MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA

SECONDARY EDUCATION CERTIFICATE LEVEL

SEPTEMBER 2014 SESSION

SUBJECT:	**Physics**
PAPER NUMBER:	I
DATE:	1st September 2014
TIME:	9:00 a.m. to 11:00 a.m.

Answer all Questions.
You are requested to show your working and to write the units where necessary.
When necessary, take g, acceleration due to gravity, as $10 m/s^2$.

Density	$m = \rho V$		
Pressure	$F = p A$	$p = \rho g h$	
Moments	Moment = F × perpendicular distance		
Energy and Work	$PE = m g h$	$KE = \frac{1}{2} m v^2$	$W = F s$
	Work Done = energy converted		$E = P t$
Force and Motion	m a = unbalanced force	$W = m g$	$v = u + a t$
	$\text{average speed} = \frac{\text{total distance}}{\text{total time}}$		$s = (u + v)\frac{t}{2}$
	$v^2 = u^2 + 2 a s$	$s = u t + \frac{1}{2} a t^2$	momentum = m v
Waves	$\eta = \frac{\text{speed of light in air}}{\text{speed of light in medium}}$		$v = f \lambda$
	$\eta = \frac{\text{real depth}}{\text{apparent depth}}$	$\text{Magnification} = \frac{\text{image distance}}{\text{object distance}}$	
	$\text{Magnification} = \frac{\text{image height}}{\text{object height}}$		$T = \frac{1}{f}$
Electricity	$Q = I t$	$V = I R$	$E = Q V$
	$P = I V$	$R \propto \frac{1}{A}$	$E = I V t$
	$R_{total} = R_1 + R_2 + R_3$	$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$	
Electromagnetism	$\frac{N_p}{N_s} = \frac{V_p}{V_s}$	$V_p I_p = V_s I_s$	
Heat	$Q = m c \Delta\theta$		
Radioactivity	$A = Z + N$		
Other equations	Area of a triangle $= \frac{1}{2} b h$	Area of a trapezium $= \frac{1}{2}(a + b)\ h$	
	Area of a circle $= \pi r^2$		

DO NOT WRITE

1. The table below shows the tuning dial of a radio. The positions of some Maltese radio stations are shown.

MHz	89.7	92.7	93.7	100.2	101.0	101.8	102.3	103.0	103.7	104.6
Radio station	Bay Radio	One Radio	Radio Malta	Solid FM	Radio 101	Calypso Radio	Radju Marija	RTK	Campus FM	Smash Radio

a. With reference to the table above state which radio station transmits with:

i. the highest frequency Smash Radio;

ii. the longest wavelength Bay Radio.

(2 ma

b. Convert 93.7 MHz to Hz.

$93.7 \times 1000000 = 93700000$ Hz

(1

c. Give two properties of radio waves which distinguish them from sound waves.

they are all transverse waves

they do not need a medium to travel through

(2

?? d. Calculate the wavelength of Bay Radio waves.

$v = f\lambda =$

$v = ?$ $\lambda = ?$

e. Complete the following sentences:

Radio waves form part of the electromagnetic spectrum. Two other types o

that are part of this spectrum are x-rays, γ-rays

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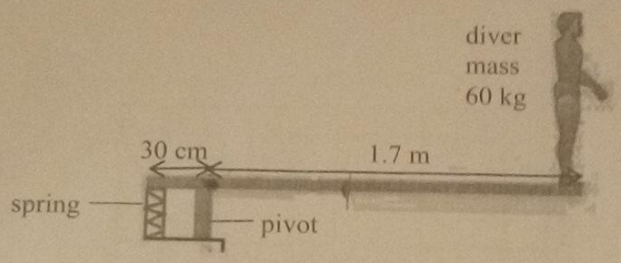
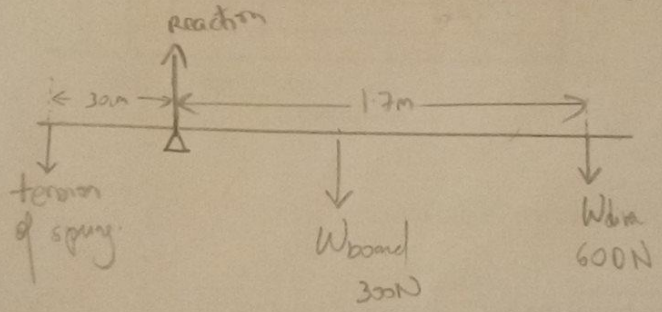
2. A diver of mass 60 kg stands on the end of a diving board of mass 30 kg and length 2 m.



