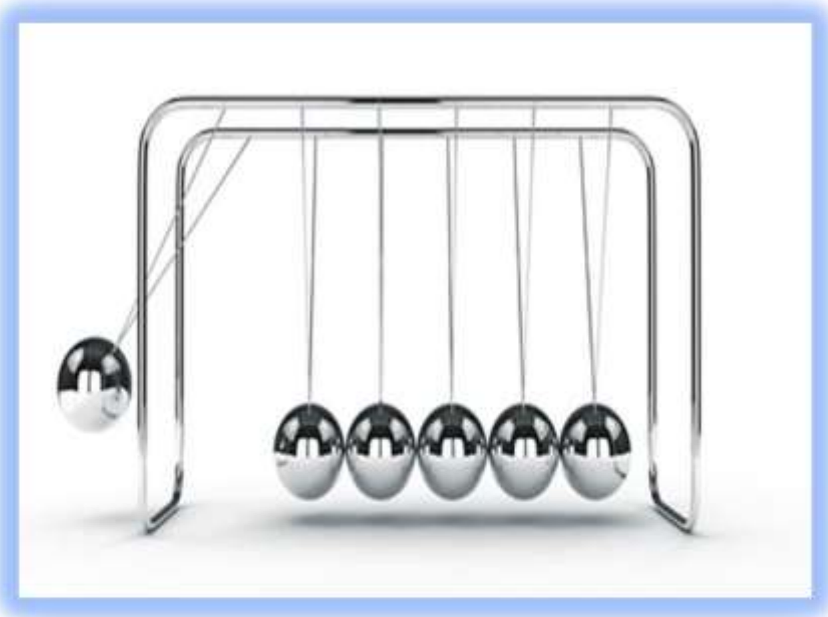
KNOWLEDGEBASE PHYSICS

2020

NEWTON'S LAWS OF MOTION



TEACHERS OF PHYSICS

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12/14/2020

MOMENTUM AND COLLISION

1. Define the term

(i) Momentum (1mk)

It is the product of mass and velocity of a body

(ii) Inelastic collisions (1mk)

These are the collisions where the colliding bodies do not separate after collision. Momentum is conserved while kinetic energy is not conserved

(iii) Elastic collisions (1mk)

These are the collisions where the bodies separate after collision. Both momentum and kinetic energy are conserved

2. State why energy is not conserved during an inelastic collision. (1mk)

Energy is lost in form of sound, light and heat. Energy is also used as the bodies get deformed.

3. Give **one** example of an inelastic collision. (1mk)

- A bullet fired to a tree gets stuck to the trunk
- Plasticine thrown and sticks to a surface
- A monkey jumping on a branch and swings on the branch as soon as it lands on the branch

4. State the principle of conservation of linear momentum. (1mk)

For a system of colliding bodies, the total linear momentum is conserved provided no external forces act.

5. State the law of conservation of energy. (1mk)

Energy can neither be created nor destroyed but can only be transformed from one form to another.

6. A motor cyclist wears a helmet in the inside with sponge. Explain how this minimizes injuries to the motorist's head when involved in an accident. (2mk)

The sponge in the helmet acts as a shock absorber. It increases the time of impulse and reducing the effect of the impulsive force or help spread the impact over a long time.

7. A trolley is moving at constant speed in a **friction compensated** track. Some plasticine is dropped on the trolley and sticks to it. State with a reason what is observed about the motion of the trolley.

The speed of the trolley decreases. Since momentum is conserved an increase in mass (plasticine) implied a decrease in velocity.

8. A trolley is moving at uniform speed along a straight horizontal path. A piece of plasticine is dropped on the trolley and sticks on it. State and explain the resultant motion of the trolley. (2mks)
The speed of the trolley decreases. Since the trolley is on a frictional surface, the speed decreases and the trolley may come to a stop. The increase in mass decreases the time taken to reduce the speed.

9. A cyclist carrying two bags of maize tied a cross back seat is traveling at uniform velocity. The bags suddenly fall. If the bags do not touch the back wheel **explain** what happens? (2mks)
The cyclist moves faster. This is because the total mass of the body is reduced and since momentum is conserved the speed of the cyclist increases.

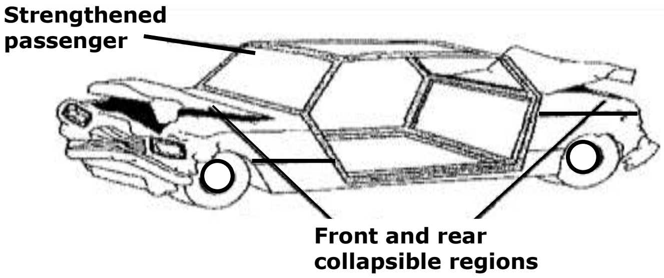
10. Explain why a high jumper flexes his knees when landing on the ground. (2mk)
To increase the time taken to land. When time is increased the force of impact is reduced making the jumper to land safely.

11. Explain why unboiled egg stops faster than a boiled egg when both are rolled together on a flat horizontal surface with same velocity. (2mks)
The unboiled egg experiences a more retarding force due to the liquid hence slowing the egg faster. The boiled egg experiences less retarding force since it is solid.

12. A high jumper usually lands on a thick soft mattress. Explain how the mattress helps in reducing the force of impact.
The mattress increases the time taken to land. This is to increase the reaction time and hence reduce the impulsive force acting on the jumper.

13. A parachutist allows his legs to bend and rolls over on the ground when he lands. Explain. (2mk)
The bending of legs increases the time o impact thus reducing the effect of force of impact. (If they hit the ground stiff-legged, then their speed goes to zero very quickly and they can get hurt)

14. A modem car with a strengthened passenger cage has regions at the front and the back which can collapse in a crash.



Explain how the collapsible regions should reduce passenger injury in a car crash. (3mks)

The collapsible regions increase the time taken for the change in momentum to take place. On collision they collapse increasing the time of impact. This reduces the rate of change of momentum of the passengers, thus force f impact is reduced.

