St. Mary's Anglican Girls' School

Semester One Exam

2007 Question/Answer Booklet

PHYSICS 12

(Questions marked with a * are for the pre 2010 course)
(Stars have not been placed in the answer key only in the blank question paper)

TIME ALLOWED FOR THIS PAPER

Reading time before commencing work: 10 minutes
Working time for paper: 2 ½ hours

MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER

TO BE PROVIDED BY THE SUPERVISOR
This Question/Answer Booklet.
Physical Formulae and Constants sheet.

TO BE PROVIDED BY THE CANDIDATE
Standard Items
Pens, pencils, eraser or correction fluid, ruler.
Special Items
Physical formulae and constants sheet, drawing implements, templates and calculators satisfying the conditions set by the Curriculum Council.

IMPORTANT NOTE TO CANDIDATES

No other items may be taken into the examination room.

It is your responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. Please check carefully and if you have any unauthorised material with you hand it in to the supervisor BEFORE reading any further.

NAME: _____

	Short Answer	Problem Solving	Comprehension	%

Out of	/52	/82	/33	/167
% Weights	/30	/50	/20	/100

STRUCTURE OF THE PAPER

Section	No of questions	No of marks out of 167	Proportion of exam total
A: Short Answers	13	52	30%
B: Problem Solving	7	82	50%
C: Comprehension & Interpretation	1	33	20%

INSTRUCTIONS TO CANDIDATES

Write your answers in the spaces provided beneath each question in sections A and B
The value of each question in section A is four marks.

Note that (where appropriate) answers should be given numerically and they should be evaluated **and not left in fractional or radical form**. Give all numerical **answers to three significant figures** except in the cases for which estimates are required.

Questions containing specific instructions to **show working** should be answered with a complete, logical, clear sequence of reasoning showing how the final answer was arrived at; **correct answers which do not show working out will not be awarded full marks**.

Questions containing the instruction **estimate** may give insufficient numerical data for their solution. Candidates should provide appropriate figures to enable an approximate solution to be obtained.

Candidates should remember that when descriptive answers are required, they should be used to display understanding of the aims and objectives of the physics 12 course. A descriptive answer, which addresses the context of a question without displaying an understanding of physics principles, will not attract marks.

Despite an incorrect final result, credit may be obtained for method and working, provided these are **clearly and legibly set out**.

SECTION A : Shorts Answers - 52 Marks (30%)

Attempt ALL 13 questions in this section.
Show all working out. (4 marks each)

A1. A soldier is performing shooting practice at a rifle range. The bullet leaves the rifle at a velocity of 50.0 m s^{-1}. The rifle is tilted upwards at an angle of 2.00 ^{0} above the horizontal. Assume that the earth is flat and that there is no air resistance. At what time will the bullet from the gun return to the same height above the ground from which it left?

A2.a) In the space provided below show the pathway (trajectory) taken by a ping pong ball and a lead ball of identical size. Assume that both balls are launched at identical angles and identical speeds.

(1 mark)

Lead Ball	Ping Pong Ball
_____	_____

b) Show the individual forces acting on the balls...

i) just <u>after</u> launch.

ii) at their maximum height.

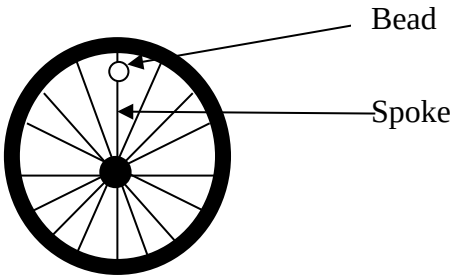
iii) just <u>before</u> landing.

(2 marks)

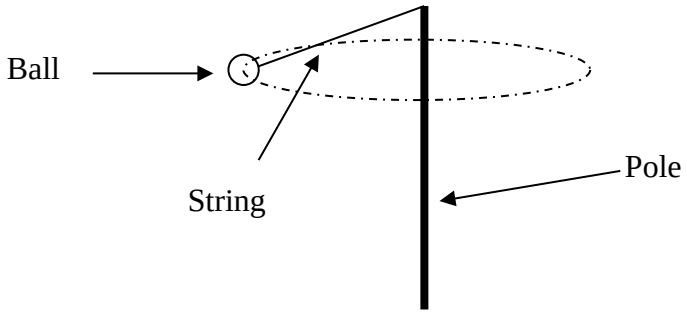
c) Explain why the different balls have different ranges.

(1 mark)

***A3.** A child has placed a small bead onto one of the spokes of her bicycle. The bicycle wheel spoke has a radius of 37.6 cm and the bead has a mass of 50.0 g. At what speed should the bicycle wheel turn so that the bead does not slide down the spoke when the spoke is at the top of the wheel?



A4. A child is playing “totem tennis”. This is a game where a tennis ball is attached to a piece of string that swivels around a central stick as shown in the diagram. What is the tension of a 30.0 g tennis ball that is making a 70.0^0 angle to the pole on a 1.80 m piece of string?

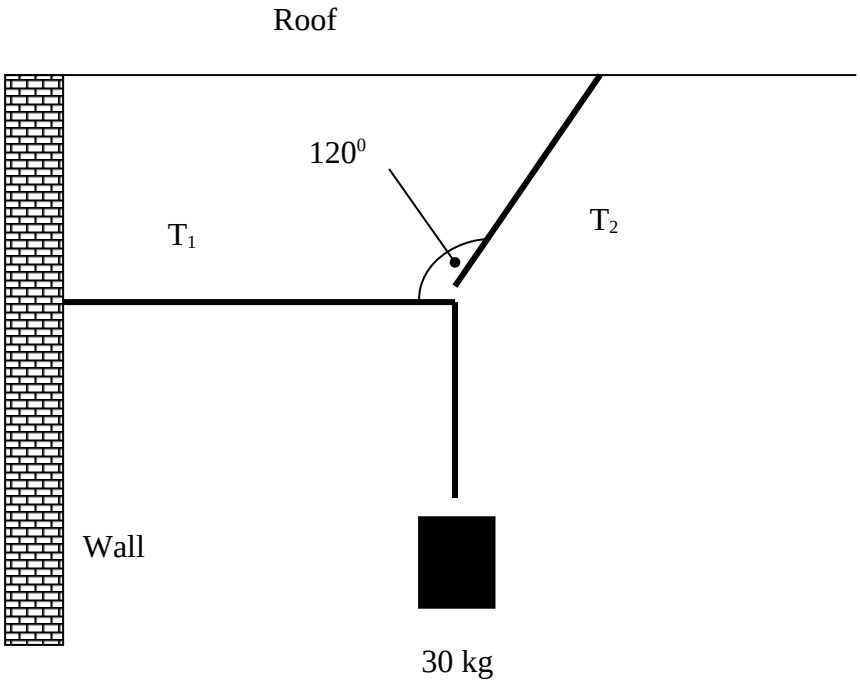


A5. At what distance from the **surface** of Mars should a 5.00 kg satellite be placed so that it experiences an orbiting centripetal force of 8.34×10^{-2} N?

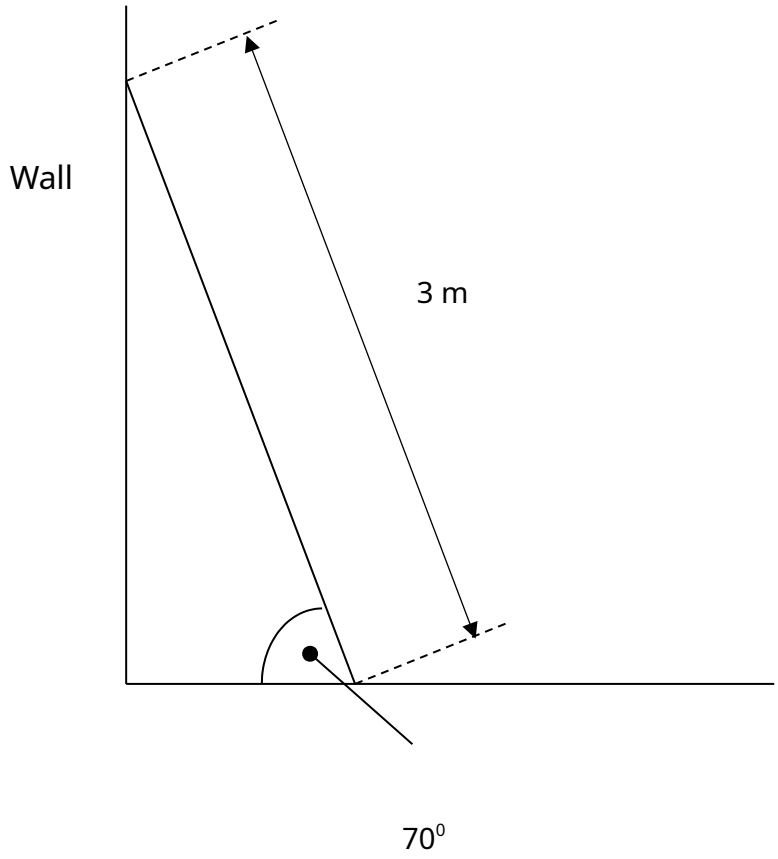
Note:- $m_{mars} = 6.37 \times 10^{23}$ kg
$r_{mars} = 3.43 \times 10^{6}$ m

A6. Dr Who is floating in outer space. He wishes to return to his spacecraft (the tardis), but has no way of propelling himself in the right direction. He is currently placed just out of arms reach of the spaceship. The space ship has a mass of 500 kg. What is the strength of gravitational attraction generated by the mass of the space ship as measured at the location of Dr Who. The distance from the centre of mass of Dr Who to the centre of mass of his space ship is 1.50 m.

A7. Calculate the tension in the piece of rope marked T2.



***A8.** A ladder is resting against a **smooth** wall. What is the normal force of the wall on the ladder if an 80 kg person is standing 2 m up the ladder? The ladder has a mass of 12 kg and the ladder is 3.00 m long. The ladder makes an angle of 70^0 with the ground.

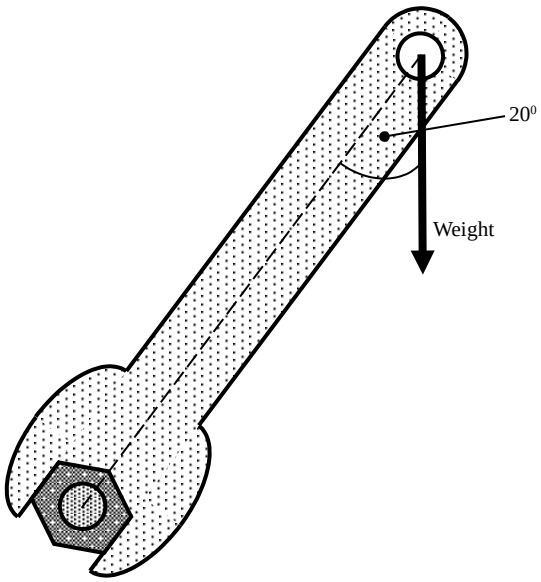


***A9.**

(you could probably manage it)

a) A student is changing a tyre on a car by using a spanner to undo the wheel nuts. The student attaches the spanner to the wheel nut as shown in the diagram below and pushes directly downwards with all their weight on the end of the spanner. The spanner has a length of 40.0cm. The student has a mass of 75.0 kg. What is the torque produced in this situation?

(3 marks)



b) How can the student make more efficient use of their weight to assist in removing the wheel?

(1 mark)

_____

_____

_____

***A10.** The Young's Modulus for a particular metal is 1.00×10^{10} N m^{-1}. A chair made from this metal has four legs, each of length 420 mm and cross-sectional area 2.00×10^{-3} m^2. Robert is a man of mass 1.00×10^2 kg. The chair has a mass of 5.00×10^0 kg.

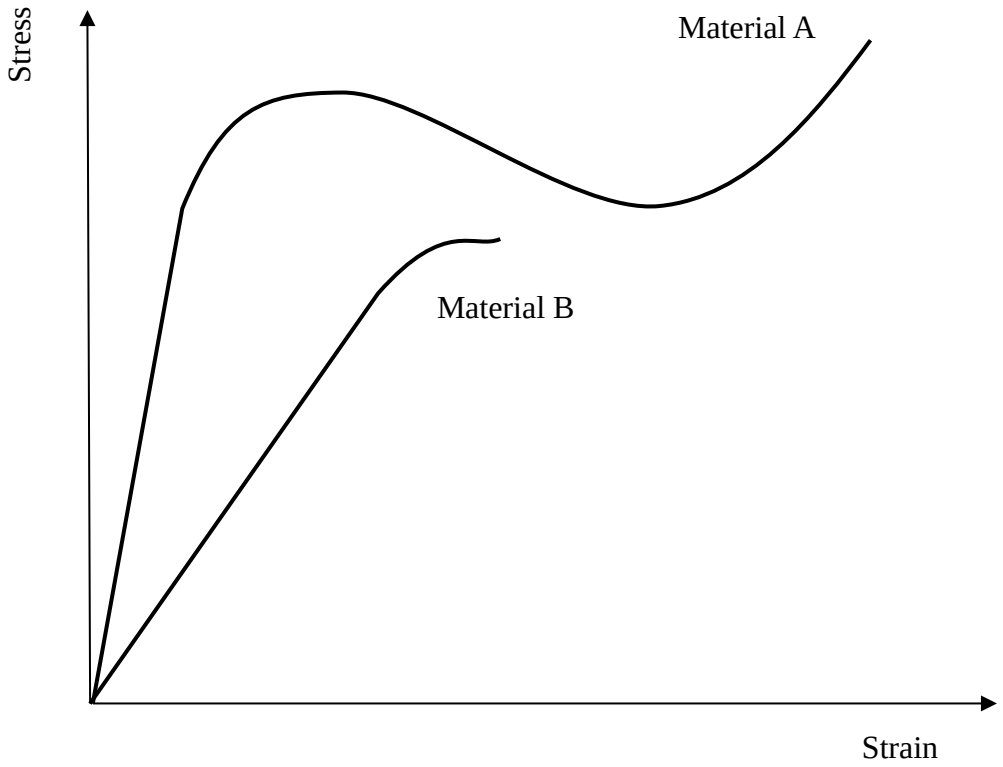
a) What is the stress on **each leg** of the chair when Robert stands on the centre of the chair?