a. Draw, a simple diagram in the space below to show the forces acting on the diving board. (2 marks)



$W = mg = 60 \times 10 = 600\,N$

b. If the diver is 1.7 m away from the pivot calculate the **total** clockwise moment about the pivot.

total ↻ mom = mom board + mom diver 1m − 0.3 = 0.7m

$= (F \times s)_{board} + (F \times s)_{diver}$

$= (300 \times 0.7) + (600 \times 1.7)$

$= 210 + 1020 = 1230\,Nm$

(4 marks)

c. Hence or otherwise, calculate the force exerted by the spring 30 cm away from the pivot. 30 ÷ 100 = 0.3m

Since ↻mom = ↺mom = 1230

$1230 = F \times s$

$1230 = F \times 0.3$

$F = 4100\,N$

(2 marks)

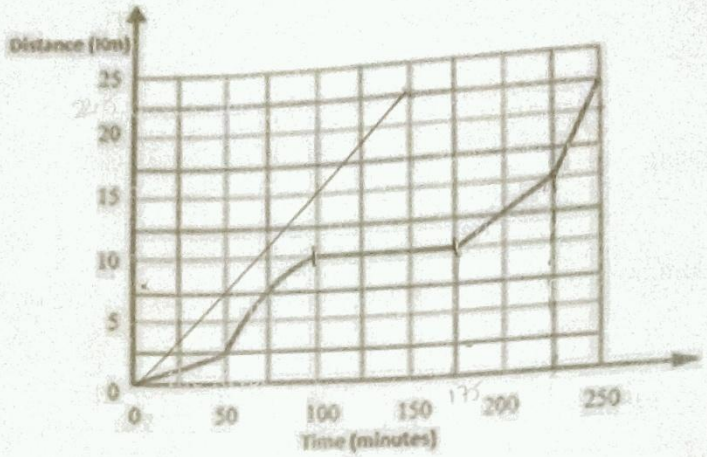
d. Calculate the upward reaction force at the pivot. State the principle you are using.

↑ forces = ↓ forces when in equilibrium

∴ 600 + 4100 = 4700 N

(2 marks)

3. Moyra cycles on her bike for 22.5 km as shown in graph below. At one point she has a puncture and repairs it on the spot to continue with her ride. The graph shows the different stages of her journey.



Use the graph to find:

i. how far she travelled in the first 75 minutes; 7.5km (1 mark)

ii. how long she took to travel the last 7.5 km of the journey; 50 minutes. (1 mark)

iii. how long did Moyra take to repair the puncture. 75km. (1 mark)

Calculate:

iv. her speed (in m/s) between the 175th and the 225th minute; $(\overset{x}{175}, \overset{y}{10})\ (225, 15)$

$m = \frac{\Delta y}{\Delta x} = \frac{10-15}{175-225} = \frac{-5000}{50\times60} = \frac{-5000}{-3000} = +1.7\text{m/s}$ (2 marks)

v. her total average speed (in m/s) for the journey;

$\text{av. speed} = \frac{\text{dist}}{\text{time}} = \frac{22.5 \times 1000}{250\times60} = \frac{22500}{15000} = 1.5\text{m/s}$ (2 marks)

vi. Moyra looked at the graph of her journey and concluded that she cycled fastest in the last 25 minutes. Do you agree? Explain.

yes, since the gradient (speed) of the last 25 mins is greater (2 marks)

vii. Adrian travelled the same distance at a constant speed in 150 minutes. On the same axes sketch a graph to represent his journey. (1 mark)

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4. Planet Earth is one of the eight planets which form part of the Solar System.

a. Give two characteristics which define a planet.

orbit the sun

has a nearly round shape

(2 marks)

b. Name one "dwarf" planet.