15. Two identical cans **A** and **B** are suspended from a horizontal support with strings of the same length as shown in Fig.4.Can **A** is empty while **B** is full of paint.

They are both displaced simultaneously and left to swing freely. Which can is likely to remain swinging for a longer time? Explain. (2mks)

Can A will continue swinging for a longer time than can B. This is because can B will have a greater reduction in momentum since it has more mass and force is constant for both.

16. A particle A of mass $\boldsymbol{m}$ moving with an initial velocity $\boldsymbol{u}$ m/s makes a head on collusion with another particle B of mass $\boldsymbol{2m}$ kg at rest. In terms of **u** express the final velocity $\boldsymbol{V}$ of the two if the collusion is perfectly inelastic. 3mk

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

$$mu + (2m*0) = (m + 2m)v$$

$$v = u/3 \; m/s$$

17. A bullet of mass **40g** is fired at a velocity of **400ms^{-1}** from a gun of mass **8kg**. Determine the corresponding velocity of the gun. (2mk)

$$0 = m_1v_1 + m_2v_2$$

$$\frac{40}{1000} * 400 = -8v$$

$$v = -2m/s$$

The recoil velocity is 2 m/s or the velocity of the gun is -2 m/s

18. A bullet of mass **0.006kg** is fired from a gun of mass **0.5kg**. If the muzzle velocity of the bullet is **300m/s**. calculate the recoil velocity of the gun. 3mk

$$m_1u_1 = -m_2v_2$$

$$0.006 * 300 = -0.5v_2$$

$$v_2 = -3.6m/s$$

The recoil velocity is 3.6 m/s

19. Calculate the recoil velocity of a gun of mass **0.4kg** which fires a bullet of mass **0.0045kg** at a velocity of **400ms^{-1}** (3mk)

$$m_1u_1 = -m_2v_2$$

$$0.0045 * 400 = -0.4v_2$$

$$v_2 = -4.5m/s$$

The recoil velocity is 4.5 m/s

20. A car of mass **800kg** starts from the rest and accelerates at **1.2ms^{-2}**. Determine its momentum after it has moved **400m** from the starting

$$v^2 = u^2 + 2as$$

$$v^2 = 0 + (2 * 1.2 * 400)$$

$$v = 30.98m/s$$

$$momentum = mv$$

$$P = 800 * 30.98$$

$$P = 24784kgm/s$$

21. Two bodies of masses 5kg and 8 kg moving in the same direction with velocities 20m/s and 15m/s respectively collide in elastically. Determine the velocity of the bodies after collision. (3mk)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$
$$(5*20) + (8*15) = (5+8)v$$
$$v = 16.92m/s$$

22. A bullet of mass **20g** moving with a velocity of **1000m/s** hits stationery antelope of mass **12kg**.The bullet embeds and the two moves in one direction. Calculate its final velocity (2mk)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$
$$(\frac{20}{1000}*1000) + (12*0) = (0.02+12)v$$
$$v = 1.664m/s$$

23. A bullet of mass **22g** traveling horizontally with a velocity of **300ms^{-1}** strikes a block of wood of mass **1,978g** which rests on a rough horizontal surface. After impact the bullet and the block move together and come to rest when the block has traveled a distance of **5m**. Calculate:

(i) The velocity of bullet and wood after impact. (2mks)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$
$$(\frac{22}{1000}*300) + (\frac{1978}{1000}*0) = (\frac{22+1978}{1000})v$$
$$v = 3.3m/s$$

(ii) The force of friction between wood and surface. (2mks)

$$v^2 = u^2 + 2as$$
$$3.3^2 = 0 + (2a*5)$$
$$a = 1.089$$
$$F = ma$$
$$= \frac{1978}{1000}*1.089$$
$$= 2.154N$$

24. A cyclist of mass **200kg** and traveling at **90km/h** is involved in a head on collision with a car of mass **600 kg** traveling at **110km/h**. The cyclist is thrown onto the bonnet of the car which continued to move after impact in the original direction. Find their velocity after impact (3mks)

$$u_1 = 90km/h = 25m/s$$
$$u_2 = -110km/h = -30.56m/s$$
$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$
$$(200 * 25) + (600 * -30.56) = (200 + 600)v$$
$$v = -16.67m/s$$

25. An arrow of mass **20g** traveling horizontally strikes a block of wood of mass **1980g** resting on a horizontal surface. The impact takes **0.2s** before the two move together with an initial velocity of **5m/s**. Calculate:

(i) The velocity of the arrow before the impact. (2mk)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$
$$(\frac{20}{1000} * u_1) + (\frac{1980}{1000} * 0) = (\frac{20 + 1980}{1000}) * 5$$
$$u_1 = 500m/s$$

(ii) The impulsive force (2mk)

$$F = \frac{mv - mu}{t}$$
$$= \frac{(\frac{20}{1000} * 5) - (\frac{20}{1000} * 500)}{0.2}$$
$$= -49.5N$$

or

$$F = \frac{(\frac{1980}{1000} * 5) - (\frac{1980}{1000} * 0)}{0.2}$$
$$= 49.5N$$

26. A body of mass **150kg** traveling at constant velocity of **20m/s** collides with a stationery object of mass **90kg**. If the impact takes **3s** before the two move together at a constant velocity for **20s**. Find;

i) Their common velocity. (2mks)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$
$$(150*20) + (90*0) = (150+90)v$$
$$v = 12.5m/s$$

ii) Distance moved after impact. (2mks)

$$v = u + at$$
$$0 = 12.5 + 20a$$
$$a = -0.625m/s^2$$
$$s = ut + \frac{1}{2}at^2$$
$$s = (12.5*20) + \frac{1}{2}*-0.625*400$$
$$s = 125m$$
$$or$$
$$v^2 = u^2 + 2as$$
$$0 = 12.5^2 + (2*-0.625*s)$$
$$s = 125m$$

iii) State the law of conservation of linear momentum. (2mks)

For a system of colliding bodies, the total linear momentum of the bodies remains constant provided no external forces act.