(2 marks)

b) By what amount do the chair legs shrink when Robert stands on the chair?

(2 marks)

***A11.** Compare the two graphs below and answer the following questions.



a) Which material has the greater Young's modulus? Explain. (1 mark)

_____

_____

_____

b) Which material is ductile? Explain. (1 mark)

_____

_____

_____

c) Which material can absorb more energy before fracture? Explain. (1 mark)

_____

_____

_____

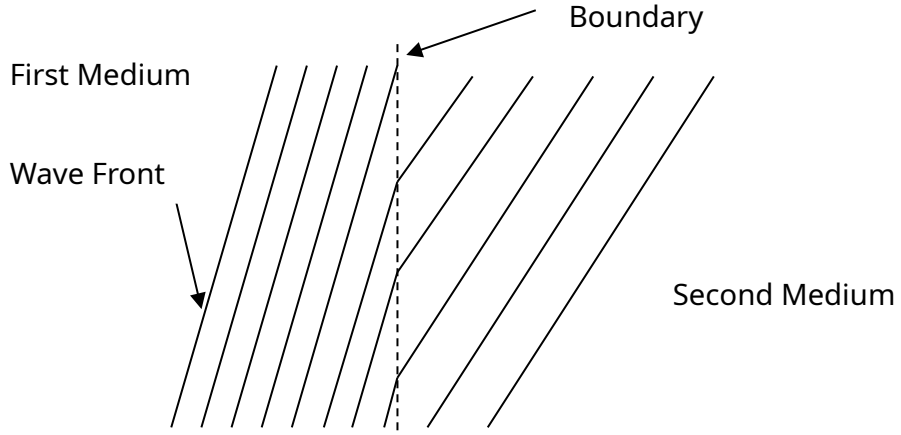
d) Which material has the larger spring constant (k) i.e. (Hooke's law constant)? Explain. (1 mark)

_____

_____

_____

A12. A sound wave is travelling from the first medium into the second medium, and changes the speed at which it is travelling at the boundary symbolised by the dotted line.



a) What is the name of the phenomenon illustrated in the above diagram?

(1 mark)

_____

b) In which medium is the sound travelling faster?

(1 mark)

_____

c) Are the waves bending towards or away from the normal?

(1 mark)

_____

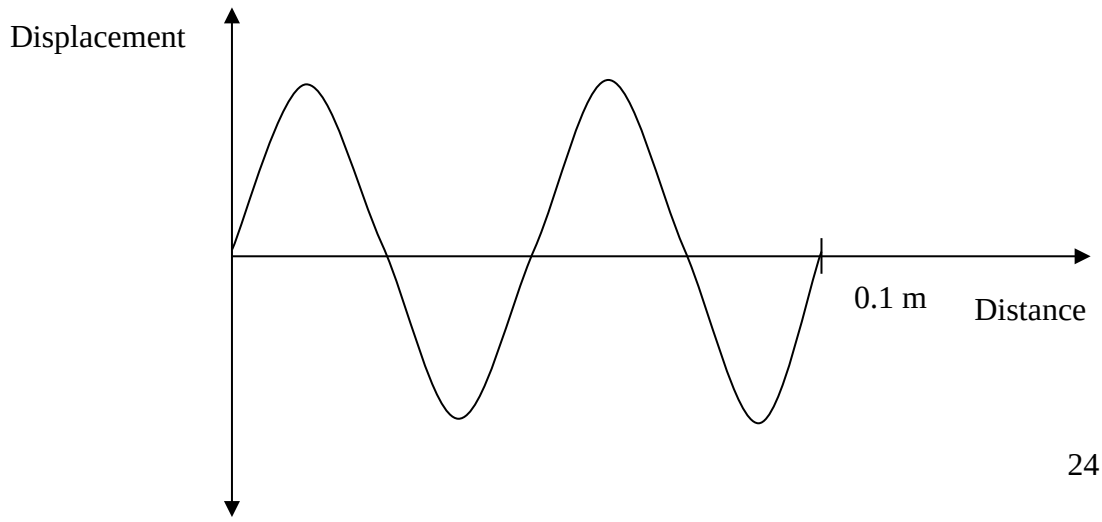
d) If the first and second mediums are air, is the temperature of the first or second medium higher?

(1 mark)

_____

A13. On the graph below insert the following words **if appropriate / possible**.

Cycle, In-phase, Displacement, Amplitude, Frequency, Period, Wavelength, Speed



SECTION B : Problem Solving - 82 Marks (50%)

Attempt ALL 7 questions.

B1. (Total = 12 marks)

A St Mary's student has been selected to represent Australia in the field archery events of the Olympic Games in London. Field archers do not aim at targets. The aim of the field archer is to get his or her arrow to land, sticking as close to vertically into the ground at a set distance (range) from where they are standing.

a) If the arrow leaves the bow with a velocity of 30.0 m s^{-1} at 60.0^0 above the horizontal and the required range is 85.0 m, is the range of the arrow greater than, smaller than or equal to the required range? Please note that the arrows final resting place will be 2.00 m lower than its release point due to the height of the person. Support your answer with calculations.

(4 marks)

b) What is the maximum height that the arrow reaches above the **ground**?

(4 marks)

c) How much heat is produced when the arrow strikes the ground, assuming all the potential and kinetic energy of the arrow is converted to heat? The arrow has a mass of 0.150 kg.

(2 marks)

d) What is the greatest range possible for an arrow if the velocity that the arrow can leave the bow at is 30.0 m s^{-1} and the archer can select any angle they desire?

(2 marks)

B2. (Total = 12 marks)

A 1.00 tonne car travelling at a constant speed of 55.0 km h^{-1} approaches a flat (horizontal) curve of radius 60.0 m. On a dry day, the maximum possible value of friction between the tyres and the road is 60.0% of the weight of the car.

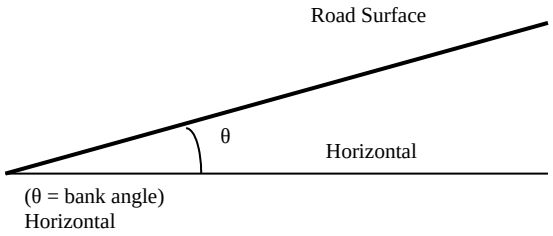
a) Will the car successfully round the curve if it maintains this speed?

(4 marks)

b) If, on a wet day, the frictional force supplied by the tyres is reduced to 25% of the weight of the car, will the car make the curve?

(2 marks)

c) These type of curved roads are in fact designed by engineers to be banked (burm) at an angle to the horizontal as shown…



Use your understanding of physics to derive equations for the vertical and horizontal forces acting on a car going around a banked curve.

(2 marks)

d) Explain why the curves are designed as shown in part c).

(1 mark)

e) If the road surface in part c) was covered in ice (no friction), then calculate the exact bank angle for the car mentioned in part a) to negotiate a curve of radius 60.0 m whilst travelling at 55.0 km h^{-1}.

(3 marks)

B3. (Total = 11 marks)

a) Combine the centripetal force formula and the universal gravitation formula, to create a formula to be used for geostationary satellites above a planet. Please show all algebraic working to obtain full marks. Please make sure the final formula is stated in terms of the variables r & T and does not contain the variable v.

(3 marks)

b) Superman is having a bad day and decides to push on the earth to increase its speed of rotation to get the day over with faster. After superman's interference the earth completes one revolution in only 18 hours. Where relative to the surface of the earth, should a geostationary satellite be placed, so that it has an orbital period that coincides with the now more rapidly spinning earth?

(4 marks)

c) Will the weight of the satellite be greater or smaller when placed in an 18 hour orbit as compared to a 24 hour orbit? Explain.

(2 marks)

d) If the mass of the earth was now increased to 4 times its original value, what is the new geostationary position for the satellite as measured from the centre of mass of the earth?

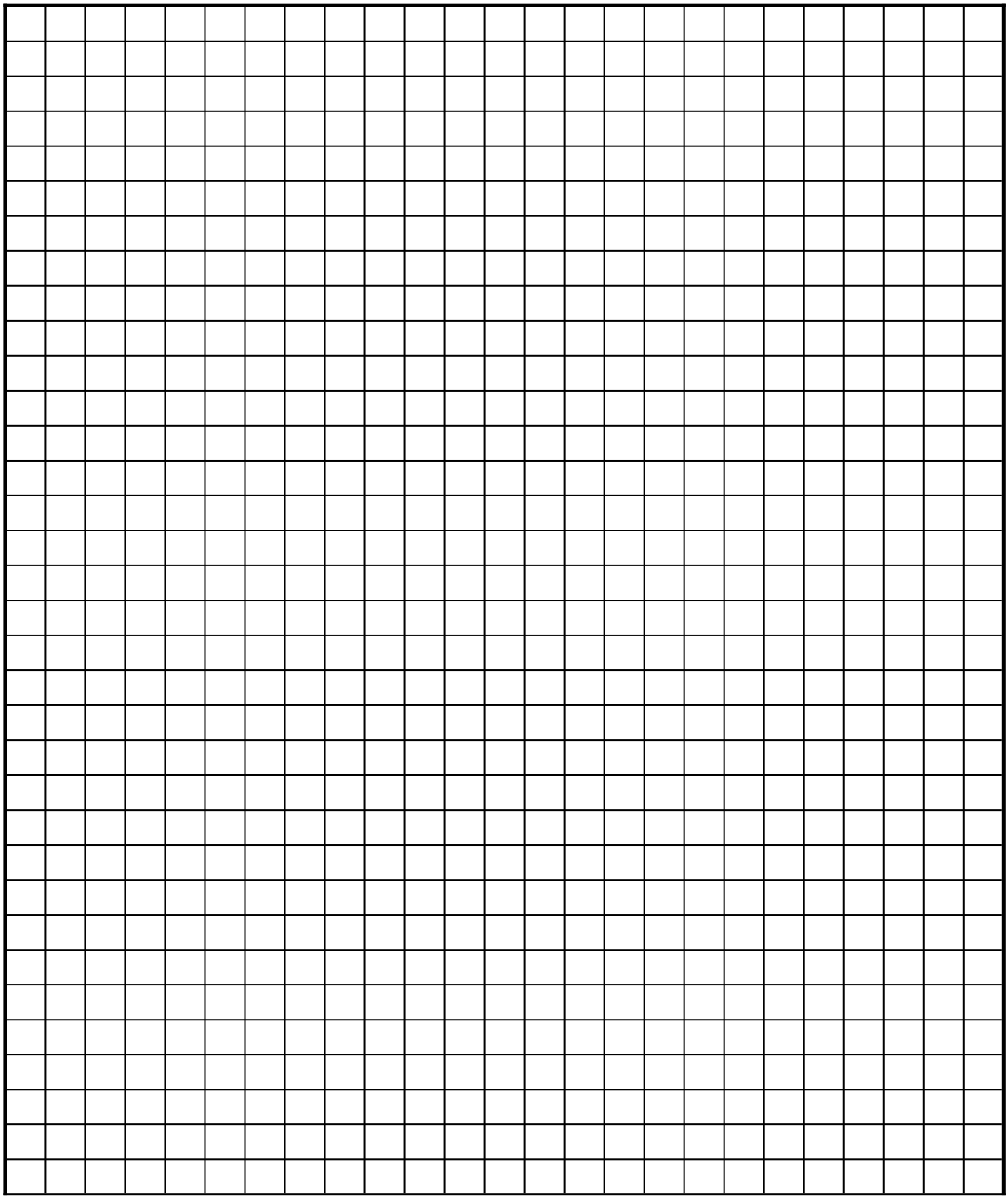
(2 marks)

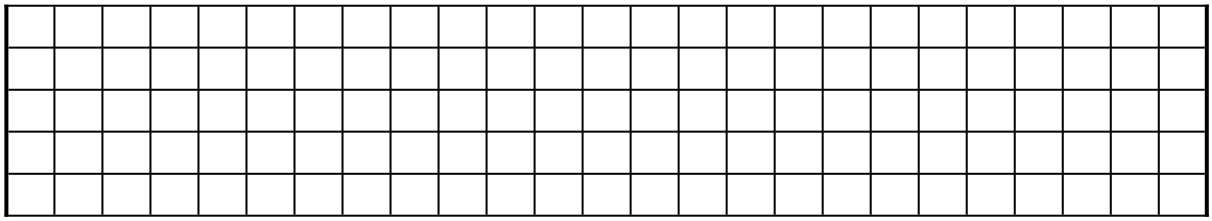
***B4. (Total = 10 marks)**

a) Graph the following data in S.I. units to create a Hooke's law graph. The data has been taken from a substance that has been placed under a gradually changing tension until it breaks at the final value listed in the below table. The substance has an original length of 4.20 m and a circular cross section of radius 5.00×10^{-4} m.