Pluto

(1 mark)

c. Name the force which keeps objects orbiting around each other.

force of gravity

(1 mark)

d. Would you expect the force mentioned in part (c) to, increase, decrease or remain the same if:

- a 5kg object is moved from the moon to planet Earth? _____
- a 10kg object is taken on top of a very high mountain? decrease a little
- a 20kg object is taken from Valletta to Mosta? same

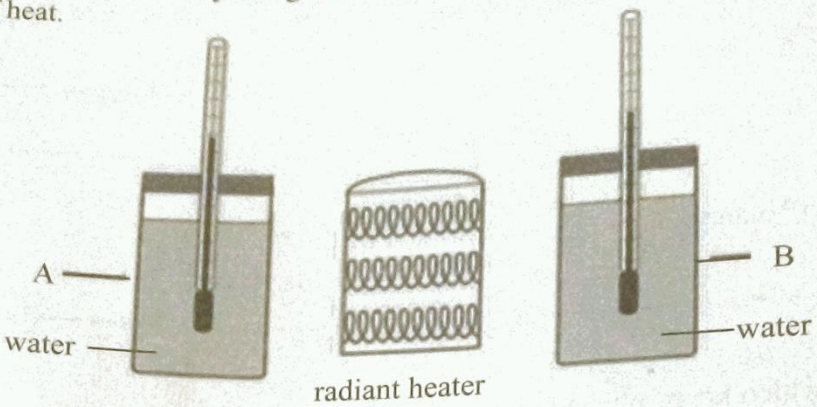
(3 marks)

e. Fill in the blanks with the most appropriate word.

The initial explosion which resulted in the formation and the expansion of the universe is called the big bang. With the use of telescopes we can observe the skies and understand how great our universe is. Distances in space are measured in light years.

(3 marks)

5. Carol and Edward investigate two surfaces A and B, which surround two beakers filled with water as shown below. They design an experiment to find whether surface A or B is the better absorber of heat.



i. Name **one** precaution that they should take to ensure a fair result.

equal amount of water in each beaker

(1 mark)

They tabulate the results obtained as shown below.

Time (min)	0	1	2	3	4	5	6	7
A (°C)	20	22	24	26	28	30	32	34
B (°C)	20	24	28	32	36	40	44	48

ii. Plot a graph of the temperature of A (y-axis) against time (x-axis). On the same graph plo also the temperature of B (y-axis) against time (x-axis).

(5 marks

iii. Which of the two materials (A or B) is the better absorber of heat? Explain.

B, since in the same time, it absorbed more heat, ∴ Reached a greater temperature

(2 marks

iv. Work out the gradient of graph A. (0, 20) (5, 40)

