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Kenya Certificate of Secondary Education
2018 Physics paper 1

SECTION A: (25 marks)

1. State the reason why an object on earth has a higher weight than on the moon. (1 mark)

An object on earth has a higher weight than on the moon because the acceleration due to gravity on earth is higher than on the moon.

2. Figure 1 shows the position of a student's eye while illustrate the length of a wooden block using a theme rule.

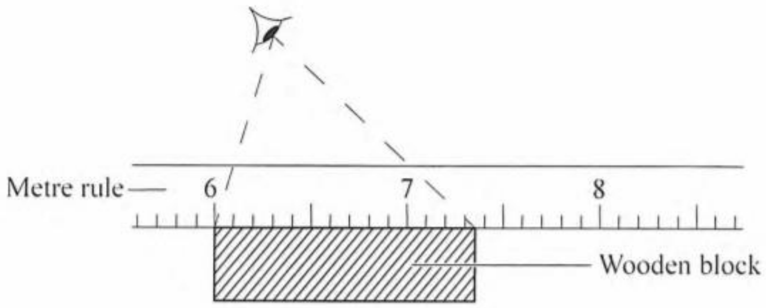


Figure 1

Determine the length of the block as viewed by the student. (1 mark)

$7.3 - 6 = 1.3$

3. Describe how the knowledge of the oil drop experiment may be used to estimate the area of oil spillage from a ship in the sea assuming the surface of the water is not distorted. (3 marks)

- Obtain a sample of the same oil and water.
- Measure the volume of the oil sample (say V_s)
- Pour it on the surface of the water sample and allow it to spread to a thin layer (assumed to be one molecule thick).
- Determine the area of the oil layer (say A_s)
- Determine the size (d) of the oil molecule using the formula

$$d = \frac{V_s}{A_s}$$

- If the ship was carrying oil volume V, then the area A of the oil spread will be;

$$A = \frac{V}{d}$$

4. Figure 2 shows an instrument used to measure atmospheric pressure.

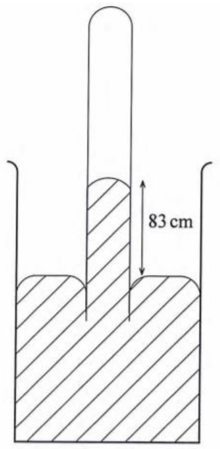


Figure 2

State with a reason the modification that would be required in a similar set-up if mercury were to be replaced with water. (2 marks)

Modification that would be required in a similar set-up if mercury were to be replaced with water – use a much longer tube. The density of water is lower hence the atmosphere can hold a much longer column.

(b) (moved to section B)

(c) Figure 10 shows heights of two immiscible liquids X and Y in a U-tube (drawn to scale).

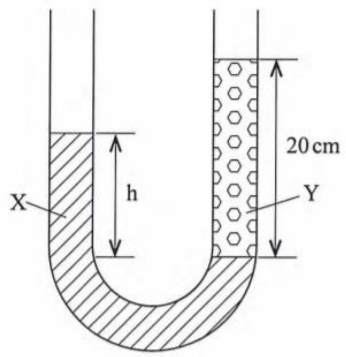


Figure 10

(i) State with a reason which of the two liquids X and Y has a higher density. (2 marks)

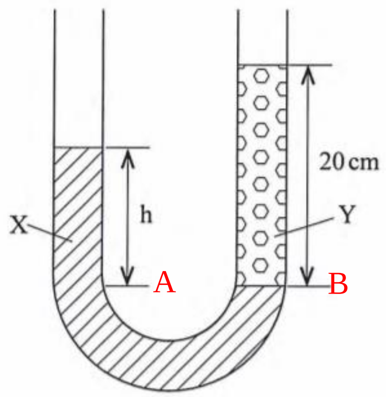


Figure 10

The liquid column above A is shorter than the liquid column above B. This means that liquid X is denser given that less of it is required to give the same pressure at point A (which is equal to pressure at B)

(ii) Determine the value of h. (2 marks)