27. A minibus of mass **1200kg** travelling at a constant velocity of **15m/s** collides with a stationary car of mass **600kg.** The impact takes **1.5** seconds before the two move together at a constant velocity for **25** seconds.

Calculate.

i) The common velocity (2mks)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$
$$(1200*15) + (600*0) = (1200+60)v$$
$$v = 10m/s$$

ii) Distance moved after impact (2mks)

$$v = u + at$$
$$0 = 10 + 25a$$
$$a = -0.4m / s^2$$
$$s = ut + \frac{1}{2}at^2$$
$$s = (10 * 25) + (\frac{1}{2} * -0.4 * 25^2)$$
$$s = 125m$$
or
$$v^2 = u^2 + 2as$$
$$0 = 10^2 + (2 * -0.4 * s)$$
$$s = 125m$$

iii) The impulsive force (3mks)

$$F = \frac{mv - mu}{t}$$
$$= \frac{(1200 * 10) - (1200 * 15)}{1.5}$$
$$= -4000N$$
or
$$F = \frac{(600 * 10) - (600 * 0)}{1.5}$$
$$= 4000N$$

iv) The change in kinetic energy (3mks)

Change in K.E = Final K.E – Initial K.E

For the minibus

$$\Delta K.e = \frac{1}{2}m_1 v_1^{\,2} - \frac{1}{2}m_1 u_1^{\,2}$$
$$= (\frac{1}{2}*1200*10^2) - (\frac{1}{2}*1200*15^2)$$
$$= -75000J$$

For the car

$$\Delta K.e = \frac{1}{2}m_1 v_1^{\,2} - \frac{1}{2}m_1 u_1^{\,2}$$
$$= (\frac{1}{2}*600*10^2) - (\frac{1}{2}*600*0)$$
$$= 3000J$$

28. A car of mass **2000kg** traveling at **5m/s** collides with a minibus of mass **5000kg** traveling in the opposite direction at **7 m/s**. The vehicles stick and move together after collision. If the collision lasts **0.1**seconds

a) Determine the velocity of the system after collision to 3 d.p (3mks)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$
$$(2000*5) + (5000*-7) = (2000+5000)v$$
$$v = -3.571m/s$$

b) Calculate the impulsive force on the minibus (3mks)

$$F = \frac{mv - mu}{t}$$
$$= \frac{(5000*-3.571) - (5000*-7)}{0.1}$$
$$= 171450N$$

(c) Calculate the change in kinetic energy of the system to 5s.f (3mk)

Change in K.E = Final K.E – Initial K.E

For the car

$$\Delta K.e = \frac{1}{2}m_1 v_1{}^2 - \frac{1}{2}m_1 u_1{}^2$$

$$= (\frac{1}{2} * 2000 * 3.571^2) - (\frac{1}{2} * 2000 * 5^2)$$

$$= -12248J$$

For the bus

$$\Delta K.e = \frac{1}{2}m_1 v_1{}^2 - \frac{1}{2}m_1 u_1{}^2$$

$$= (\frac{1}{2} * 5000 * 3.571^2) - (\frac{1}{2} * 5000 * (-7)^2)$$

$$= -90620J$$

(d) Explain the change in kinetic energy of the system (1mk)

Energy is lost in form of sound, heat and in the bodies deformed.

29. A bus of mass **3000kg** traveling at a velocity of **20m/s** collides with a stationary car of mass **600kg**. The two then moves together at a constant velocity for **30** seconds. Find

(i) The common velocity after impact (3mks)

$$m_1 u_1 + m_2 u_2 = (m_1 + m_2)v$$

$$(3000 * 20) + (600 * 0) = (3000 + 600)v$$

$$v = 16.67m/s$$

(ii) The distance moved after impact (2mks)

$$v = u + at$$
$$0 = 16.67 + 30a$$
$$a = -0.5557 m/s^2$$

$$v^2 = u^2 + 2as$$
$$0 = 16.67^2 + (2 * -0.5557 * s)$$
$$s = 250.04 m$$

(iii) The impulse (2mks)

$$F = \frac{mv - mu}{t}$$

NOTE:TIME OF IMPACT NOT GIVEN

(iv) Kinetic energy before collision (2mks)

K.E before collision for the bus

K.E before collision for the car

$$K.E = \frac{1}{2} m_2 u_2{}^2$$
$$= \frac{1}{2} * 600 * 0$$
$$= 0 J$$

(v) Kinetic energy after collision (2mks)

K.E after collision for the bus

$$K.E = \frac{1}{2} m_1 v_1{}^2$$
$$= \frac{1}{2} * 3000 * 16.67^2$$
$$= 416833.35 J$$

K.E after the collision for the car

$$K.E = \frac{1}{2} m_2 v_2^{\ 2}$$

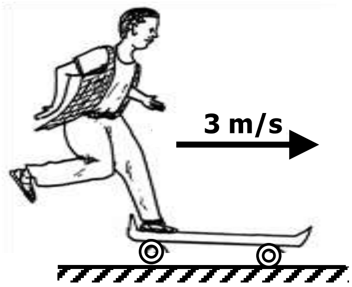
$$= \frac{1}{2} * 600 * 16.67^2$$

$$= 83366.67J$$

(vi) State a reason why kinetic energy before collision is not the same as kinetic energy after collision (1mk)

Energy is lost in form of sound, heat and in the bodies deformed.