$m = \frac{\Delta y}{\Delta x} = \frac{40-20}{5-0} = \frac{20}{5} = 4\,°C/s$

(2 mark

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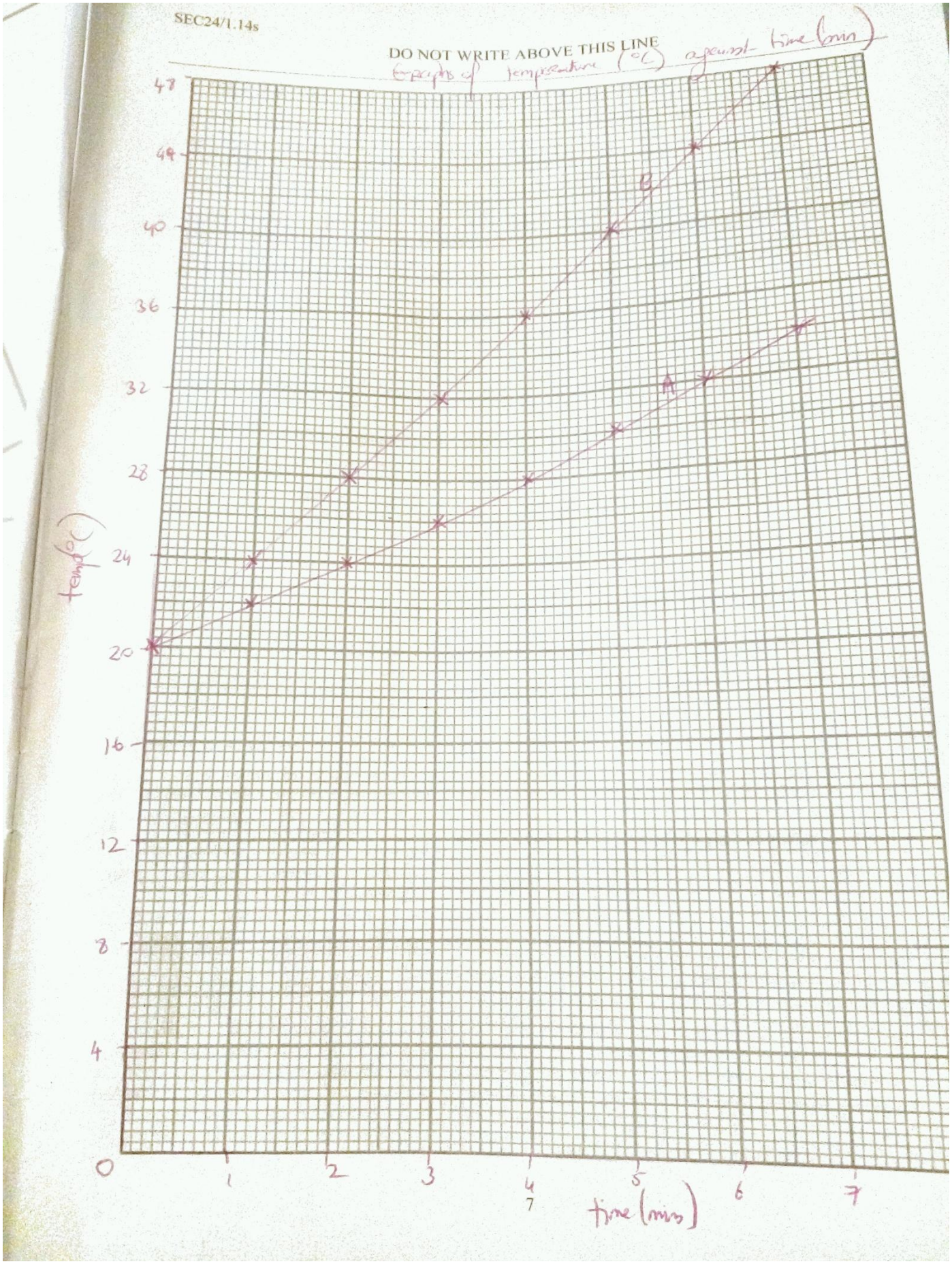
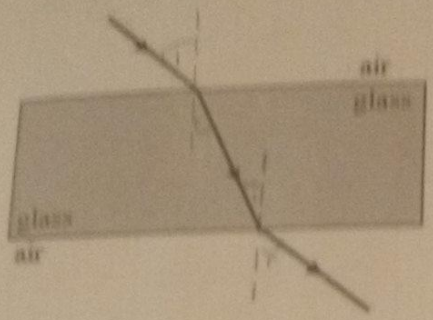


6. A student is studying the relation between the angle of incidence and the angle of refraction of a ray of light as it enters a particular glass block.



a. Mark on the diagram the angle of incidence and the angle of refraction at **each** boundary. Mark also the normal at each boundary (3 marks)

b. List the procedure the student should follow to measure these angles.

- Set up = ray box at an angle towards one of the boundaries.
- Mark outline of glass block
- With a pencil mark the point of incidence + the points of the rays exiter + emergent by means of crosses.
- Remove glass block, join crosses until they meet boundaries + also join the two rays through the glass block.
- Use a protractor to measure each of the marked angles

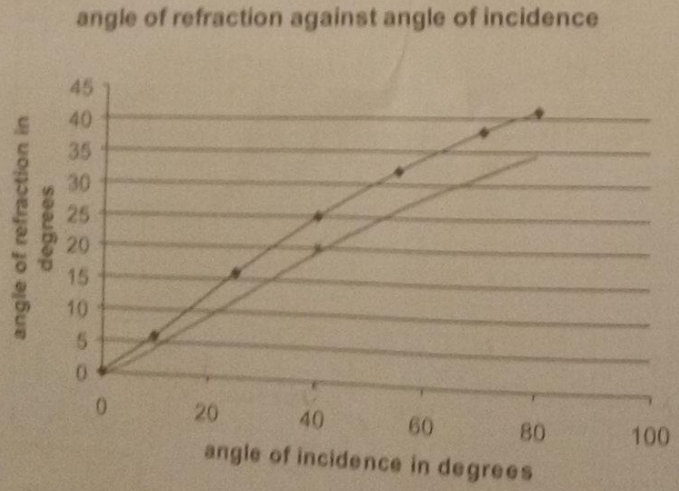
(3 marks)

c The speed of light in air is 3×10^8 m/s whilst the speed of light in glass is 2×10^8 m/s. Calculate the refractive index from air to glass.