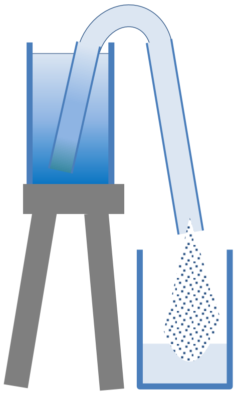
Since drawn to scale: h=12 cm

iii) Given that the density of liquid Y is p, write down an expression for the density d of liquid x in terms of p. (2 marks)

$$dh_x g = \rho h_y g$$
$$dh_x = \rho h_y$$
$$d \times 12 = \rho \times 20$$
$$d = \frac{20}{12}\rho$$
$$d = 1.67\rho$$

(c) (i) With the aid of a diagram, describe how a liquid may be siphoned from one container to another using a flexible tube. (3 marks)

Dip one end (inlet) of the syphon in the liquid. Arrange the empty container in such a way that the other end (outlet) of the syphon is at a lower level relative to the inlet. Ensure that the syphon is filled with the liquid (can suck at the outlet until the liquid starts flowing out).



iii) State one application of the siphon. (1 mark)

- Drinking straw,
- Transferring water from one container to the next

5. It is observed that a drop of milk carefully put into a cup of water tums the water white after some time. State the reason for this observation. (1 mark).

Milk turns water white (without stirring) due to diffusion. The milk particles move and occupy the spaces between the water particles.

6. Figure 3 shows the shape of a bimetallic strip after it was cooled below room temperature.

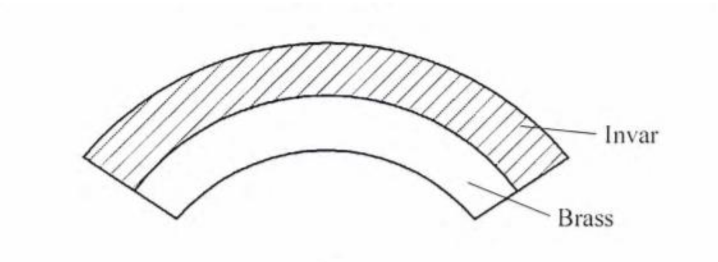


Figure 3

Explain why the strip curved is as shown. (2 marks)

Strip is curved because invar has a higher coefficient of linear expansion than brass. This means that invar expands more than brass.

7. A wooden cube of side 0.5m floats in water fully submerged. Determine the weight of the cube. (Density of the water = 1g.cm^{-3}). (2 marks)

Since object is fully submerged, then the weight of the cube equals the weight of the water displaced.

Volume of the object equals V the volume of liquid displaced.

$V = 0.5^3 = 0.125\ m^3$

$1\ g/cm^3 = 1000\ kg/m^3$
$Weight\ of\ liquid\ displaced = \rho g V = 0.125 \times 1000 = 125\ kg$
$Weight\ of\ the\ cube = 125\ kg$

8. Figure 4 shows a stone whirled in a vertical circle.

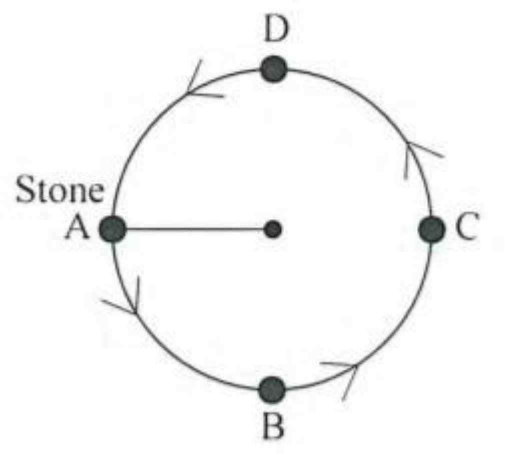
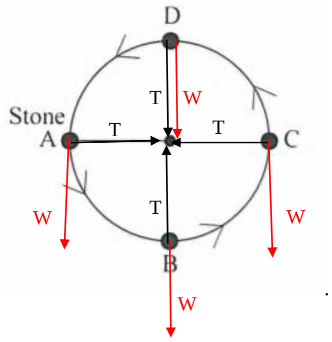