30. A boy of mass **58kg** jumps with a horizontal velocity of **3ms^{-1}** onto a skateboard of mass **2kg** as shown below



What is his velocity as he moves off on the skateboard? (2mk)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

$$(58*3) + 0 = (58+2)v$$

$$v = 2.9m/s$$

31. A rugby player of mass **75kg**, running east at **8.0 m/s**, tackles another player of mass **90kg** and who is running directly towards him at **5.0m/s**. If the two players cling together, determine their common velocity. (3mk)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

$$(75*8) + (90*-5) = (75+90)v$$

$$v = 0.909m/s$$

32.

A bullet of mass **20g** moving with a velocity of **1000m/s** hits stationery wooden block of mass **12kg**. The bullet embeds and the two move in one direction. Calculate its final velocity (3mks)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

$$(\frac{20}{1000} * 1000) + 0 = (\frac{20}{1000} + 12)v$$

$$u_1 = 1.664 m/s$$

33. A minibus of mass **1600kg** traveling at a constant velocity of 20m/s collides with a stationery car of mass **800kg**. The impact takes **2s** before the two moves together and come to rest after **15s**. Determine;

(i) The common velocity (3mks)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

$$(1600 * 20) + 0 = (1600 + 800)v$$

$$v = 13.33 m/s$$

(ii) The distance moved after the impact (3mks)

$$v = u + at$$

$$0 = 13.33 + 15a$$

$$a = -0.8887 m/s^2$$

$$s = ut + \frac{1}{2}at^2$$

$$s = (13.33 * 15) + (\frac{1}{2} * -0.8887 * 15^2)$$

$$s = 99.97 m$$

(iii) The impulse force (3mks)

$$F = \frac{mv - mu}{t}$$

$$= \frac{(800 * 13.33) - 0}{2}$$

$$= 5332 N$$

34. A truck of mass **5000 kg** and traveling at **5 ms^{-1}** collides and couples with a stationary truck. They travel off together at **0.5 ms^{-1}**.

(i) Determine the mass of the stationary truck. (3 mk)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$
$$(5000*5) + 0 = (5000 + m_2)*0.5$$
$$m_2 = 45000kg$$

(ii) Determine the of impulse on the **5000kg** truck (3 mk)

$$F = \frac{mv - mu}{t}$$

TIME OF IMPACT NOT GIVEN

35. A body of mass **4 kg** is moving at **12ms^{-1}** before colliding with a stationary body of mass **6 kg**. If the bodies stick together, what is the common velocity with which they move? (3mks)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$
$$(4*12) + 0 = (4 + 6)v$$
$$v = 4.8m/s$$

36. A bullet of mass **10g** traveling horizontally with a velocity of **300m/s** strikes a block of wood of mass **290g** which rests on rough horizontal floor. After impact they move together and come to rest after traveling a distance of **15m**.

(i) Calculate the common velocity of the bullet and the block.

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$
$$(\frac{10}{1000}*300) + 0 = (\frac{10 + 290}{1000})v$$
$$u_1 = 10m/s$$

(ii) Calculate the acceleration of the bullet and the block.

$$v^2 = u^2 + 2as$$
$$0 = 10^2 + (2a*15)$$
$$a = -3.333m/s^2$$

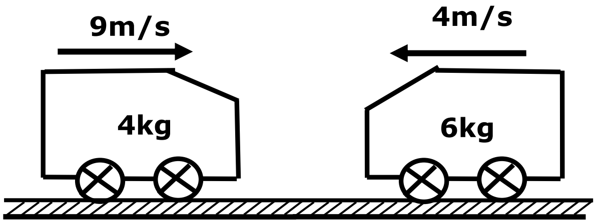
(iii) Calculate the coefficient of sliding friction between the block and the floor.

$$F = ma = \mu R$$

$$\frac{290}{1000} * 3.333 = \mu * 2.9$$

$$\mu = 0.3333$$

37. The figure below shows two trolleys of mass **4kg** and **6kg** traveling towards each other at **9m/s** and **4m/s** respectively. The trolleys combine on collision.



i) Calculate the velocity of the combined trolleys.

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

$$(4*9) + (6*-4) = (4+6)v$$

$$v = 1.2m/s$$

ii) In what direction do the trolleys move after collision?
In the direction of the 4kg trolley (to the right)

38. Two trolleys of masses **2kg** and **1.5kg** are traveling towards each other at **0.25m/s** and **0.4m/s** respectively. Two trolleys combine on collision.

i) Calculate the velocity of the combined trolleys. (3mk)

$$m_1u_1 + m_2u_2 = (m_1 + m_2)v$$

$$(2*025) + (1.5*-0.4) = (2+1.5)v$$

$$v = -0.0286m/s$$

ii) In what direction do the trolleys move after collision? (1mk)

In the direction of the 1.5kg trolley (to the left)

PERFECTLY ELASTIC COLLISIONS

39. A mini bus of mass **2500 kg** traveling at a speed of **40m/s** collides head on with a lorry of mass **3500kg m**oving at a speed of **20m/s**. The two vehicles separate on collision and the lorry moves with a speed of **1.2m/s.** Calculate the speed of the mini bus after collision.