(4 marks)

Force	(N)	26.2	52.4	78.6	102	110	80	102	122
Extension	(mm)	2	4	6	7.79	9	13	17	23





b) What is the Young's modulus for the substance and hence, what is the most likely name for the substance or material being tested?

(3 marks)

c) Which is the last tabulated data value that obeys Hooke's Law?

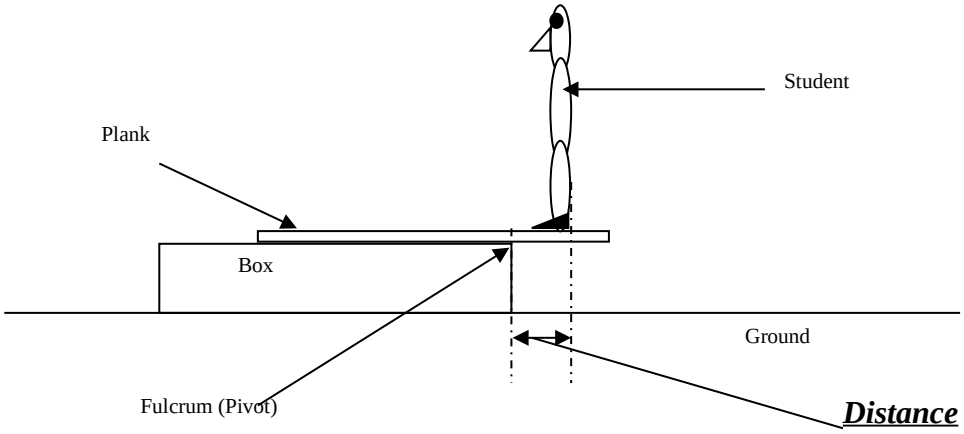
(1 mark)

d) Assuming that the proportional region ends at the data value stated in part c) above, how much energy can be stored in the substance's proportional region?

(2 marks)

B5. (Total = 10 marks)

A student is playing a game of walk the plank with his friends. The plank is placed on a box. The student then walks backwards along the plank until the plank tips off the box. The plank can be positioned so that as much or as little of the end to the plank is protruding off the end of the box as the student wishes. The aim of the game is to position the plank so that the student's heels are as far along the plank as possible as measured from the edge of the box before the plank tips.



a) Under what conditions will the plank tip in a clockwise direction towards the ground?

(1 mark)

_____

_____

_____

b) The plank is uniform, has mass of 20.0 kg, and has a length of 2.00 m. What is the maximum ***Distance*** that a 60 kg student can obtain?

Note :- Assume that the weight of the student is exerted through the back edge of his / her heels.

(5 marks)

c) Will a heavier or lighter student have an advantage? Explain.

(2 marks)

d) If the game was moved to the moon, would the results / winner of the game change? Explain. Note that gravity on the moon is $1/6^{th}$ that on earth.

(2 marks)

***B6. (Total = 15 marks)**

A physics student is approached by her grandparents who are interested in purchasing a house near the airport. The grandparents are worried about the noise from the low flying aircraft. They ask their grandchild to apply her knowledge of physics to calculate the height of the low flying air craft passing above the house's backyard by using the loudness of the noise coming from the aircraft's engines.

a) A typical individual aircraft engine has a loudness of 130 dB at a distance of 30.0 m. What is the intensity of this sound?

(3 marks)

b) What is the power output as sound energy by the engine? Assume that the power of the sound output of the engine is spread over a spherical surface area.

(3 marks)

c) An aircraft with three identical engines is flying over the house that the grandparents are interested in purchasing. The loudness of the aircraft in the backyard of the house is 100 dB. What is the loudness (in dB) of each individual engine in the backyard at the aircraft's current position?

(5 marks)

d) Grandma is a bit deaf and can not hear sounds with an intensity of less than 1×10^{-2} W m^{-2}. Will she hear the aircraft mentioned in part c)?

(1 mark)

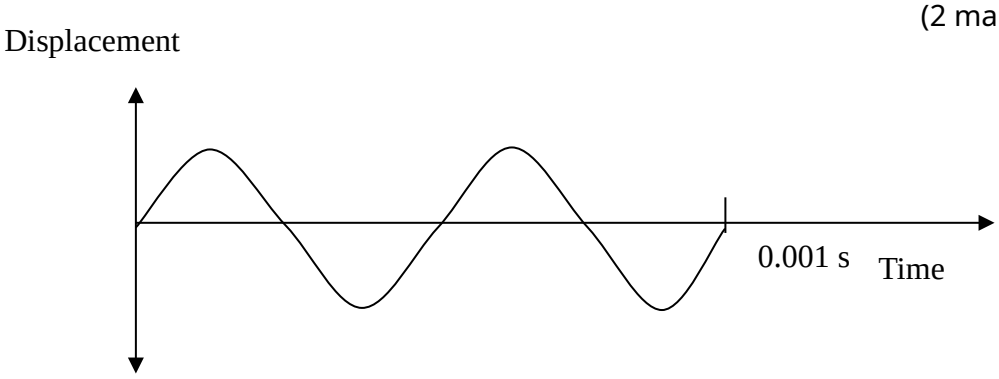
e) What is the height of the aircraft above the ground?

(3 marks)

B7. (Total = 12 marks)

a) Is the graph below that of a single particle or multiple particles? Please circle the correct response and explain.

(2 marks)



Single or Multiple

Explanation_____

b) What is the approximate range of audible frequencies of the human ear?

(1 mark)

_____

c) Would you classify the pitch of the sound shown in the graph as being high or low? Explain.

(2 marks)

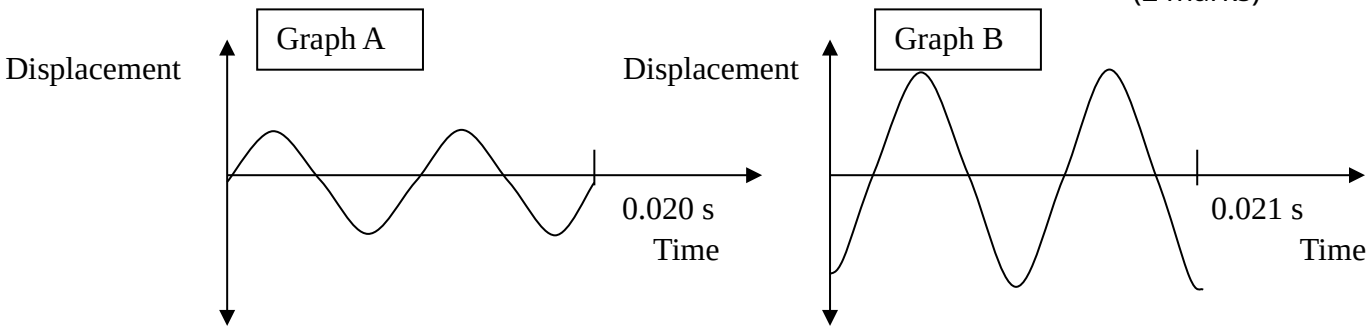
_____

_____

_____

d) Which of the waves below is louder? Explain.

(2 marks)



_____

_____

_____

e) Are the two waves in question d) in-phase with each other? Explain.

(2 marks)

_____

_____

_____

f) If these two waves were played at the same time, would there be an audible effect to a non hearing impaired student? If so what would the effect sound like? What is the name of this phenomenon?

(3 marks)

_____

_____

_____

SECTION C : Comprehension and Interpretation - 33 Marks (20%)

Read the passage below carefully and answer all of the questions at the end of the passage. Candidates are reminded of the need for correct English and clear and precise presentation of answers.

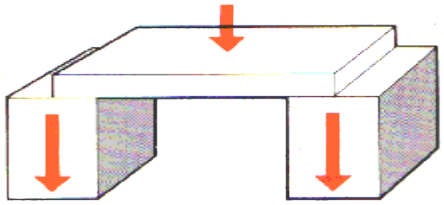
Show all working out for questions requiring numerical answers.

The Right Bridge for the Right Job

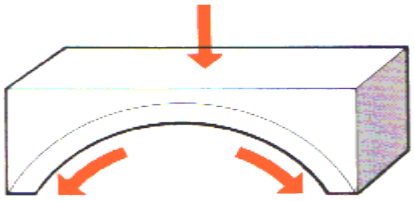
There are essentially 4 types of bridge. They are...

1. Beam	2. Arch	3. Suspension / Cable Stay	4. Cantilever.

1. Beam - The beam type is the simplest type of bridge. The beam bridge could be anything as simple as a plank of wood to a complex structure. It is made of two or more supports which hold up a beam.



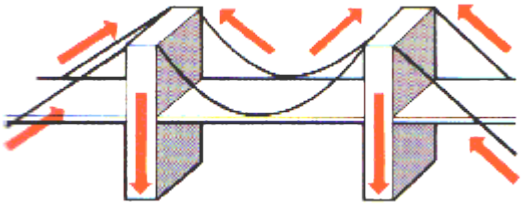
2. Arch - In the arch type of bridge, weight is carried outward along two paths, curving toward the ground. The horizontal forces are supported by abutments (banks of earth or rock) to the left and right of the gap to be spanned.

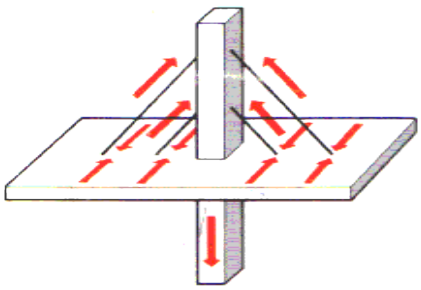


3. Suspension/Cable-Stayed

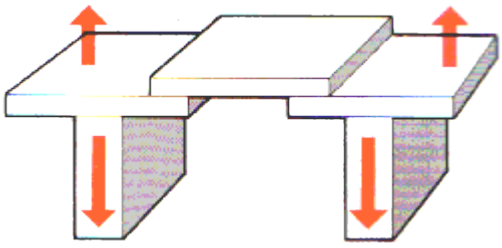
The deck (traffic way) of a suspension bridge is hung by cables, which hang from towers. The cables transfer the weight to the towers, which transfer the weight to the ground.

Cable-Stayed bridges have towers, but cables from the towers go directly to the road deck, instead of spanning from tower to tower.

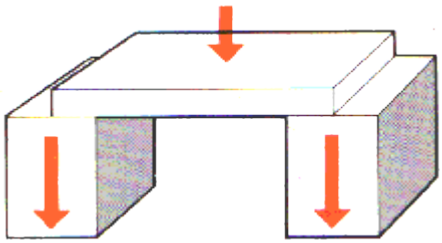




4. Cantilever - In the cantilever type of bridge, two beams support a third beam, which is where the deck or traffic way is. The two beams must be well anchored to their supports.



The Beam Type



The beam type of bridge is by far the simplest. The beam type of bridge is also the most common. A beam bridge is just a beam supported by pillars or columns. (See figure above)

Materials and Construction

Beam bridges are commonly built from concrete. Beam bridges are also made of steel, or a mixture of steel and concrete. They often are made (prefabricated) in sections, or boxes at another location. These prefabricated boxes are then transported to the site and assembled. The boxes are made out of steel and concrete or just concrete.

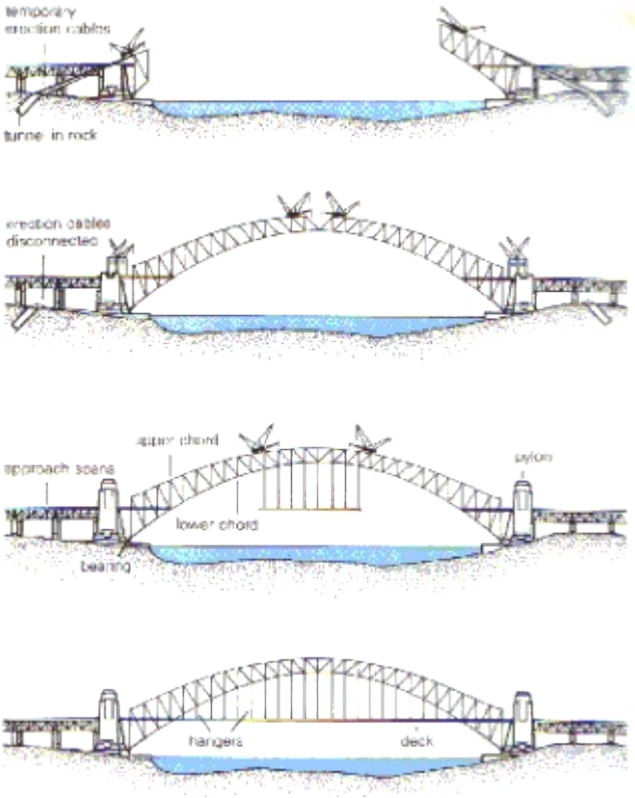
Steel beams and boxes

Modern steel beam bridges are usually made section-by-section and then they are transferred to the site of the bridge and welded together. They are attached to the supports. It is very costly to maintain a steel beam bridge. The boxes are made in a trapezoid shape, so that wind harmlessly passes under the boxes.