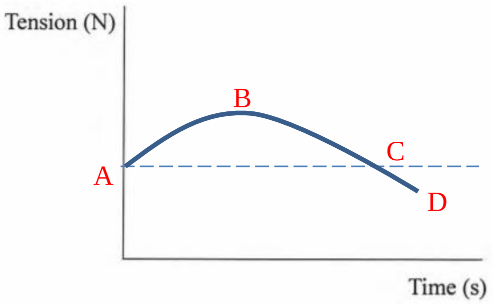
Figure 4

On the axes provided, sketch a graph of tension against time as the stone moves through point A, B, C and D. (3 marks)

Suppose the stone is now swirled in a vertical circle. At points A and C, the weight of the stone has no impact on the tension. At point B, the weight of the stone acts vertically downwards while the centripetal force acts vertically upwards. The tension in the string is therefore maximum at B.



At point D, both the weight and centripetal force act in the same direction. The tension in the string will therefore have a minimum value at this point.



9. Figure 5 shows a ball spinning as it moves.

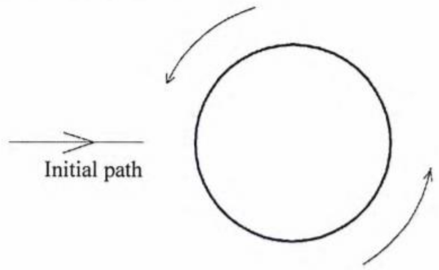


Figure 5

(a) On the diagram, sketch the path followed by the ball as it moves. (1 mark)

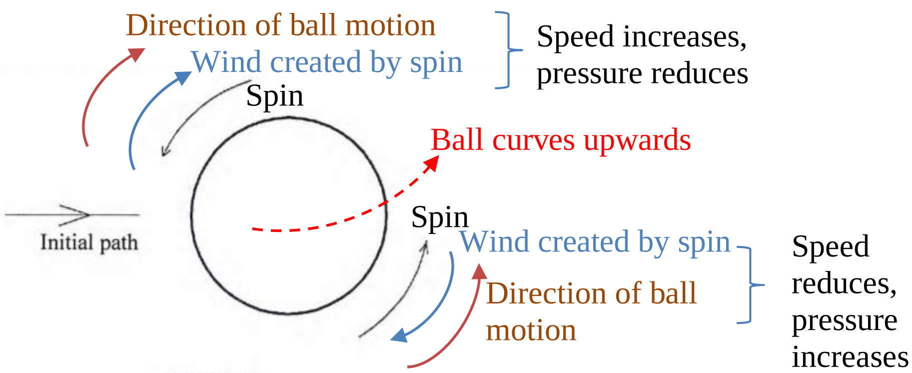


Figure 5

Curves upwards

(b) Explain why the ball takes that path. (3 marks)

Bernoulli's principle

At the upper part, the spin of the ball is opposite the direction of motion of the ball. This causes the air above the ball to move in the opposite direction (and in the direction of the moving ball). The effective speed of the upper side of the ball and hence that of the air around it increases and pressure drops. Below the ball, the spin causes air motion opposite the direction of motion of the ball. The effective speed of the lower part of the ball and of the air around it reduces hence pressure increases. This higher pressure pushes the ball up.

10. moved to section B

11. Figure 7 shows an L-shaped wooden structure.

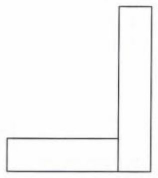
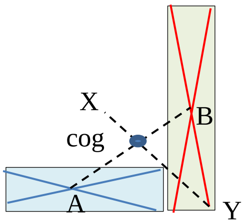


Figure 7

On the diagram construct appropriate lines to show the position of the centre of gravity for the structure. (2 marks)

For a regular isotropic medium, cog corresponds to the geometrical center. The body is made of two regular parts. To obtain the cog of object, first obtain the geometrical center of each shape independent of the other. Draw a straight-line AB joining the two cogs. Draw a straight line XY joining the furthest corner, the corner at the interface and the line joining the cogs. The point where line XY cuts line AB is the cog of the system.