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$
$$(2500*40) + (3500*-20) = 2500v_1 + (35000*-1.2)$$
$$v_1 = 13.68m/s$$

40. A bullet of mass **20g** traveling horizontally at a speed of **200m/s** hits a block of wood of mass **800g** suspended by a light inextensible string so that it swings freely. If the bullet emerges on the other side of the block at **80m/s**, find:

(i) The initial velocity of the block after being hit by the bullet. (3mks)

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$
$$(\frac{20}{1000}*200) + 0 = (\frac{20}{1000}*80) + \frac{800}{1000}v_2$$
$$v_2 = 3m/s$$

(ii) The maximum height through which the block may rise. (2mks)

$$v^2 = u^2 + 2gh$$
$$0 = 3^2 + (-2*10h)$$
$$h = 0.45m$$

41. Two stationary trolleys **A** and **B** are separated by a compressed spring and held together by a thread. The mass of trolley **A** is **2.0Kg** and that of trolley **B** is **1.0Kg**. When the thread is cut the trolleys move rapidly apart.

(i) What is the cause of movement of trolleys when the thread is cut. (2mk)

Elastic potential energy is converted to kinetic energy.

(ii) What is the total momentum of the trolleys just before the thread is cut. (4mk)

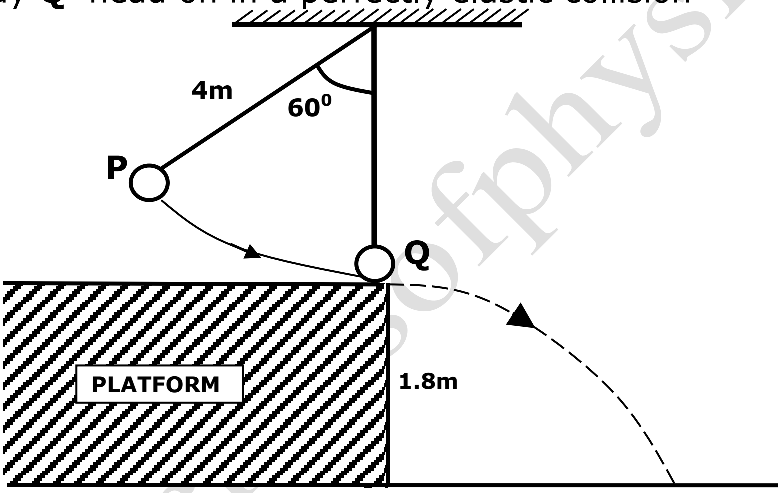
iii) If trolley **A** moves off with a speed of **0.25m/s**. calculate the speed with which trolley **B** moves off. (4mk)

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

$$0 = (2*0.25) + 1v_2$$

$$v_2 = -0.5m/s$$

42. A body **P** of mass **4kg** supported on a light cord **4m** long is held at an angle of **60** from the vertical position as shown below. A second body **Q** of mass **1kg** rest at the edge of a platform **2m** high the body is released and strike body **Q** head on in a perfectly elastic collision



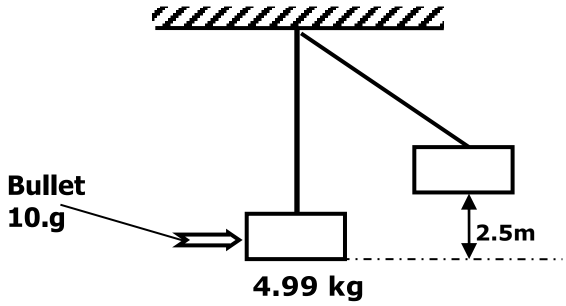
(i) Explain the term elastic collision (2mk)

Elastic collision is the collision where the two bodies separate after collision. Kinetic energy and momentum is conserved

(ii) Determine how long it takes after **P** is released for body **Q** to strike the ground (4mk)

(iii) How far from the base of the platform will the body **Q** strike the ground if **P** stops after the collision (2mk)

43. A bullet of mass **10.0g** is fired at a close range into a block of mass **4.99kg** suspended from a rigid support by an elastic string and becomes embedded into the block. The block rises through a height of **2.5cm** before momentarily coming to rest. Calculate initial speed of the bullet. 5mks

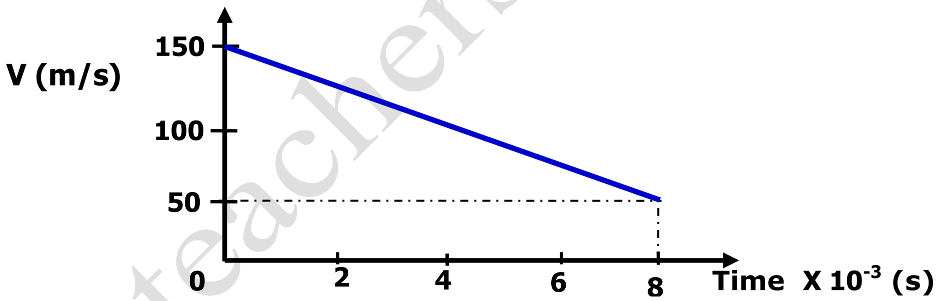


$$v^2 = u^2 + 2as$$

$$0 = u^2 + (2 * -10 * 0.025)$$

$$u = 0.7071 m/s$$

44. The graph below shows the variation of velocity with time for a bullet of mass **50g** moving thru the trunk of a tree until it comes out on the other side.