Concrete beams

This is the most common type of bridge. The concrete beam is versatile and does not require much maintenance. Concrete beams contain large amounts of steel inside of them. None of this steel is exposed. The supports that hold up the sections are made at the site of the bridge.

Arch Type



In this type of bridge, the weight is carried outward along two curving paths. The points where the arch reaches the ground keep the bridge up by resisting the outward thrust. The roadway is located on top of the arch.

Materials and Construction

Like beam bridges, arch bridges can be made of both steel and concrete.

Steel Arches

There are a few different methods used to construct steel arches. One design uses an arch structure with the traffic way passing through the arch. The traffic way rests on the part of the arch it passes through. Cables, suspended from the arch, pull the traffic way up so it does not sag. (See diagram above) e.g. (Sydney Harbour Bridge)

Another method used is one that is useful when the other type of steel arch bridge is not possible. It is built by building an arch (which is often supported by pillars until completed) and then building a traffic deck above the arch. The traffic deck is supported by pillars. It's almost like a beam-type bridge on top of a steel arch! (see diagram below)

Suspension Bridges and Cable-Stayed Bridges

Suspension bridges "bridge the unbridgeable". In a suspension bridge, cables which are suspended via towers which support them hold up the road deck. The weight is transferred by the cables to the towers, which then in turn transfer the weight to the ground.

The amount of towers on suspension bridges can vary, but a suspension bridge MUST have at least two towers. These towers are built on the ground. Towers are usually built with hollow steel boxes, but some are built with concrete.

Cable-stayed bridges are similar to suspension bridges because cables support the roadway. Two or more towers have cables hanging from them. These cables support the roadway by transferring the weight to the towers. In turn, the towers transfer the weight to the ground. Construction of a cable-stayed bridge is similar to the construction of a regular suspension bridge, except the tower cables attached directly to the road.

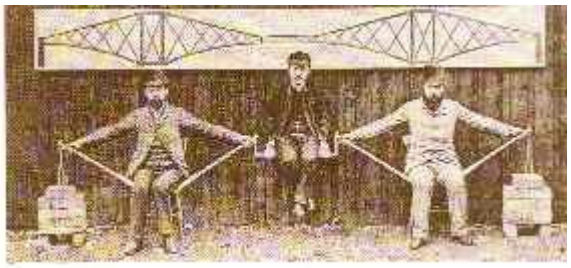
The road deck

A while ago, the common design for the road deck was a truss; an arrangement of horizontal and vertical girders (steel bars), stiffened (or strengthened) by diagonal bars. The truss design allows wind to pass through it. A truss design still takes lots of steel.

This design was replaced by the aerodynamic box-girder. The aerodynamic box-girder design allows wind to pass around it. They use less steel, reducing weight and cost. Construction and painting is therefore easier. In fact, much of the construction can be done at a factory in large sections, making things a whole lot easier for everyone. (You can see an aerodynamic [trapezoid shaped] box-girder above.)

Cantilever Bridges

Cantilever bridges depend on counterbalances. But what are counterbalances? Counterbalances are weights used to balance another weight. They consist of two or more (which many cantilever bridges have at least four) arms that equally balance each other, almost like a perfectly balanced see-saw. Often, the part of the bridge that leads to the first cantilever is just a beam bridge. (You can see this on the cantilever bridge at the top of this page.)



Materials and Construction

Cantilever bridges are built with many materials in different ways. Some use one arch to connect (and essentially act as) the arm, as shown in the “soon-to-be-here” picture above. Others just have arms and a roadway, or arms, a roadway, and cables that work like a cable-stayed bridge. Cantilever bridges are built in a way similar to beam and arch bridges, depending on how the bridge is designed.

References

This article was extracted from...

http://library.thinkquest.org

Questions

1. What are the conditions required for a bridge (or any structure) to be stable?

(3 marks)

2. What are the advantages of using concrete in a structure?

(4 marks)

3. What are the disadvantages of using exposed steel in a structure?

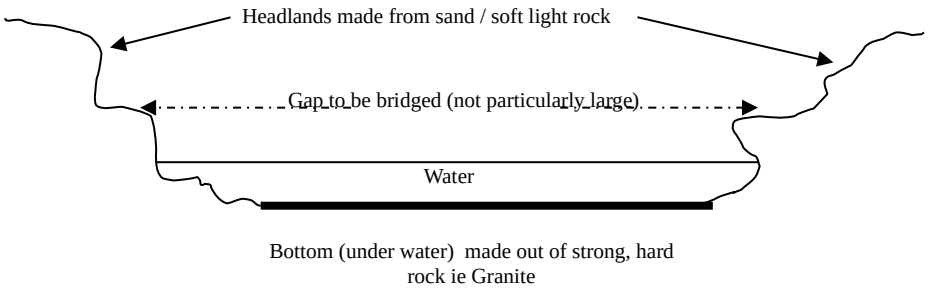
(2 marks)

4. What is the advantage of using reinforced concrete instead of using pure concrete for the span of a beam bridge? Use diagrams to assist your explanation.

(4 marks)

5. In the following situation which type of bridge would you **not** use? Why? Draw the bridge on the diagram to assist your explanation

(3 marks)

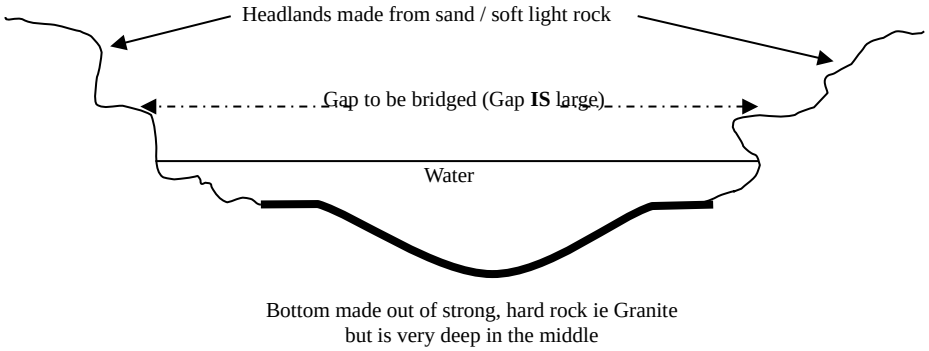


6. In the diagram shown in question 5 what would be the <u>simplest</u> way of spanning the gap with a bridge? Explain why with reference to the surfaces on which the bridge will be built.

(3 marks)

7. If the gap to be bridged is very large and the river is very deep **in the middle**, what type of bridge would you use and why? Explain why with reference to the surfaces on which the bridge will be built. Draw an example of the bridge on the diagram.

(4 marks)



8. Why does the roadway of a bridge need to take into account wind? How have past and present engineers taken wind into account in their design of roadways?

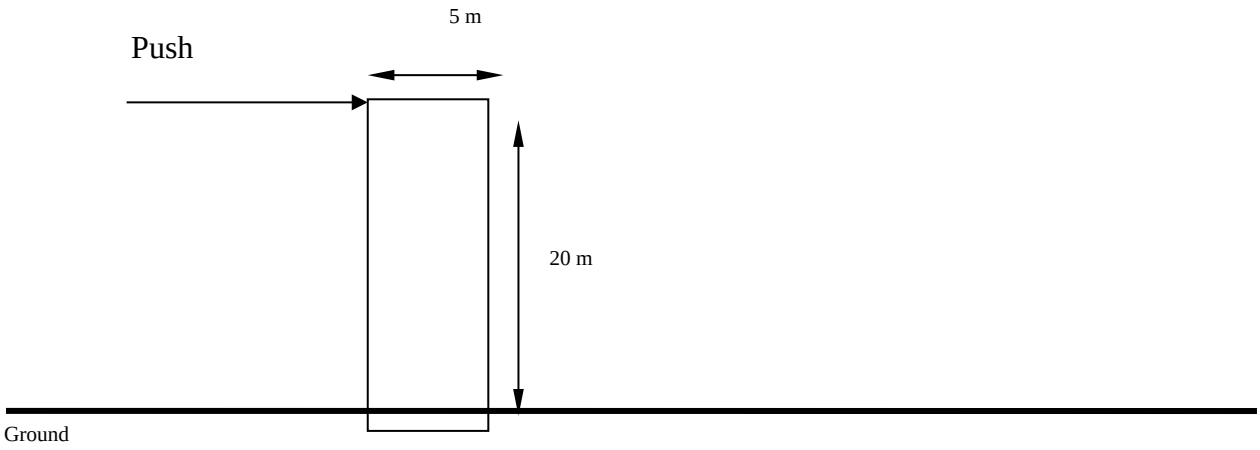
(3 marks)

9. Why must a suspension bridge contain two towers and what else must be present at either end of the bridge? Use a diagram to assist your explanation.

(4 marks)

10. The following diagram is a pillar (post) that is going to be used in a beam bridge. At what angle (as formed between the base of the post and the ground) will the post topple (toppling angle) when the post is pushed sideways? Assume that the whole post is above ground level and that none of the post is buried.

(3 marks)



END OF EXAM

St. Mary's Anglican Girls' School

Semester One Exam

2007

Answers

PHYSICS 12

TIME ALLOWED FOR THIS PAPER

Reading time before commencing work: 10 minutes
Working time for paper: 2 ½ hours

MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER

TO BE PROVIDED BY THE SUPERVISOR
This Question/Answer Booklet.
Physical Formulae and Constants sheet.

TO BE PROVIDED BY THE CANDIDATE
Standard Items
Pens, pencils, eraser or correction fluid, ruler.
Special Items
Physical formulae and constants sheet, drawing implements, templates and calculators satisfying the conditions set by the Curriculum Council.

IMPORTANT NOTE TO CANDIDATES

No other items may be taken into the examination room.

It is your responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. Please check carefully and if you have any unauthorised material with you hand it in to the supervisor BEFORE reading any further.

NAME: _____

	Short Answer	**Problem Solving**	**Comprehension**	**%**
Out of				

	/52	/82	/33	/167
% Weights	/30	/50	/20	/100

STRUCTURE OF THE PAPER

Section	No of questions	No of marks out of 167	Proportion of exam total
A: Short Answers	13	52	30%
B: Problem Solving	7	82	50%
C: Comprehension & Interpretation	1	33	20%

INSTRUCTIONS TO CANDIDATES

Write your answers in the spaces provided beneath each question in sections A and B
The value of each question in section A is four marks.

Note that (where appropriate) answers should be given numerically and they should be evaluated **and not left in fractional or radical form**. Give all numerical **answers to three significant figures** except in the cases for which estimates are required.

Questions containing specific instructions to **show working** should be answered with a complete, logical, clear sequence of reasoning showing how the final answer was arrived at; **correct answers which do not show working out will not be awarded full marks**.

Questions containing the instruction **estimate** may give insufficient numerical data for their solution. Candidates should provide appropriate figures to enable an approximate solution to be obtained.

Candidates should remember that when descriptive answers are required, they should be used to display understanding of the aims and objectives of the physics 12 course. A descriptive answer, which addresses the context of a question without displaying an understanding of physics principles, will not attract marks.

Despite an incorrect final result, credit may be obtained for method and working, provided these are **clearly and legibly set out**.

SECTION A : Shorts Answers - 52 Marks (30%)

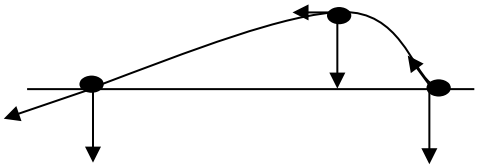
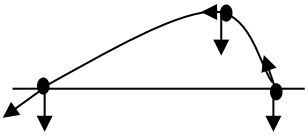
Attempt ALL 13 questions in this section.
Show all working out. (4 marks each)

A1. A soldier is performing shooting practice at a rifle range. The bullet leaves the rifle at a velocity of 50.0 m s^{-1}. The rifle is tilted upwards at an angle of 2.00 ^{0} above the horizontal. Assume that the earth is flat and that there is no air resistance. At what time will the bullet from the gun return to the same height above the ground from which it left?
(1)

$u_v = 50 \sin 2^0$ $u_v = 1.745$ m/s up (1) $v = u + at$ (1) $1.745 = +1.745 + (-9.8)\, t$ (1) $t = 0.356$ s (1)	

A2.a) In the space provided below show the pathway (trajectory) taken by a ping pong ball and a lead ball of identical size. Assume that both balls are launched at identical angles and identical speeds.