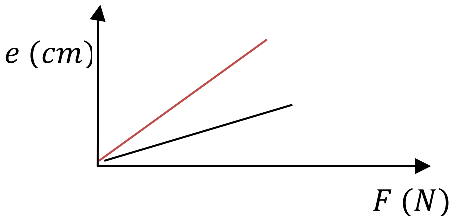


12. Figure 8 shows the graph of extension against force for a certain helical spring. On the same diagram sketch the graph of extension against force for a spring with a lower value of spring constant. (1 mark)

$$F = ke$$

$$\frac{e}{F} = \frac{1}{k}$$

If k is small, then 1/k is large implying the gradient is steep.



13. State two ways in which a mercury-based thermometer can be modified to read very small temperature changes. (2 marks)

Mercury-based thermometer modification to read very small temperature changes;

- Make bulb thinner so that heat reaches the bulb easily
- Make capillary tube narrower so that a small expansion produces a longer mercury column.

SECTION B (55 marks)

14. (a) State two differences between boiling and evaporation. (2 marks)

- Boiling occurs at all temperature while boiling occurs at a specific fixed temperature
- Evaporation occurs at the surface while boiling involves the entire liquid

(b) State three ways in which loss of heat by conduction is minimised in a vacuum flask. (3 marks)

- Glass walls
- Vacuum
- Plastic stopper

(c) In a certain experiment, 50 g of dry steam at 100 c was directed into some crashed ice at o C. Given that latent heat of vaporization of water is 2.26×10^6 J/kg, latent heat of fusion of ice is 3.34×10^5 and specific heat capacity of water of 4.2×10^3 J/kgC

Determine the:

(i) quantity of heat lost by steam to change to water at 100 °C. (2 marks)

Quantity of heat lost by 0.05 kg steam to change to water at 100 °C heat if specific heat of vaporization of water 2,260 kJ/kg

$Q = mL = 0.05 \times 2.25 \times 10^6 = 1.13 \times 10^5\ J$

(ii) quantity of heat lost by the water to cool to 0°C.(2 marks)

Water cools hence temp not constant

$Q = mc\Delta\theta$

$Q = 0.05 \times 4200 \times 100$

$Q = 21000\,J$

(iii) mass of ice melted at 0 °C.(2 marks)

$Heat\ lost\ by\ steam = heat\ gained\ by\ ice$

$Heat\ lost\ by\ steam$

$= heat\ lost\ by\ steam\ to\ turn\ to\ water$

$+ heat\ lost\ by\ the\ water\ to\ cool\ to\ 100$

$Heat\ lost\ by\ steam = 113000 + 21000 = 134000$

If mass of ice be m;

$Heat\ gained\ by\ steam\ to\ melt = mL = 334000\mathrm{m}$

$Heat\ lost\ by\ steam\ to\ tuen\ to\ water\ at\ oC = heat\ gained\ by\ ice$

$134000 = 334000\mathrm{m}$

$$m = \frac{134000}{334000} = 0.401\ kg$$

15. (a) State Newton's first law of motion. (1 mark)

First law: Law of inertia – a body remains at rest or in motion with constant velocity along a straight line unless acted upon by an external force.

(b) A wooden block resting on a horizontal bench is given an initial velocity u so that it slides on the bench for a distance x before it stops. Various values of x are measured for different values of the initial velocity. Figure 9 shows a graph of u^2 against x.