Determine:

(i) The change of momentum of the bullet.

$$\Delta P = mv - mu$$

$$= \frac{50}{1000}(50 - 150)$$

$$v = -5 kgm/s$$

(ii) The diameter of the tree trunk.

$$v = u + at$$

$$a = \frac{50 - 150}{0.008}$$

$$= 12500 m/s^2$$

$$s = ut + \frac{1}{2}at^2$$

$$= (150 * 0.008) + (\frac{1}{2} * (-12500) * 0.008^2)$$

$$= 0.8m$$

(iii) The retarding force on the bullet.

$$F = ma$$

$$= \frac{50}{1000} * (-12500)$$

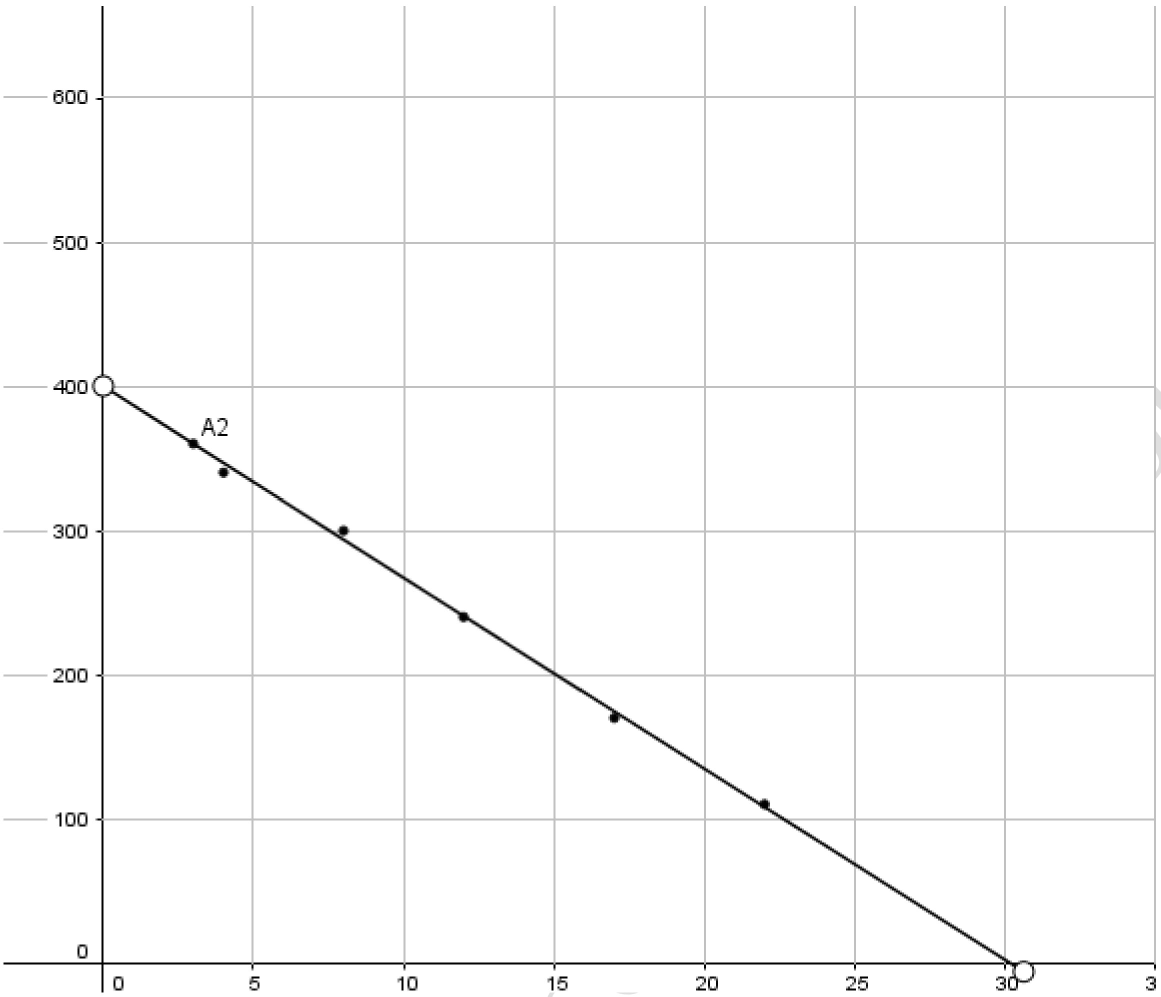
$$= -625N$$

The retarding force is 625 N

45. The table below shows the values of the resultant force **F** and the time t for a bullet traveling inside the gun barrel after the trigger is pulled.

Force F (N)	**360**	**340**	**300**	**240**	**170**	**110**
Time (Milliseconds)	**3**	**4**	**8**	**12**	**17**	**22**

a) Plot a graph of force, **F** against time **t** (5mks)



b) Determine from the graph

(i) The time required for the bullet to travel the length of the barrel assuming that the force becomes **Zero** just at the end of the barrel (2mks)

Time is 30/1000=0.03s (time when force is zero)

(ii) The impulse of the force (3mks)

$$\text{Im}\; pulse = Ft$$
$$= 400 * 0.03$$
$$= 12Ns$$

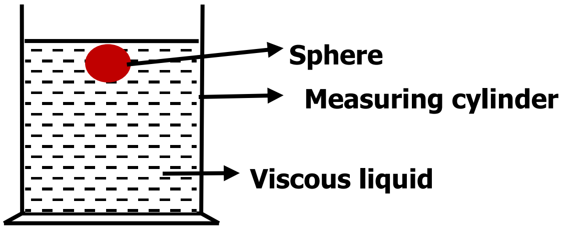
(iii) Given that the bullet emerges from the muzzle of the gun with a velocity of **200ms^{-1}**, calculate the mass of the bullet. 3mks)