$n = \frac{\text{speed light air}}{\text{speed light glass}} = \frac{3 \times 10^8}{2 \times 10^8} = 1.5$

(2 marks)

d. The table below shows how the angle of refraction, **r** varies with the angle of incidence, **i**.



Draw clearly a second graph for a medium with a much greater refractive index. Explain your reasoning

greater n → slower speed
∴ small angles of refraction
∴ smaller gradient in this graph.

(2 marks)

$n = \frac{\sin i}{\sin R}$

$\sin R = \frac{\sin i}{n}$ = p/m = 1/n

Area of a circle

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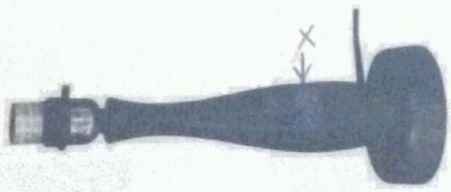
7. The diagram shows a picture of a lamp stand made from solid wood.



a. Define 'Centre of Gravity'.

the point at which all the mass/weight of the object is acting (2 marks)

b. Mark on the diagram with a letter **X** the approximate position of the centre of gravity. (1 mark)

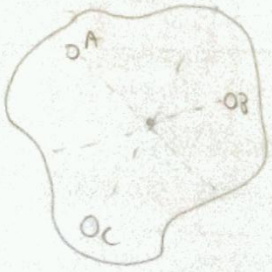
c. State clearly how you would check that the position of the centre of gravity of the lamp stand is correct using only the triangular prism block.

Place the Δ prism block below the centre of gravity and if the lamp stand balances, then point is correct. (2 marks)

d. If a glass shade is fitted on the lamp stand, what will be the effect, if any, on the centre of gravity previously found. Explain

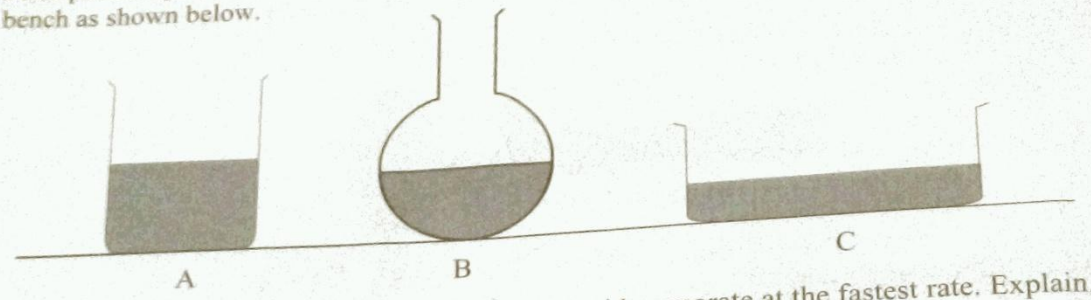
C.o.g will shift towards the left because more mass was added to that side. (2 marks)

e. Describe with the aid of a diagram, how the centre of gravity of an irregular shaped metal shee can be found.



- Punch 3 holes in irregular metal sheet
- Hang it through hole A, Put a plumbline infront of it and mark its position using crosses
- Remove plumbline + join crosses by a line
- Repeat for hole B + C. (3 marks)
- Point where 3 lines intersect is the c.o.g

8. Peter places equal volumes of a liq... bench as shown below.



i. Predict in which container A, B or C will the liquid evaporate at the fastest rate. Explain.

C since it has the biggest surface area

(2 marks)

ii. Name **two** other conditions which increase the rate of evaporation.

temperature (surface area)
humidity (wind)

(2 marks)

iii. Peter calculates that 10 ml of the liquid evaporates in 1 hour. Calculate the rate of evaporation per second.

10ml → 3600s
1 → 1s
$\frac{1 \times 10}{3600}$ = 0.003 ml per second

(2 marks)

iv. Peter observes that as the liquid evaporates, some water droplets between the container and the wooden bench start to freeze. Explain why.

as liquid evaporates, there will be a drop in the K.E of the liquid ∴ it cools down leading to the freezing of the water droplets between the container & the bench.

(2 marks)

v. Athletes put on more clothes as soon as they end their race. Explain why.