(1 mark)

Lead Ball	Ping Pong Ball
1 mark for the range of the lead ball being greater than the ping pong ball *1 mark for the weight vectors being bigger on the lead ball* *1 mark for the correct directions on air resistance* 	

b) Show the individual forces acting on the balls…

i) just <u>after</u> launch.

ii) at their maximum height.

iii) just <u>before</u> landing.

(2 marks)

c) Explain why the different balls have different ranges.

(1 mark)

The surface area or the balls is the same. This means that the force due to air resistance is the same.

Hence F_{air} at and given time is the same.

The balls have different mass and so have different weights. This will not change their acceleration due to gravity because g = 9.8 m/s^2 for all object regardless of mass.

The acceleration (backwards) on the balls due to air resistance will be different because of the different masses

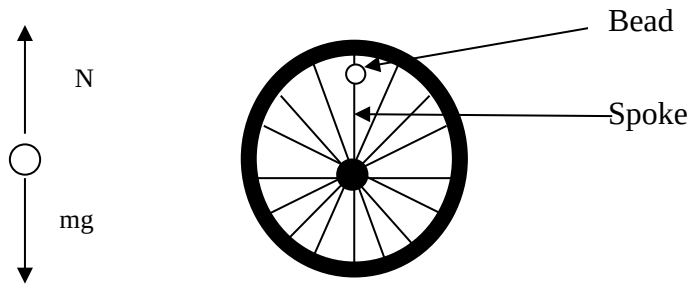
E.g.
F = m a

$F_{air} = m_{ball} * a$
For the lead ball, F (air) is constant, m is large and so (retarding acceleration) will be small → hence the longer range.

For the ping pong ball, F (air) is constant, m is small and so (retarding acceleration) will be large → hence the small range.

A3. A child has placed a small bead onto one of the spokes of her bicycle. The bicycle wheel spoke has a radius of 37.6 cm and the bead has a mass of 50.0 g. At what speed should the bicycle wheel turn so that the bead does not slide down the spoke when the spoke is at the top of the wheel?

Diagram (1)



Sum of the forces vertically = force centripetal

$-mg + N = -mv^2 / r$ *(1)*

the minimum speed will correspond to N = 0 hence

$mg = mv^2 / r$

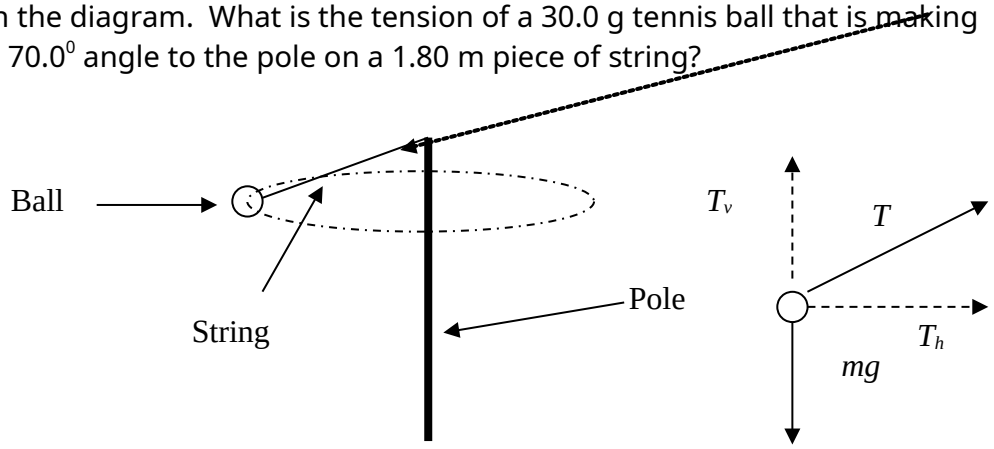
$g = v^2 / r$

v = square root of (gr)

*v = square root of (9.8 * 0.376) (1)*

v = 1.92 m/s (1)

A4. A child is playing "totem tennis". This is a game where a tennis ball is attached to a piece of string that swivels around a central stick as shown in the diagram. What is the tension of a 30.0 g tennis ball that is making a 70.0^0 angle to the pole on a 1.80 m piece of string?



Sum f the forces vertical = 0

$(-mg) + (+T_v) = 0$ (1)

$= T_v$

Sum of the forces horizontal = force centripetal

$T_h = mv^2 / r$ (1)

$T = T_v / \cos 70$

$T = 30 \times 10^{-3} \times 9.8 / \cos 70$ (1)

$T = 0.860$ N along the string (1)

A5. At what distance from the **surface** of Mars should a 5.00 kg satellite be placed so that it experiences an orbiting centripetal force of 8.34×10^{-2} N?

Note:- m_{mars} = 6.37×10^{23} kg
r_{mars} = 3.43×10^{6} m

$F = G\ m \times m / r^2$ (1)

r= square root of (G m m / F)

r = square root of (G m m / F)

$r = \text{square root of } (6.67 \times 10^{-11} \times 6.37 \times 10^{23} \times 5 / 8.34 \times 10^{-2})$ (1)

$r = 5.05 \times 10^{7}$ (1)

$h = 5.05 \times 10^{7} - 3.43 \times 10^{6}$

$h = 4.70 \times 10^{7}$ m (1)

A6. Dr Who is floating in outer space. He wishes to return to his spacecraft (the tardis), but has no way of propelling himself in the right direction. He is currently placed just out of arms reach of the spaceship. The space ship has a mass of 500 kg. What is the strength of gravitational attraction generated by the mass of the space ship as measured at the location of Dr Who. The distance from the centre of mass of Dr Who to the centre of mass of his space ship is 1.50 m.

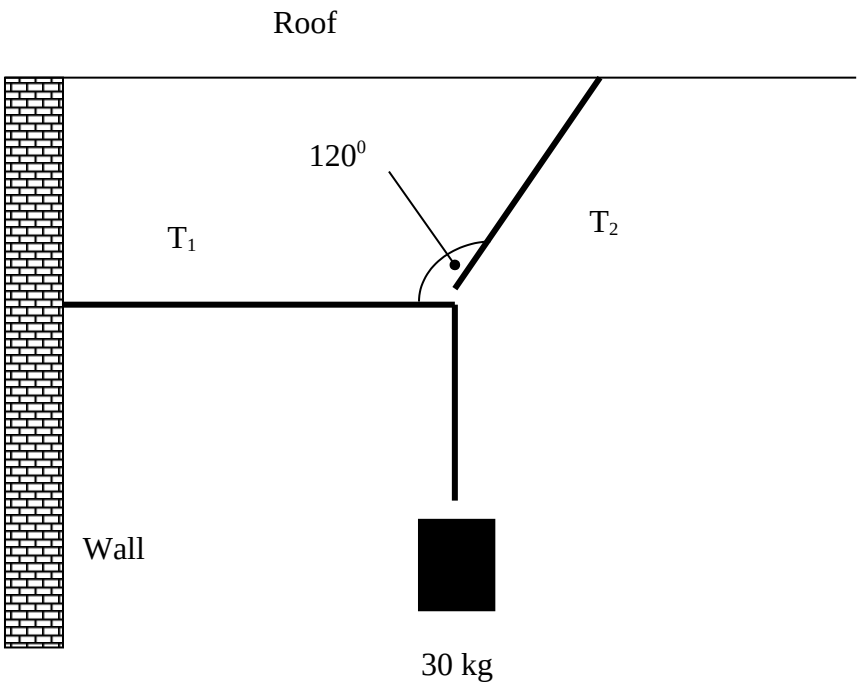
$g = G m / r^2$ (1)

$g = 6.67 \times 10^{-11} \times 500 / 1.5^2$ (1)

$g = 1.48 \times 10^{-8}$ m s^{-2}

(1) (1)

A7. Calculate the tension in the piece of rope marked T2.



Method 1

Label all angles

Sine rule (1)

$\frac{\text{Sin } 90}{T_2} = \frac{\text{Sin } 120}{30 \times 9.8} = \frac{\text{Sin } 150}{T_1}$ (1)

$T_2 = 30 \times 9.8 / \text{Sin } 120$ (1)

$T_2 = 3.39 \times 10^2$ N (1)

Method2

Sum of the forces vertically = 0 (1)

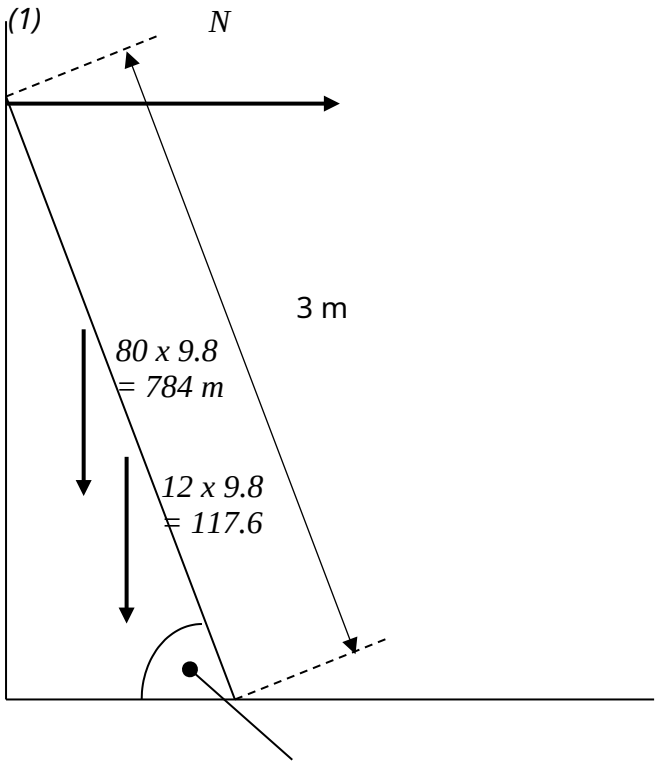
$T_{2v} = 30 \times 9.8 = 294$ N (1)

$T_2 = 294 / \cos 30^0$ (1)

$T_2 = 3.39 \times 10^2$ N (1)

A8. A ladder is resting against a **smooth** wall. What is the normal force of the wall on the ladder if an 80 kg person is standing 2 m up the ladder? The ladder has a mass of 12 kg and the ladder is 3.00 m long. The ladder makes an angle of 70^0 with the ground.

Diagram *(1)*



Sum of the torques clock = sum of the torques anti *(1)*

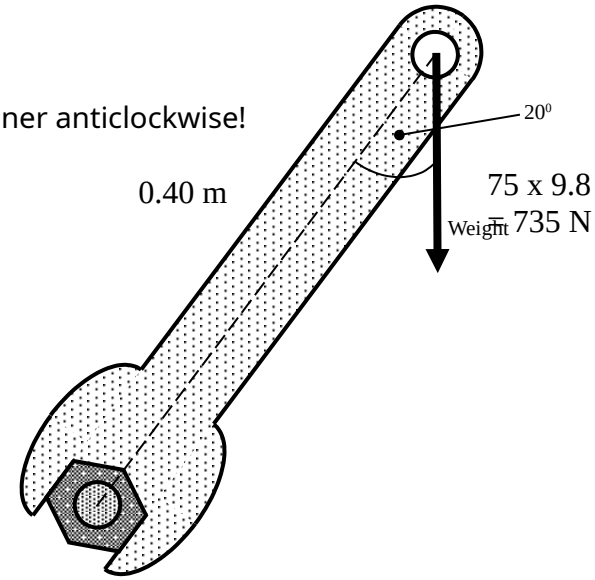
N x 2.82 = (117.6 x ½ x 1.03) + (784 x 2/3 x 1.03) *(1)*

N = 2.12 x 10^2 N at right angles to wall *(1)*

A9.a) A student is changing a tyre on a car by using a spanner to undo the wheel nuts. The student attaches the spanner to the wheel nut as shown in the diagram below and pushes directly downwards with all their weight on the end of the spanner. The spanner has a length of 40.0cm. The student has a mass of 75.0 kg. What is the torque produced in this situation?

(3 marks)

to undo a wheel nut you need to turn the spanner anticlockwise!



Method 1

Torque = r F
Torque = 0.4 x 735 sin 20

Torque = 1 x 10^2 Nm clockwise

Method 2

Torque = r F (1)
Torque = 0.4 sin 20 x 735 (1)

Torque = 1 x 10^2 Nm clockwise (1)

b) How can the student make more efficient use of their weight to assist in removing the wheel?

(1 mark)

- *Increase the length of the arm by using a longer spanner.*
- *Apply force at a more perpendicular angle to the handle.*
- *Move spanner so that the handle is more parallel with the ground and so the weight force will naturally be at right angles to the handle.*

A10. The Young's Modulus for a particular metal is 1.00×10^{10} N m^{-1}. A chair made from this metal has four legs, each of length 420 mm and cross-sectional area 2.00×10^{-3} m^2. Robert is a man of mass 1.00×10^2 kg. The chair has a mass of 5.00×10^0 kg.

c) What is the stress on **each leg** of the chair when Robert stands on the centre of the chair?