FRICTION AND VISCOSITY

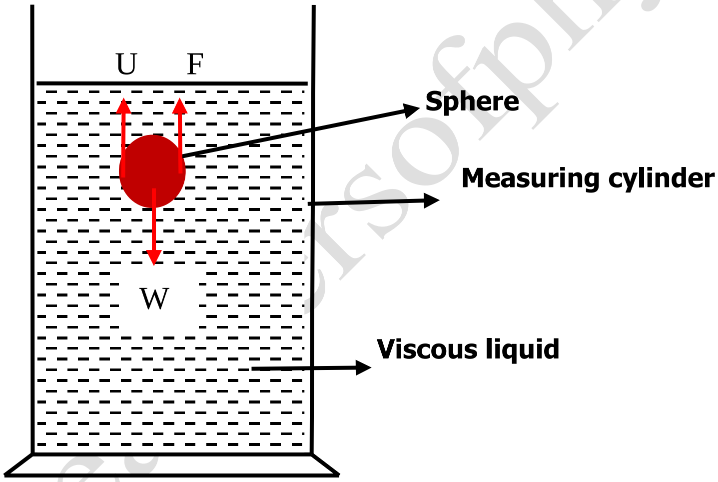
1. In the study of a free fall, it is assumed that the force **F** acting on a given body of mass **m** is gravitational, given by **F= mg**. State two other forces that act on the same body.
Frictional force due to air resistance
Upthrust

2. State how the viscosity of a liquid is affected by temperature.
An increase in temperature leads to a decrease in viscosity and vice versa.

3. The figure below shows a sphere moving in a viscous liquid in a tall measuring cyl

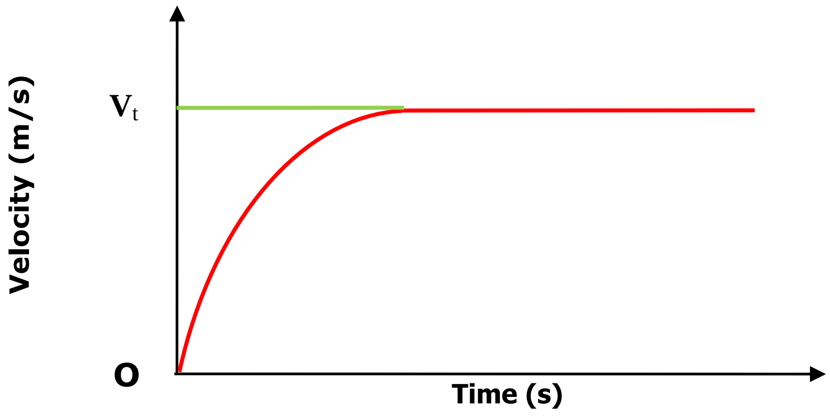


i) Show on the diagram the forces acting on the sphere. (3mks)

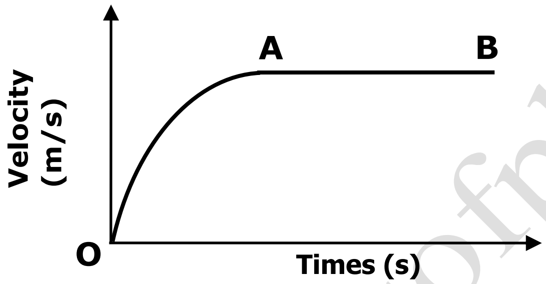


U- Upthrust
F- Frictional force/ Viscosity
W- Weight

ii) Sketch a graph showing the variation of velocity with time and show on the sketch the terminal velocity $\mathbf{V_t}$. (2mks)



4. The figure below shows a graph of velocity against time for a ball bearing released at the surface of a viscous liquid.



Explain the motion of the ball bearing for parts.

(i) **OA** (2mk)

The ball is accelerating (non-uniformly). The velocity is increasing with time

(ii) **AB** (2mk)

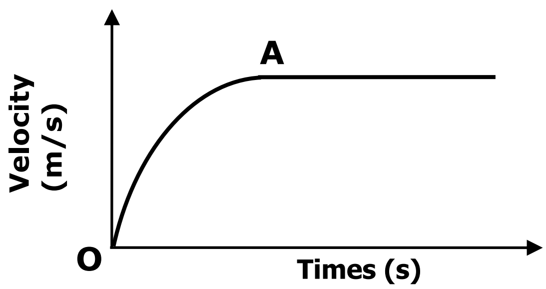
The ball is moving with uniform velocity (constant velocity) i.e terminal velocity

5. A ball bearing is released from rest just below the surface of lubricating contained is a tall measuring cylinder.

a) State any one force acting on the ball bearing (1mk)

Weight, upthrust, frictional force/viscosity

b) Sketch a velocity time graph for the motion briefly explain the nature of your graph. (2mk)

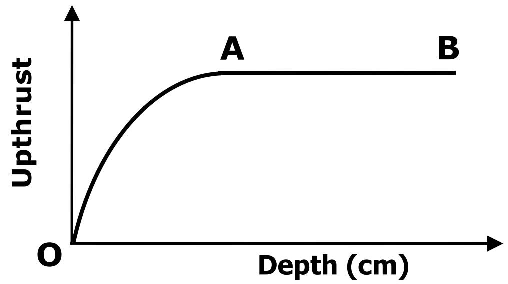


Between O and A the velocity of the ball bearing increases with increase in time. After some time (at A) the ball bearing attains a constant velocity known as terminal velocity.

6. Name **one** other force, other than weight and upthrust, acting on an object falling through a fluid. (1mk)

Viscosity

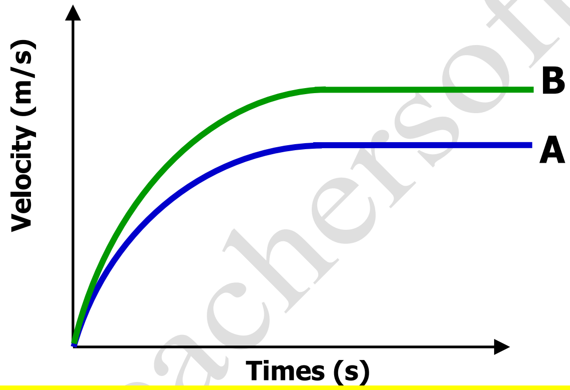
7. The sketch in the figure below shows an upthrust - depth graph for steel ball which is released into a container filled with water until it just touches bottom.