After a race, athletes sweat a lot due to the increase in their body temperature, hence they easily start to loose their body temperature rapidly leading to hypothermia. Hence they wear clothes to prevent this from happening. Clothes will trap the heat & stop it from escaping

(2 marks)

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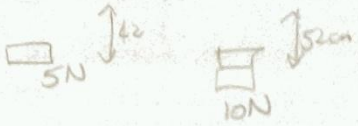
9.a. State Hooke's law.

For an Elastic material, the extension produced is directly ∝ to the applied force, as long as elastic limit is not exceeded.

(2 marks)

b. Lisa attached some loads to a spring. Each time she measured the new length of the spring using a ruler. When she attached a load of 5 N the length of the spring extended to 42 cm. She then added another 5 N and the new length was 52 cm.



i. Calculate the original length of the spring.

∴ 5N → ext. 10cm.

When 5N is removed from 1st set up, F=0N, length = 42-10 = 32cm

(1 mark)

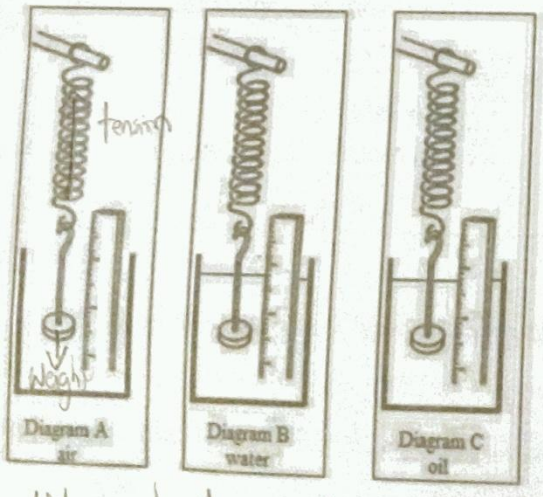
ii. Calculate the force required to produce an extension of 1 cm.

5N → 10cm ext $\quad \frac{1 \times 5}{10} = 0.5\,N$

? → 1cm

(2 marks)

c. Now Lisa places the same spring with a load of 5N in a beaker filled with water and then in an identical beaker filled with oil.



i. Mark the forces acting in diagram A.

(2 marks)

ii. The spring will extend most when it is placed in

water whilst it will extend least when placed in AIR.

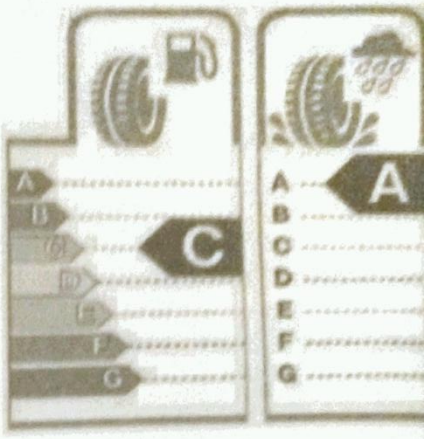
(2 marks)

iii. Give a reason using correct scientific terms for your answer to part (ii).

When placed in water, weight of water above weight adds to the stretching force, Also water is the densest of air, water & oil.

(1 mark)

10.a A TV advertisement encourages car drivers to look out for EU Tyre Labels before purchasing a tyre. Tyres are labelled from 'A' to 'G'. It is claimed that tyres labelled 'A' reduce the fuel consumption of the car and increase the car's safety on the road.



i. Explain how car tyres which have a good grip on wet roads affect the braking distance of a car driver applies a sudden brake.

good grip, ↓ braking distance, since friction increase

(2 marks)

ii. Do tyres which have a good grip affect the thinking distance of the driver? Explain.

No, since tyre grip has nothing to do with how fast the driver reacts

(2 marks)

iii. Name **one** other factor which has an effect on the:

- thinking distance; consumption of alcohol
- braking distance. mass of car

(2 marks)

b. A driver of a car travelling at 10 m/s has a reaction time of 0.5 s before he applies the brake.

i. Calculate the distance covered by the car during this time. constant speed

Speed = s/t 10 = s/0.5 s = 10 × 0.5 s = 5m

(2 marks)

ii. The driver brakes and stops the car in 3 s. Calculate the total distance covered by the car during braking. dc

$s = \left(\frac{u+v}{2}\right)t = \left(\frac{10+0}{2}\right)3 = 5 \times 3 = 15m$ ∴ t. distance = thinking + braking = 5 + 15 = 20m

(2 marks)