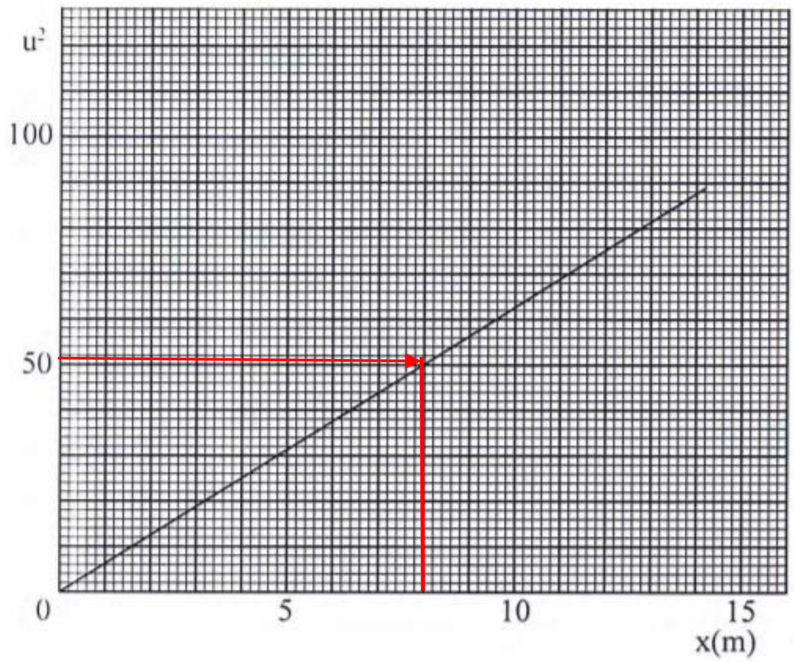


Figure 9

(i) Determine the slope S of the graph. (3 marks)

Use (8, 50) and (0,0)

$$S = \frac{\Delta y}{\Delta x} = \frac{50}{8} = 6.25$$

(ii) Determine the value of k given that $u^2 = 20kd$ where k is a frictional constant for the surface. (2 marks)

$$\frac{u^2}{d} = 20k$$

$$S = \frac{\Delta y \equiv u^2}{\Delta x \equiv d} = 6.25$$

$$20k = 6.25$$

$$k = \frac{6.25}{20} = 0.3125$$

(iii) State with a reason what happens to the value of k when the roughness of the bench surface is reduced. (2 marks)

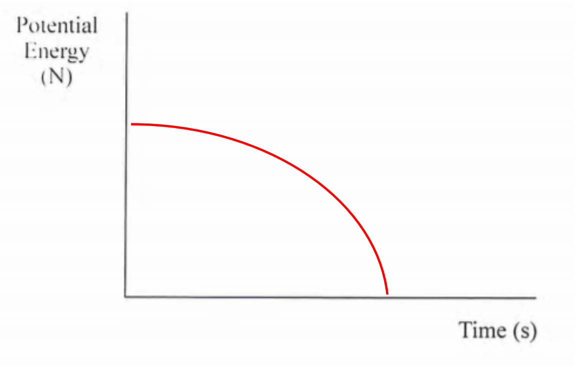
When roughness reduces, friction reduces hence the value of k reduces.

(c) An object is thrown vertically upwards with an initial velocity of 30 m/s. Determine its maximum height (acceleration due to gravity g is 10 m/s^2). (3 marks)

$$s = \frac{u^2}{2g} = \frac{30^2}{2 \times 10}$$

$$s = \frac{900}{20} = 45\ m$$

(d) A stone is dropped from the top of a building to the ground. On the axes provided, sketch a graph of potential energy against time for the stone. (1 mark)



16. An electric crane uses 8.0 x 10^4 J of energy to lift a load of 2.0 X 10^4 N in 4 s.

(i) Determine the;

a. power developed by the crane, (3 marks)

output work = 8.0 x 10^4 J, time= 4 s.

$$output\ power = \frac{output\ work}{time} = \frac{80000}{4} = 20000\ W$$

b. height to which the load is lifted, (2 marks)

$$output\ work = load \times distance$$

$$distance = \frac{output\ work}{load} = \frac{80000}{20000} = 4m$$

c. efficiency of the crane whose motor is rated 2.5 X 10^4 W. (2 marks)

$$Efficiency = \frac{output\ power}{input\ power} \times 100\%$$

$$Efficiency = \frac{20000}{25000} \times 100\%$$

$$Efficiency = 80\%$$

ii) State two forms of energy transformation that lead to the crane's inefficiency. (2 marks)

- Heat
- sound

17. (a) State Pascal's principle of transmission of pressure in liquids.