(2 marks)

$F_{total} = (100 + 5) \times 9.8 = 1.029 \times 10^3$

$A_{each\ leg} = 2 \times 10^{-3}\ m^2$

$Y = 1 \times 10^{10}$ N m^{-2}

Stress = F / A

$$\text{Stress} = \frac{1.029 \times 10^3 / 4}{2 \times 10^{-3}\ m^2} \quad (1)$$

Stress = 1.29×10^5 N m^{-2} (1)

d) By what amount do the chair legs shrink when Robert stands on the chair?

(2 marks)

Y = stress / strain

Strain = stress / Y

Stress = $1.29 \times 10^5 / 1 \times 10^{10}$

Stress = 1.29×10^{-5} (1)

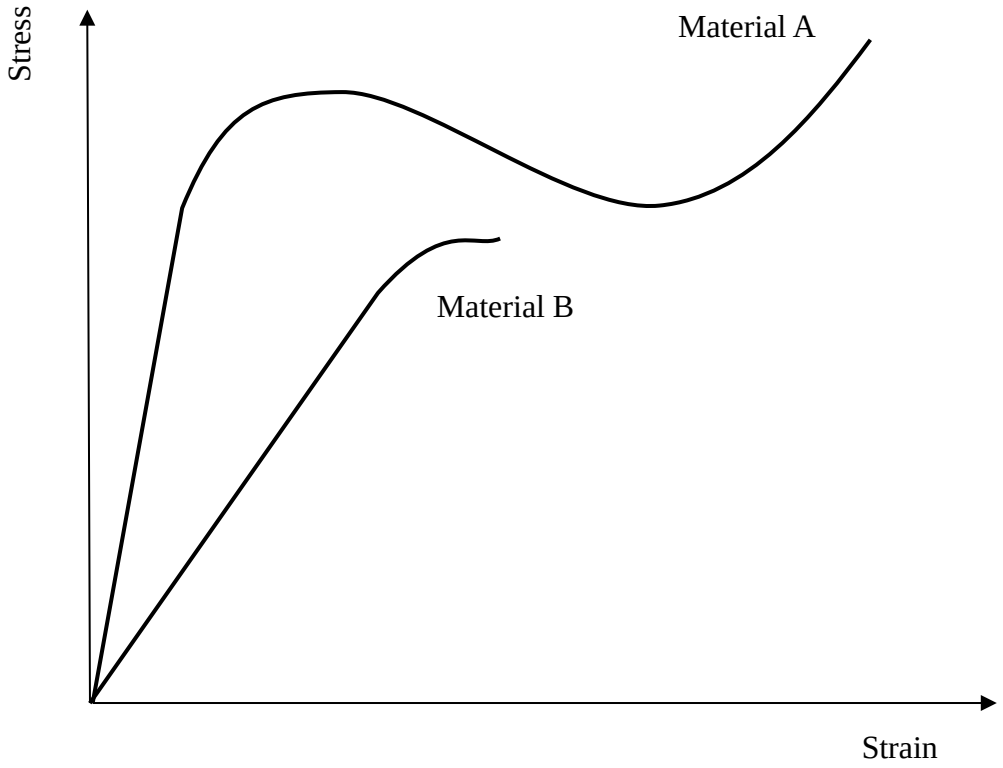
Stress = change in length / original length

Stress x original length = change in length

$1.29 \times 10^{-5} \times 0.42$ = Change in Length

Change in Length = 5.40×10^{-6} m (1)

A11. Compare the two graphs below and answer the following questions.



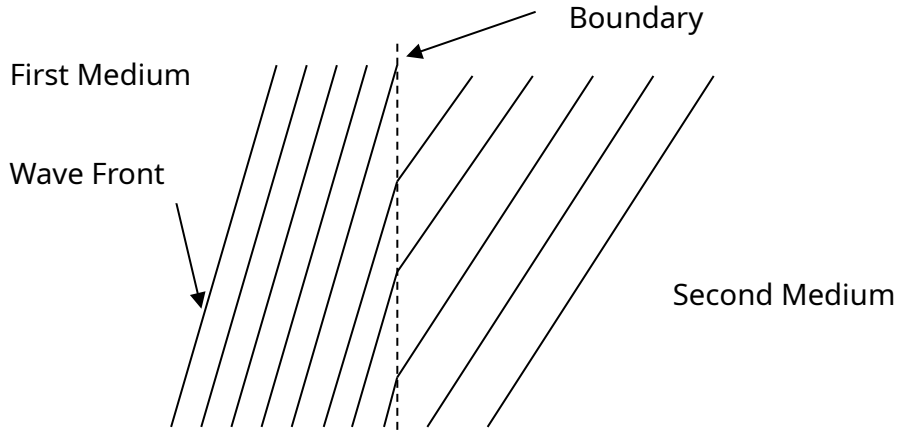
a) Which material has the greater Young's modulus? Explain. (1 mark)
material A = Proportional region is steeper

b) Which material is ductile? Explain. (1 mark)
Material A = has a plastic region

c) Which material can absorb more energy before fracture? Explain. (1 mark)
Material A = absorbs energy in its elastic and plastic regions (has a greater area under the curve).

d) Which material has the larger spring constant (k) i.e. (Hooke's law constant)? Explain. (1 mark)
Material A = the graph with the greater Young's modulus will also have the greater Hooke's law constant k.

A12. A sound wave is travelling from the first medium into the second medium, and changes the speed at which it is travelling at the boundary symbolised by the dotted line.



a) What is the name of the phenomenon illustrated in the above diagram?

(1 mark)

Refraction

b) In which medium is the sound travelling faster?

(1 mark)

Second Medium

c) Are the waves bending towards or away from the normal?

(1 mark)

Away

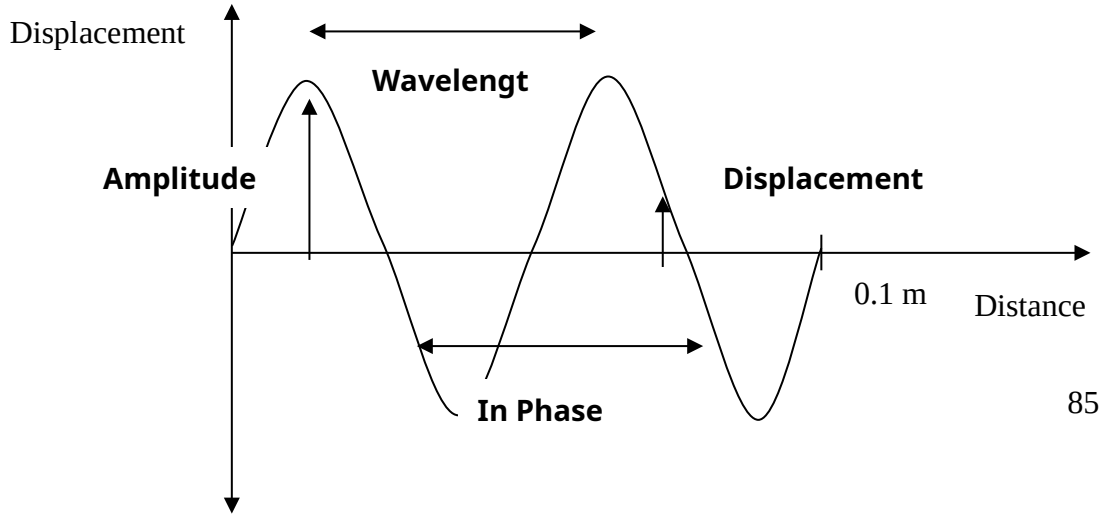
d) If the first and second mediums are air, is the temperature of the first or second medium higher?

(1 mark)

Second is higher

A13. On the graph below insert the following words **if appropriate / possible**.

Cycle, **In-phase**, **Displacement**, **Amplitude**, Frequency, Period, **Wavelength**, Speed



SECTION B : Problem Solving - 82 Marks (50%)

Attempt ALL 7 questions.

B1. (Total = 12 marks)

A St Mary's student has been selected to represent Australia in the field archery events of the Olympic Games in London. Field archers do not aim at targets. The aim of the field archer is to get his or her arrow to land, sticking as close to vertically into the ground at a set distance (range) from where they are standing.

a) If the arrow leaves the bow with a velocity of 30.0 m s^{-1} at 60.0^0 above the horizontal and the required range is 85.0 m, is the range of the arrow greater than, smaller than or equal to the required range? Please note that the arrows final resting place will be 2.00 m lower than its release point due to the height of the person. Support your answer with calculations.

(4 marks)

Diagrams (1)

$s = ut + 1/2\ at^2$ (1)

$-2 = 30 \sin 60\ t + 1/2 \times 9.8\ t^2$

$t = +\ 5.378$ s (1)

$s_h = 5.378 \times 30 \text{ Cos } 60$

$s_h = 80.7$ m forward. (1)

b) What is the maximum height that the arrow reaches above the **ground**?

(4 marks)

$v^2 = u^2 + 2 \times a \times s$ (1)

$0^2 = (30 \sin 60)^2 = 2 \times -9.8 \times s$ (1)

s = 34.4 m above take off point (1)

s = 34.4 + 2 = 36.4 m above the ground (1)

c) How much heat is produced when the arrow strikes the ground, assuming all the potential and kinetic energy of the arrow is converted to heat? The arrow has a mass of 0.150 kg.

(2 marks)

Energy total = Heat

Energy total = Ek + Ep (1)

Et = $(0.5 \times 0.15 \times 30^2) + (0.15 \times 9.8 \times 2)$

Et = 67.5 + 2.94

Et = 70.4 J (1)

d) What is the greatest range possible for an arrow if the velocity that the arrow can leave the bow at is 30.0 m s^{-1} and the archer can select any angle they desire?

(2 marks)

s_h = ?

$-2 = 30 \sin 45\ t + -4.9\ t^2$

$t = 4.42$ (1)

$v = s/t$

$s = v \times t$

$s = 20 \cos 45 \times 4.42$

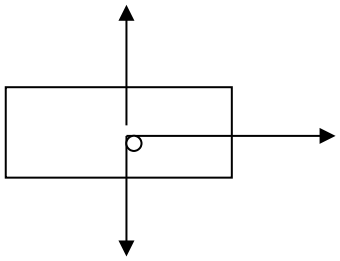
$s = 93.8$ m (1)

B2. (Total = 12 marks)

A 1.00 tonne car travelling at a constant speed of 55.0 km h^{-1} approaches a flat (horizontal) curve of radius 60.0 m. On a dry day, the maximum possible value of friction between the tyres and the road is 60.0% of the weight of the car.

a) Will the car successfully round the curve if it maintains this speed?

(4 marks)



Sum of the forces horizontal = force centripetal

$F_f = mv^2 / r$ *(1)*

$F_f = 1000 \times (55/3.6)^2 / 60$

$F_f = 3.89 \times 10^3$ N *(1)*

Maximum available force of friction = 60 % or weight

$F_{f\,max} = 0.6 \times 1000 \times 9.8$

$F_{f\,max} = 5.88 \times 10^3$ N *(1)*

$F_f < F_{f\,max}$
Car rounds bend safely *(1)*

b) If, on a wet day, the frictional force supplied by the tyres is reduced to 25% of the weight of the car, will the car make the curve?

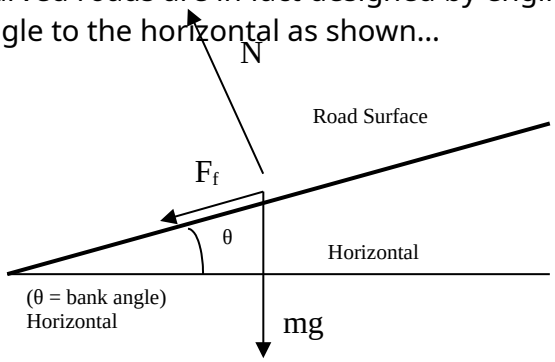
(2 marks)

$F_{f\,max} = 0.25 \times 1000 \times 9.8$

$F_{f\,max} = 2.45 \times 10^3$ N *(1)*

$F_f > F_{f\,max}$
Car does not round bend safely *(1)*

c) These type of curved roads are in fact designed by engineers to be banked (burm) at an angle to the horizontal as shown…



Use your understanding of physics to derive equations for the vertical and horizontal forces acting on a car going around a banked curve.

(2 marks)

Sum f the forces horizontal = force centripetal

Sum of the forces vertical = 0

F_f horizontal + N Horizontal = mv^2/ r (1)

F_f Vertical + N Vertical + (-mg) = 0 (1)

d) Explain why the curves are designed as shown in part c).

(1 mark)

*So **that the Normal** has a horizontal component that assists the frictional force in moving the car around the curve.*

e) If the road surface in part c) was covered in ice (no friction), then calculate the exact bank angle for the car mentioned in part a) to negotiate a curve of radius 60.0 m whilst travelling at 55.0 km h^{-1}.