Explain the shape of the graph. (2 mk)

As the ball moves down the upthrust increases upto when the ball is fully

8. Figure below shows the velocity time graph of two identical spheres released from the surfaces of two fluids A and B



(i) State with reason, the fluid with a higher viscosity. 2mks

(ii) Mark on the diagram the terminal velocity on the sphere in each fluid. 1mk

9. Clouds consist of very small drop of water. Explain why although water is much denser than air clouds do not seem to fall. (1mk)

10. A steel sphere released in water attains a constant velocity after a while. The same object released in air falls at a constant acceleration. Explain with a reason the difference in its motion in water and in air.

11. Two identical stones **A** and **B** are released from the same height above the ground. **B** falls through air while A falls through water. Sketch the graphs of kinetic energy (**KE**) against time (**t**) for each stone. Label the graph appropriately.

12. The following table shows the velocity of a bead falling in a tall cylinder filled with water.

Time (s)	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Velocity cm/s	**0**	**1.0**	**1.4**	**1.7**	**1.9**	**2.2**	**2.3**	**2.3**			

(a) **Complete** the table by filling in the velocities for the 8th, 9th, and 10th Second. (1mk)

(b) **Plot** a graph of velocity (y-axis) and time (5mks)

(c) (i) **Explain** how you would know that the acceleration of the bead is decreasing. (2mks)

(ii) **Explain** why the acceleration of the bead decreases as it falls into the water (3mks)

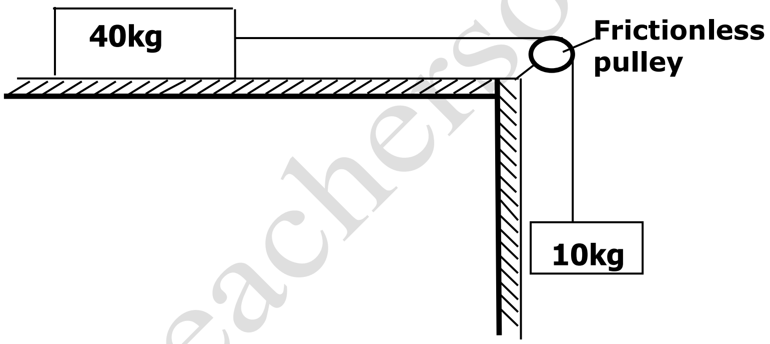
13. State **two** factors which affect frictional force of a body (2mk)

14. State **two** factors that effect friction between solid surfaces (2mk)

15. Suggest **three** ways in which friction can be minimized (3mk)

16. State **three** advantages of friction (3mk)

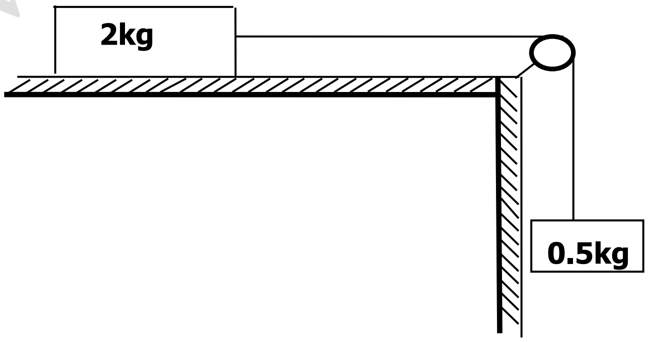
17. A trolley of mass 40kg is initially at rest on a horizontal surface. It is connected by a light inextensible rope running over a frictionless pulley to a mass of 10kg.



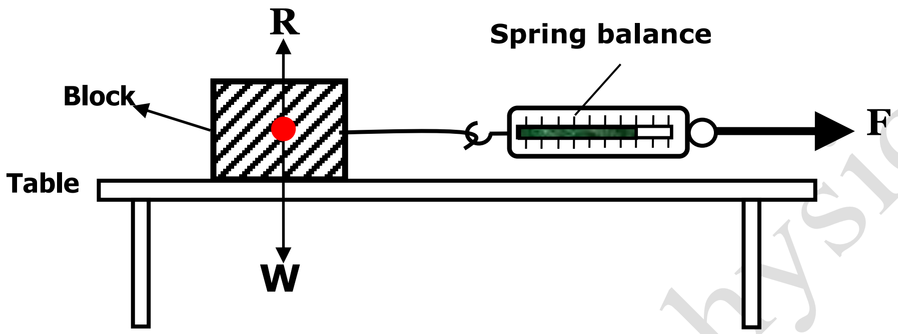
Determine the acceleration of the masses when the system starts to move.

18. The fig. shows a **2 kg** block attached to **0.5 kg** mass by a light inextensible string which passes over a pulley. The force of friction between the horizontal bench and block is **3N**. The block is released from rest so that both masses move through a distance of **0.6m**. Calculate the velocity of the string.

19.



20. Omukaga, a form three physics student in Father Okodoi secondary school conducted an experiment purposed to establish relationship between normal reaction and frictional force between two surfaces. He measured the masses of the blocks of wood. Then he hooked the blocks of wood on the spring balance and pulled each of them gradually in turn until the block just begins to slide. He recorded the maximum reading registered by the spring balance for each of the block.



Mass of block (g)	Normal reaction R (N)	Spring balance reading (N)
160		0.9
250		1.8
390		2.7
490		3.7
600		4.6
640		5.0

i) If $g=9.807\ m/s^2$ complete the table 3mks

(ii) Plot a graph of normal reaction R (y-axis) against spring balance reading 4mks

iii) from the graph determine the gradient of the graph 3mks

iv) What physical quantity does the gradient of the graph represent. 1mk

v) What is the type of friction measured by the spring balance. 1mk