Pascal's principle (Pascal's law) states that for a liquid at rest and enclosed in a container, pressure applied at one point is equally transmitted throughout the liquid.

18. Figure 6 shows the relationship between volume and pressure for a certain gas.

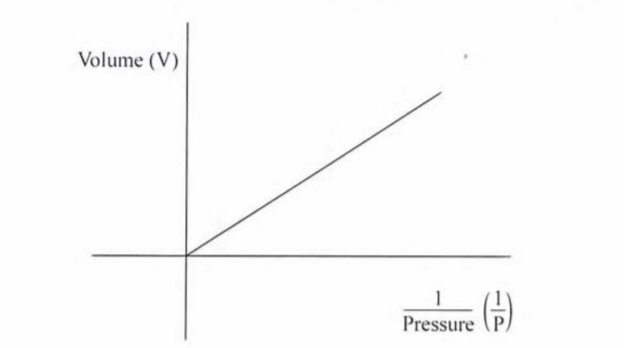


Figure 6

Name the law that the gas obeys.

$V \infty \frac{1}{p}$

$pV = constant$

Boyles law

19. (a) State two quantities that must be kept constant in order to verify Boyle's law. (2 marks)

- Temperature
- Number of moles (mass)

(b) An air bubble at the bottom of a beaker full of water becomes larger as it rises to the surface. State the reason why;

(i) the bubble rises to the surface, (1 marks)

The air in the bubble is less dense than water.

(ii) it becomes larger as it rises. (1 marks)

Pressure exerted by a column of water reduces with the reduction in depth (distance below the surface). A bubble at the bottom of the beaker is under the pressure of the water above it. As it rises on account of being less dense, the pressure exerted by water on the bubble reduces. Since the temperature is constant, then by Boyle's law, the volume subsequently increases. If the pressure on the bubble falls below the pressure of the air inside the bubble, the bubble extends to the limit and eventually bursts.

(c) Figure 11 shows an incomplete experimental set up that was prepared by a student to verily one of the gas laws.

Thermometer Pressure gauge

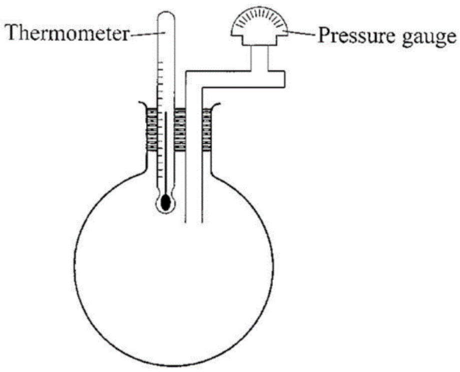


Figure 11

(i) State with a reason which one of the laws may be verified using the set up. (2 marks)

Pressure gauge measures pressure

Thermometer measures temp

Container does not expand. Hence

$P\infty T$

Pressure law

(ii) State what the student left out in the diagram of the set up. (1 mark)

Source of heat to vary temperature

(d) The volume of a fixed mass of a gas reduced from 500 cm^3 to 300 cm^3 at constant pressure. The initial temperature was 90K. Determine the final temperature. (3 marks)

Pressure constant - use Charles's law:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{500}{90} = \frac{300}{T_2}$$

$$T_2 = \frac{90}{500} \times 300 = 54\ K$$

(e) State two assumptions made in explaining the gas laws using the kinetic theory of gases. (2 marks)

- Molecules of a given gas are identical
- Collisions between particles and the container are perfectly elastic and therefore energy and momentum are conserved.
- Molecules do not exert any force on other molecules except during collisions. The influence of gravity on the particles is also ignored.
- The number of particles is high enough for statistics to be meaningfully applied.
- The size of molecules is negligible compared to their separation.
- The laws of Newtonian (classical) mechanics apply (as opposed to quantum mechanics).

END