(3 marks)

F_f horizontal + N Horizontal = mv^2 / r

F_f Vertical + N Vertical + (-mg) = 0

Let $F_f = 0$

Hence…

N horizontal = mv^2 / r (1)

N vertical = (mg) (1)

N Sin θ = mv^2 / r

N Cos θ = mg

Tan θ = $mv^2 / r / mg$

Tan θ = $v^2 / r g$

θ = Arc tan($(55/3.6)^2$ / (60 x 9.8))

θ = 21.7 ^{0} (1)

B3. (Total = 11 marks)

a) Combine the centripetal force formula and the universal gravitation formula, to create a formula to be used for geostationary satellites above a planet. Please show all algebraic working to obtain full marks. Please make sure the final formula is stated in terms of the variables r & T and does not contain the variable v.

(3 marks)

$mv^2 / r = G\ m\ m / r^2$ (1)

Sub $v^2 = 4\ pi^2\ r^2 / T^2$ into above (1)

$r^3 / T^2 = G\ m / 4\ pi^2$ (1)

The above working it too brief. Must show all working

b) Superman is having a bad day and decides to push on the earth to increase its speed of rotation to get the day over with faster. After superman's interference the earth completes one revolution in only 18 hours. Where relative to the surface of the earth, should a geostationary satellite be placed, so that it has an orbital period that coincides with the now more rapidly spinning earth?

(4 marks)

$r^3 / T^2 = G\ m / 4\ pi^2$

appropriate substitutions for T and m (2)

$r = 3.49 \times 10^7 m$ (1)

$h = 2.85 \times 10^7$ m (1)

c) Will the weight of the satellite be greater or smaller when placed in an 18 hour orbit as compared to a 24 hour orbit? Explain.

(2 marks)

wt = greater the closer it is to earth (1)

satellite is closer in a faster orbit period (1)

d) If the mass of the earth was now increased to 4 times its original value, what is the new geostationary position for the satellite as measured from the centre of mass of the earth?

(2 marks)

$m = 4 \times m_e$ *(1)*

re run through same formula as at b

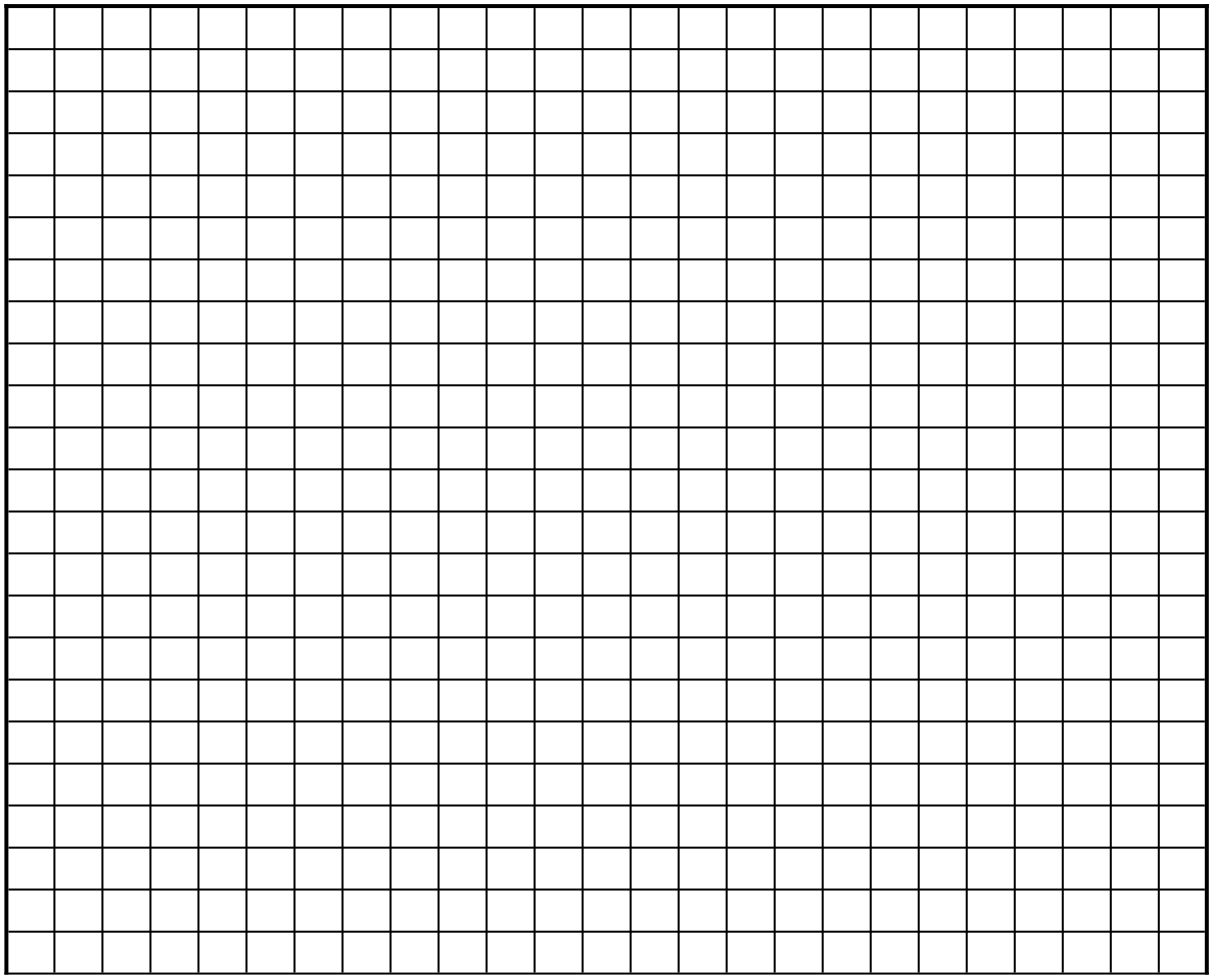
$r = 5.54 \times 10^7 m$ *(1)*

B4. (Total = 10 marks)

a) Graph the following data in S.I. units to create a Hooke's law graph. The data has been taken from a substance that has been placed under a gradually changing tension until it breaks at the final value listed in the below table. The substance has an original length of 4.20 m and a circular cross section of radius 5.00×10^{-4} m.

(4 marks)

Force	(N)	26.2	52.4	78.6	102	110	80	102	122
Extension	(mm)	2	4	6	7.79	9	13	17	23



Title (1)

Axies labeled (1)

Scales (1)

Graph / data point / line / curve (1)

b) What is the Young's modulus for the substance and hence, what is the most likely name for the substance or material being tested?

(3 marks)

Y = (rise / run) x l / A (1)

Y = (102 – 26.2)/ (7.79 x 10^{-3} – 0.002) x 4.2 / 7.355 x 10^{-7} (1)

Y = 6.9 x 10^{10} N m^{-2} (1/2)

There for Aluminum (1/2)

c) Which is the last tabulated data value that obeys Hooke's Law ?

(1 mark)

(x,y)

(102, 7.79 x 10^{-3}) (1)

d) Assuming that the proportional region ends at the data value stated in part c) above, how much energy can be stored in the substance's proportional region?

(2 marks)

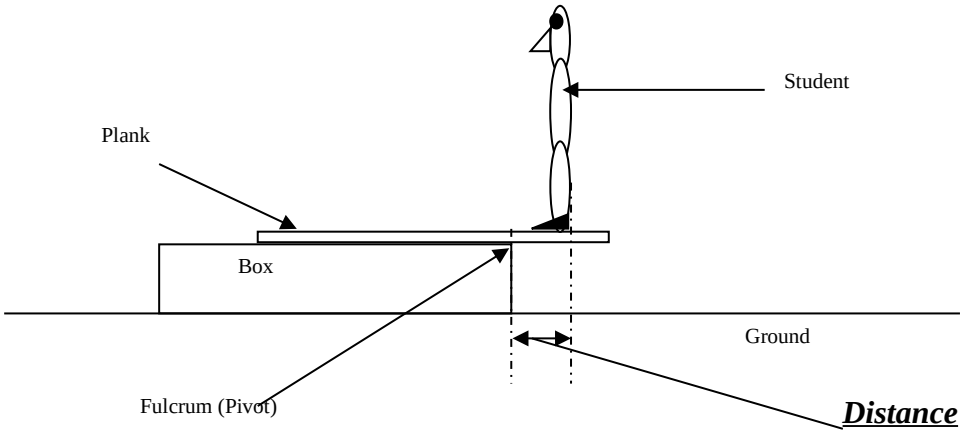
E = ½ k x^2 (1)

E = 0.5 x 1.31 x10^4 x 0.00779

E = 0.397 J (1)

B5. (Total = 10 marks)

A student is playing a game of walk the plank with his friends. The plank is placed on a box. The student then walks backwards along the plank until the plank tips off the box. The plank can be positioned so that as much or as little of the end to the plank is protruding off the end of the box as the student wishes. The aim of the game is to position the plank so that the student's heels are as far along the plank as possible as measured from the edge of the box before the plank tips.



a) Under what conditions will the plank tip in a clockwise direction towards the ground?

(1 mark)

When the torques clock are greater than the torques anti

b) The plank is uniform, has mass of 20.0 kg, and has a length of 2.00 m. What is the maximum ***Distance*** that a 60 kg student can obtain?

Note :- Assume that the weight of the student is exerted through the back edge of his / her heels.

(5 marks)

method 1

$x_{cm} = x1\ m1 + x2\ m2 / m1 + m2$ *(1)*

$x_{cm} = (1 \times 20) + (60 \times 2) / (20 + 60)$ *(1) (1) (1)*

$x_{cm} = 20 + 120/ 80$

$x_{cm} = 140 / 80$

$x_{cm} = 1.75$ m *(1)*

method 2

Take torques about left end of plank

sum of force s up = sum of forces down (1)

Normal = (20 + 60) x 9.8

Normal = 80 x 9.8

$M_c = M_a$

(1x20x9.8) + (2x60x9.8) = ? x 80 x 9.8
(1) (1) (1)

? = 1.75 m from left end of plank (1)

c) Will a heavier or lighter student have an advantage? Explain.

(2 marks)

Lighter student has the advantage

since less force requires a longer distance to achieve the same torque.

d) If the game was moved to the moon, would the results / winner of the game change? Explain. Note that gravity on the moon is $1/6^{th}$ that on earth.

(2 marks)

Lighter student will still have the advantage

because both will have their weight adjusted by the same factor (1/6) on the moon.

B6. (Total = 15 marks)

A physics student is approached by her grandparents who are interested in purchasing a house near the airport. The grandparents are worried about the noise from the low flying aircraft. They ask their grandchild to apply her knowledge of physics to calculate the height of the low flying air craft passing above the house's backyard by using the loudness of the noise coming from the aircraft's engines.

a) A typical individual aircraft engine has a loudness of 130 dB at a distance of 30.0 m. What is the intensity of this sound?

(3 marks)

L = 130 dB *(1)*

$L = 10 \text{ Log } (I / 10^{-12})$ *(1)*

Using graphics

$I = 10 \text{ W m}^{-2}$ *(1)*

b) What is the power output as sound energy by the engine? Assume that the power of the sound output of the engine is spread over a spherical surface area.

(3 marks)

P = I x A *(1)*

$P = 10 \times 4 \times \text{pi} \times 30^2$ *(1)*

$P = 1.13 \times 10^5 \text{ W}$ *(1)*

c) An aircraft with three identical engines is flying over the house that the grandparents are interested in purchasing. The loudness of the aircraft in the backyard of the house is 100 dB. What is the loudness (in dB) of each individual engine in the backyard at the aircraft's current position?

(5 marks)

L = 100 dB

L = 10 Log (I / 10^{-12}) *(1)*

Using graphics

I = 1 x 10^{-2} (3 engines) *(1)*

I of 1 engine = 1/3 x 10^{-2} *(1)*

$I_{1\ engine}$ = 3.333 x 10^{-3} W m^{-2} *(1)*

Using graphics

L = 95.2 dB *(1)*

d) Grandma is a bit deaf and cannot hear sounds with an intensity of less than 1 x 10^{-2} W m^{-2}. Will she hear the aircraft mentioned in part c)?

(1 mark)

Just. This is the threshold of her hearing. *(1)*

e) What is the height of the aircraft above the ground?

(3 marks)

Power of 1 engine = 1.13 x 10^{5} W

Power of 3 aircraft = 3 x 1.13 x 10^{5} W *(1)*

I = 1 x 10^{-2} W m^{-2} *(1)*

P = I x A

3 x 1.13 x 10^{5} = 1 x 10^{-2} x A

A = 3.42 x 10^{7} m^{2}

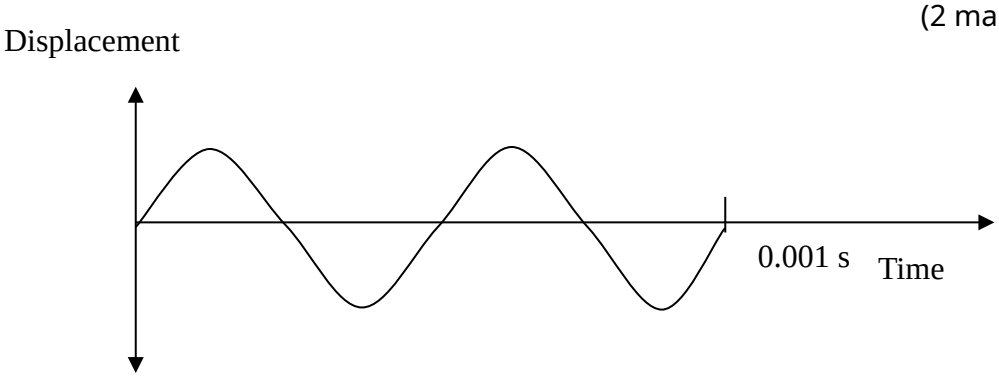
$A = 4 \pi r^2$

$r = 1.65 \times 10^3 m$ (1)

B7. (Total = 12 marks)

a) Is the graph below that of a single particle or multiple particles? Please circle the correct response and explain.

