

B.P.H.S Solutions to S.3 Physics Test One –Term One 2019

1. (a) What is friction?

This is a force which opposes relative motion between two bodies in contact ✓ 01

(b) Give the factors on which limiting friction depends

- *The nature of the surfaces that are in contact.* ✓
- *The magnitude of the force causing the motion.* ✓ 03
- *The weight of the object* ✓

(c) State the laws of friction

- *Friction always opposes motion* ✓
- *Friction is independent of area of contact but depends on the nature of the surface* ✓
- *Limiting friction and sliding friction are both proportional to the normal reaction* ✓ 03

(d) Give two advantages and two disadvantages of friction

Advantages of friction

- *Helps in writing* ✓
 - *Helps in the movement of people, animals and vehicles without sliding* ✓
 - *Helps in lighting a match stick* ✓
 - *Helps in braking systems of vehicles and individual machines* ✓
 - *Helps in gripping objects firmly* ✓
 - *It is used to generate static electricity* ✓
 - *Helps in painting and bathing* ✓
- Any two (02)

Disadvantages of friction

- *It causes unnecessary noise and heat* ✓
 - *Causes wear and tear of surfaces in contact* ✓
 - *Friction reduces efficiency of machines* ✓
- Any two (02)

(e) Mention three ways of reducing friction

- *Lubrication (oiling and greasing)* ✓
 - *Using ball bearing* ✓
 - *Using rollers* ✓
 - *Making surfaces in contact smooth* ✓
- Any three (03)

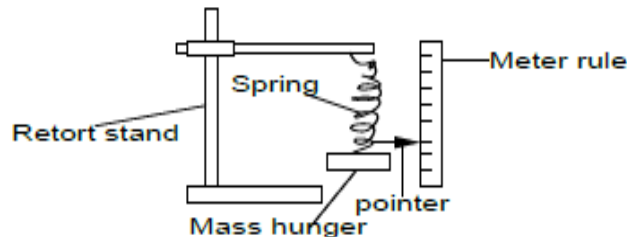
- By streamlining objects. ✓

2. (a) State Hooke's law of elasticity

It state that the extension of a material is directly proportional to the force applied provided the elastic limit is not exceeded.

(b) Describe a simple experiment to verify Hooke's law

- A spring is damped on a retort stand and a meter rule put besides it as shown below.



01

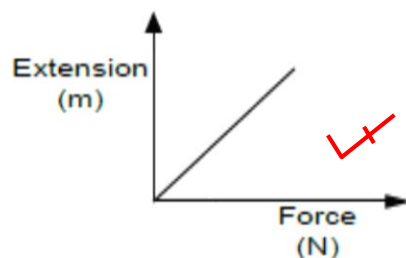
- A pointer is attached at the bottom of the spring and the initial position L_0 of the pointer is noted. ✓
- A known mass M is suspended from the spring and new reading L_1 of the pointer is noted. ✓
- The extension e , which is equal to $L_1 - L_0$ is obtained. ✓
- The procedure is repeated for about five increasing values of the mass. ✓
- The values are tabulated as shown below. ✓

03

Mass(kg)	Force(N)	New position Of pointer	Extension $e = L_1 - L_0$



A graph of extension against force is plotted. ✓



03

A straight line through the origin shows that extension is directly proportional to the force and this verifies Hooke's law ✓

(c) Define the following terms

(i) Stress

This is the force per unit cross sectional area of a material. ✓

01

(ii) Strain

This is the extension per original length of a material. ✓ 01

(iii) Young's modulus of a material

This is the ratio of stress to strain. ✓ 01

(e) A wire of natural length 5cm and cross sectional area 2cm^2 is stretched to 7cm by a force of 10N. find the;

(i) Extension produced

$$\begin{aligned}\text{Extension} &= \text{new length} - \text{original length} \quad \checkmark \times \\ &= 7 - 5 = 2\text{cm} \quad \checkmark \times \quad 01\end{aligned}$$

(ii) Stress

$$\text{Area} = 2\text{cm}^2 = 0.0002\text{m}^2$$

$$\text{Force} = 10\text{N}$$

$$\begin{aligned}\text{Stress} &= \frac{\text{force}}{\text{area}} = \frac{10}{0.0002} \quad \checkmark \times \quad 02 \\ &= 50000\text{Nm}^2 \quad \checkmark\end{aligned}$$

(iii) Strain

$$\text{Original length} = 5\text{cm} = 0.05\text{m}$$

$$\text{Extension} = 2\text{cm} = 0.02\text{m}$$

$$\begin{aligned}\text{Strain} &= \frac{\text{extension}}{\text{original length}} = \frac{0.02}{0.05} \quad \checkmark \times \quad 02 \\ &= 0.4 \quad \checkmark\end{aligned}$$

(iv) Young's modulus of a material.

$$\begin{aligned}\text{Young's modulus} &= \frac{\text{stress}}{\text{strain}} = \frac{50000}{0.4} \quad \checkmark \times \quad 02 \\ &= 125000\text{Nm}^2 \quad \checkmark\end{aligned}$$

3. (a) Define moments of a force.

