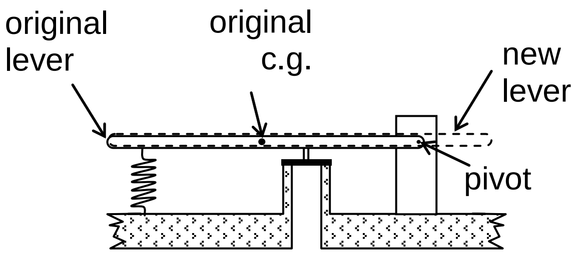


**Fig. 11.4**

Compare the two options of fixing the lever. Explain how each option affects the performance of the safety valve.

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…………………………………………………………………………………….[3]

**End of Paper**

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