This is the product of the force and its perpendicular distance from the pivot to the line of action of the force. ✓ 01

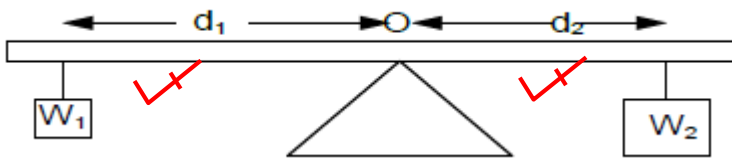
(b) State two quantities upon which the moment of a force depends

- Mass ✓ 02
- force. ✓

(c) State the Principle of moments.

It states that when a body is in equilibrium, the sum of the anti-clockwise moments about any point is equal to the sum of clockwise moments about the same point ✓ 01

(d) Describe an experiment how the principle can be verified



- Balance a meter rule on a knife edge about center O. ✓
- Suspend two different masses of weight W_1 and W_2 on the meter rule using a thread as shown above. ✓
- Adjust their position until the meter rule balances in a horizontal position. ✓
- Note the distances d_1 of W_1 and d_2 of W_2 from the pivot. ✓
- It is noted that for each set of value $W_1 d_1 = W_2 d_2$. ✓
- Clockwise moments = Anti clockwise moments, ✓
- Hence principle of moments is verified ✓

04

(e) State two practical applications of the principle of moments.

- Beam balance ✓
- See Saw ✓
- Determination of mass of a uniform meter rule using a standard mass. ✓
- Determination of mass or weight of an object using a uniform meter rule and Standard. ✓

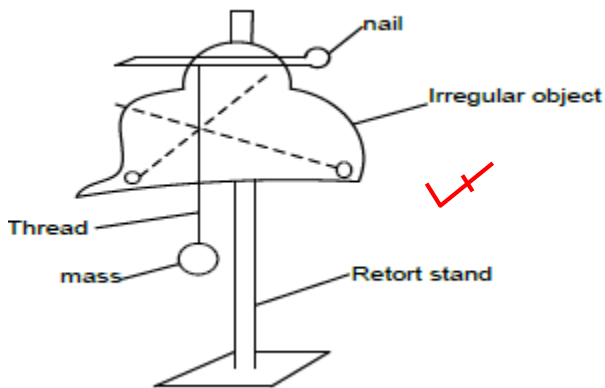
Any two(02)

4. Define centre of gravity of a body.

This is the point through which the total weight of the body acts. ✓ 01

(b) Show how the centre of gravity of an irregular lamina can be obtained

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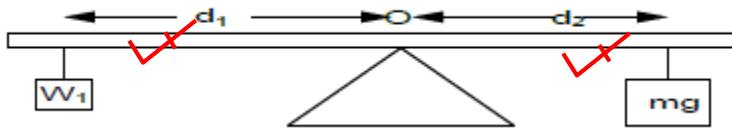


- Clamp a nail on the stand so that the pointed end is free. ✓
- Make three holes at the edges of the card board ✓
- Hung the card board on the nail through one of the holes. ✓
- Tie the thread on a mass to make a plumb line. ✓

- Tie the plumb line on the nail allow it to rest freely. ✓✓
- Trace the thread using a pencil. ✓
- Repeat the procedure when the plumb line using the other holes. ✓✓
- The point of intersection of the three lines is the centre of gravity of the board. ✓✓

04

(c) Describe an experiment to determine mass of a metre rule



- Balance the uniform meter rule on a knife edge and record the balance point. ✓✓
- Suspend the standard weight W_1 at one end of the meter rule adjust the meter rule until it balances horizontally as shown below. ✓✓
- Measure the perpendicular distances d_1 from the pivot to the standard weight and d_2 from the center of gravity of the meter rule ✓✓

At equilibrium; $mg \times d_2 = W_1 \times d_1$

$$m = \frac{W_1 \times d_1}{g \times d_2}$$

03

5. What is meant by couple?

A couple are two equal and opposite parallel forces whose lines of action do not meet ✓✓

01

(b) What is meant by moment of couple?

This is the product of one of the forces of the couple and the perpendicular distance between the lines of action of the forces ✓✓

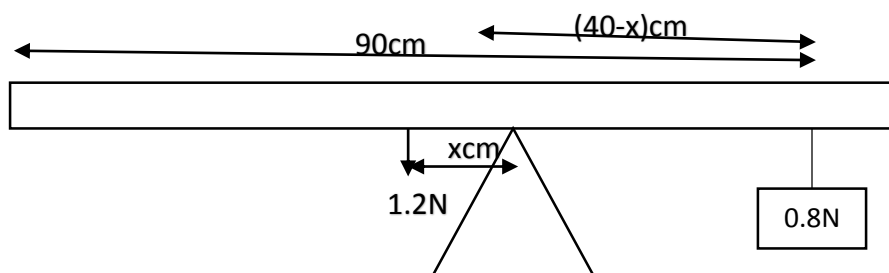
01

(c) State the conditions under which a body may be in equilibrium.

- The resultant force on the body must be zero. ✓✓
- Sum of the clock wise moments about a point is equal to the sum of the anti-clock wise moment about the same point ✓✓

02

(d) A uniform metre rule weighing 1.2N has a weight of 0.8N suspended at the 90cm mark. At what mark is rule supported on a knife – edge?



From the principle of moments,

Sum of clockwise moments = sum of anticlockwise moments ✓✓

$$0.8 \times \frac{40-x}{100} = 1.2 \times \frac{x}{100} \quad \checkmark \checkmark$$

$$32 - 0.8x = 1.2x$$

$$2x = 32$$

$$x = 16\text{cm}$$

the pivot is at 66cm mark. ✓

03

6. State the principle of conservation of linear momentum.

It states that when two or more bodies collide, their total momentum remains constant provided no external force acts on them. ✓ 01

(b) A trolley P of mass 150g moving with a velocity of 20m/s collides with another stationary trolley Q of mass 100g. If P and Q move together after collision, calculate:

(i) The momentum of P before collision.

$$M_p = 150\text{g} = 0.15\text{Kg}$$

$$U_p = 20\text{ms}^{-1}$$

$$\text{Momentum of P before collision} = 0.15 \times 20 \quad \checkmark$$

$$3\text{Kgm s}^{-1} \quad \checkmark$$

02

(ii) The velocity which P and Q move after collision

$$M_q = 100\text{g} = 0.1\text{Kg}$$

$$U_q = 0\text{ms}^{-1}$$

$$\text{Momentum before collision} = \text{momentum after collision} \quad \checkmark$$

$$M_p U_p + M_q U_q = V(M_p + M_q) \quad \checkmark$$

$$0.15 \times 20 + 0.1 \times 0 = V(0.15 + 0.1)$$

$$3 = 0.25V$$

03

$$V = 12\text{ms}^{-1} \quad \checkmark$$

(e) A bullet, fired vertically upwards from a gun held 2m above the ground, reaches its maximum height in 4s. Calculate

(i) The initial velocity of the bullet

$$u = ?$$

$$v = 0$$

$$t = 4\text{s}$$

$$g = 10\text{ms}^{-2}$$

$$\text{from } v = u - gt \quad \checkmark \checkmark$$

$$0 = u - 10 \times 4 \quad \checkmark \checkmark$$

$$u = 40\text{ms}^{-1} \quad \checkmark$$

02

(ii) The total distance the bullet travels by the time it hits the ground.

$$\text{from } h = ut + \frac{1}{2}gt^2$$

$$h = 40 \times 4 + 0.5 \times 10 \times 4^2$$

$$h = 80\text{m}$$

$$\text{total distance moved by the bullet} = 80 \times 2 + 2 = 162\text{m}$$

03

7. . (a) Define the following terms as applied to machines

(i) Mechanical advantage

This is the ratio of load to effort.

01

(ii) Velocity ratio

This is the ratio of distance moved by effort to distance moved by the load in the same time.

01

(iii) Efficiency

This is the ratio of work output to work input expressed as a percentage
OR it is a ratio of mechanical advantage to velocity ratio expressed as a percentage

01

(b) Two gear wheels P and Q with 25 and 50 teeth respectively lock into each other. They are fastened on axles of equal diameters such that a weight of 400N attached to a string wound around one axle raises a load of 600N attached to a string wound around the other axle.

Calculate the velocity ratio when P drives Q and the efficiency of the system

$$\text{Velocity ratio} = \frac{\text{number of teeth on the driven}}{\text{number of teeth on the driving wheel}} = \frac{50}{25}$$

$$= 2$$

$$\text{Mechanical advantage} = \frac{600}{400} = 1.5$$

$$\text{Efficiency} = \frac{1.5}{2} \times 100\%$$

$$= 75\%$$

04