(2 marks)



Single or Multiple

Explanation = *Single particle at different moments in time*

b) What is the approximate range of audible frequencies of the human ear?

(1 mark)

20 Hz to 20 000 Hz

c) Would you classify the pitch of the sound shown in the graph as being high or low? Explain.

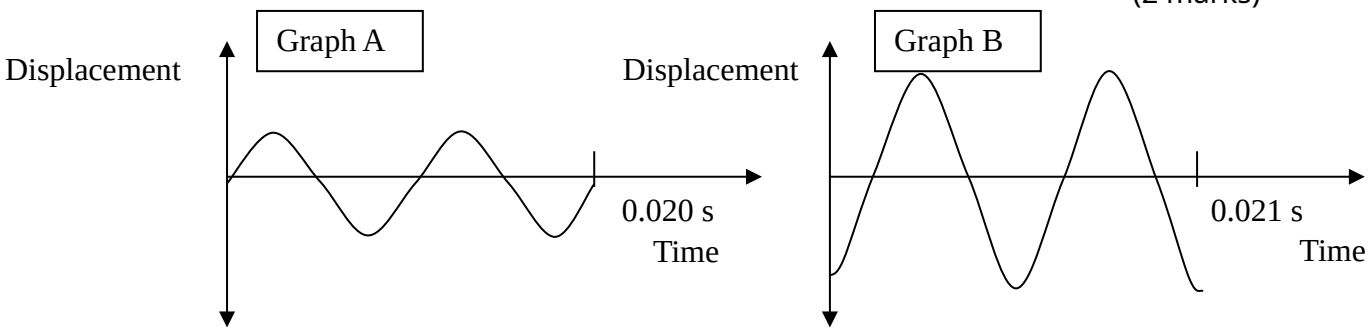
(2 marks)

Calculate the pitch = 2000 Hz (1)

Justify your answer (1)

d) Which of the waves below is louder? Explain.

(2 marks)



Graph B – Large amplitude

e) Are the two waves in question d) in-phase with each other? Explain.

(2 marks)

No - Different T means not in phase. (2)

f) If these two waves were played at the same time, would there be an audible effect to a non hearing impaired student? If so what would the effect sound like? What is the name of this phenomenon?

(3 marks)

Yes *(1)*

Fluctuations in loudness *(1)*

Beats *(1)*

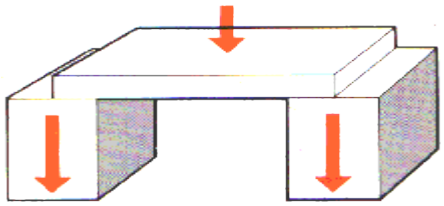
SECTION C : Comprehension and Interpretation - 33 Marks (20%)
Read the passage below carefully and answer all of the questions at the end of the passage. Candidates are reminded of the need for correct English and clear and precise presentation of answers.
Show all working out for questions requiring numerical answers.

The Right Bridge for the Right Job

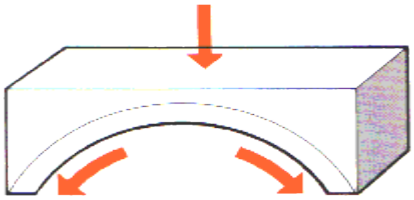
There are essentially 4 types of bridge. They are...

1. Beam	2. Arch	3. Suspension / Cable Stay	4. Cantilever.

1. Beam - The beam type is the simplest type of bridge. The beam bridge could be anything as simple as a plank of wood to a complex structure. It is made of two or more supports which hold up a beam.

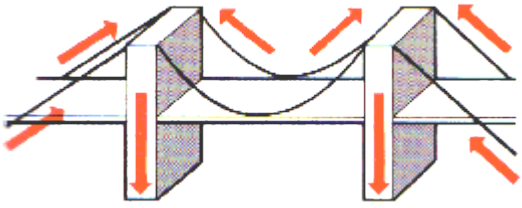


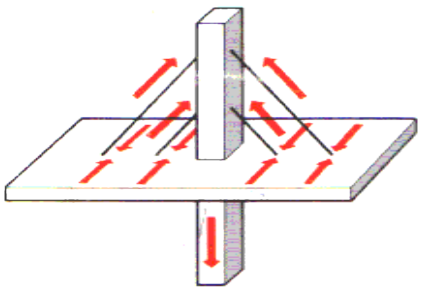
2. Arch - In the arch type of bridge, weight is carried outward along two paths, curving toward the ground. The horizontal forces are supported by abutments (banks of earth or rock) to the left and right of the gap to be spanned.



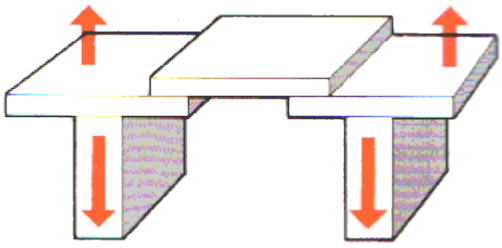
3. Suspension/Cable-Stayed
The deck (traffic way) of a suspension bridge is hung by cables, which hang from towers. The cables transfer the weight to the towers, which transfer the weight to the ground.

Cable-Stayed bridges have towers, but cables from the towers go directly to the road deck, instead of spanning from tower to tower.

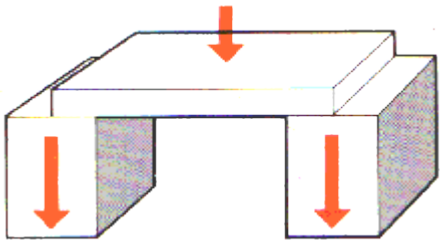




4. Cantilever - In the cantilever type of bridge, two beams support a third beam, which is where the deck or traffic way is. The two beams must be well anchored to their supports.



The Beam Type



The beam type of bridge is by far the simplest. The beam type of bridge is also the most common. A beam bridge is just a beam supported by pillars or columns. (See figure above)

Materials and Construction

Beam bridges are commonly built from concrete. Beam bridges are also made of steel, or a mixture of steel and concrete. They often are made (prefabricated) in sections, or boxes at another location. These prefabricated boxes are then transported to the site and assembled. The boxes are made out of steel and concrete or just concrete.

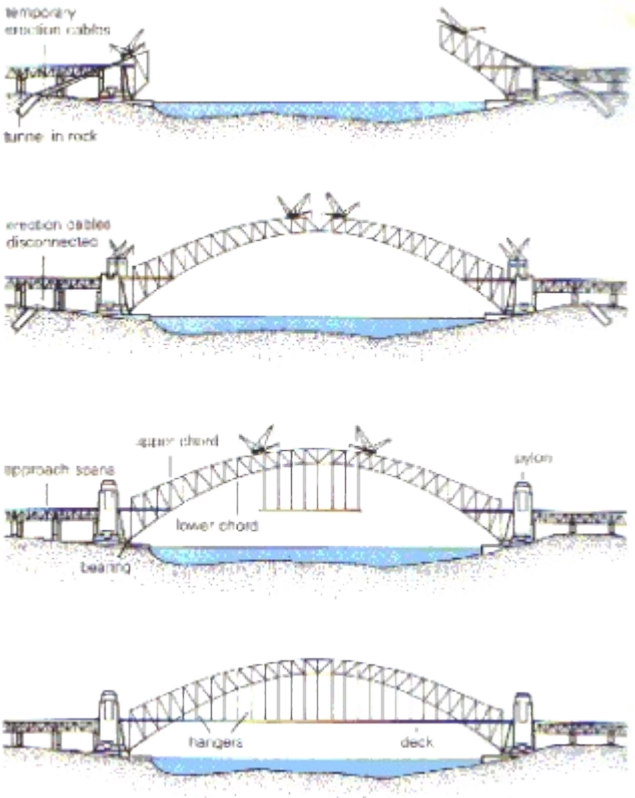
Steel beams and boxes

Modern steel beam bridges are usually made section-by-section and then they are transferred to the site of the bridge and welded together. They are attached to the supports. It is very costly to maintain a steel beam bridge. The boxes are made in a trapezoid shape, so that wind harmlessly passes under the boxes.

Concrete beams

This is the most common type of bridge. The concrete beam is versatile and does not require much maintenance. Concrete beams contain large amounts of steel inside of them. None of this steel is exposed. The supports that hold up the sections are made at the site of the bridge.

Arch Type



In this type of bridge, the weight is carried outward along two curving paths. The points where the arch reaches the ground keep the bridge up by resisting the outward thrust. The roadway is located on top of the arch.

Materials and Construction

Like beam bridges, arch bridges can be made of both steel and concrete.

Steel Arches

There are a few different methods used to construct steel arches. One design uses an arch structure with the traffic way passing through the arch. The traffic way rests on the part of the arch it passes through. Cables, suspended from the arch, pull the traffic way up so it does not sag. (See diagram above) e.g. (Sydney Harbour Bridge)

Another method used is one that is useful when the other type of steel arch bridge is not possible. It is built by building an arch (which is often supported by pillars until completed) and then building a traffic deck above the arch. The traffic deck is supported by pillars. It's almost like a beam-type bridge on top of a steel arch! (see diagram below)

Suspension Bridges and Cable-Stayed Bridges

Suspension bridges "bridge the unbridgeable". In a suspension bridge, cables which are suspended via towers which support them hold up the road deck. The weight is transferred by the cables to the towers, which then in turn transfer the weight to the ground.

The amount of towers on suspension bridges can vary, but a suspension bridge MUST have at least two towers. These towers are built on the ground. Towers are usually built with hollow steel boxes, but some are built with concrete.

Cable-stayed bridges are similar to suspension bridges because cables support the roadway. Two or more towers have cables hanging from them. These cables support the roadway by transferring the weight to the towers. In turn, the towers transfer the weight to the ground. Construction of a cable-stayed bridge is similar to the construction of a regular suspension bridge, except the tower cables attached directly to the road.

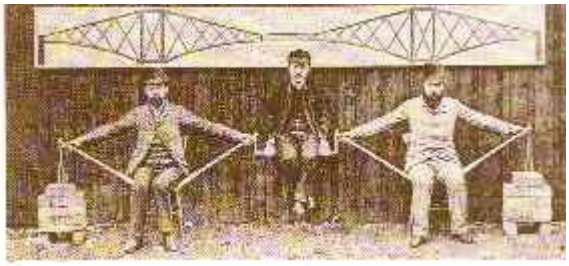
The road deck

A while ago, the common design for the road deck was a truss; an arrangement of horizontal and vertical girders (steel bars), stiffened (or strengthened) by diagonal bars. The truss design allows wind to pass through it. A truss design still takes lots of steel.

This design was replaced by the aerodynamic box-girder. The aerodynamic box-girder design allows wind to pass around it. They use less steel, reducing weight and cost. Construction and painting is therefore easier. In fact, much of the construction can be done at a factory in large sections, making things a whole lot easier for everyone. (You can see an aerodynamic [trapezoid shaped] box-girder above.)

Cantilever Bridges

Cantilever bridges depend on counterbalances. But what are counterbalances? Counterbalances are weights used to balance another weight. They consist of two or more (which many cantilever bridges have at least four) arms that equally balance each other, almost like a perfectly balanced see-saw. Often, the part of the bridge that leads to the first cantilever is just a beam bridge. (You can see this on the cantilever bridge at the top of this page.)



Materials and Construction

Cantilever bridges are built with many materials in different ways. Some use one arch to connect (and essentially act as) the arm, as shown in the “soon-to-be-here” picture above. Others just have arms and a roadway, or arms, a roadway, and cables that work like a cable-stayed bridge. Cantilever bridges are built in a way similar to beam and arch bridges, depending on how the bridge is designed.

References

This article was extracted from...

http://library.thinkquest.org

May 2004

Questions

1. What are the conditions required for a bridge (or any structure) to be stable?

(3 marks)

And three of the below

- *low COM*
- *Wide Base*
- *Static*
- *Sum of the forces = 0*
- *Sum of the torques = 0*

2. What are the advantages of using concrete in a structure?

(4 marks)

- *Cheep*
- *Low maintenance*
- *Strong*
- *Moldable (versatile) on or of site fabrication*

3. What are the disadvantages of using exposed steel in a structure?

(2 marks)

And two of the below

- *Corrosion*
- *Cost to build*
- *Cost to maintain*

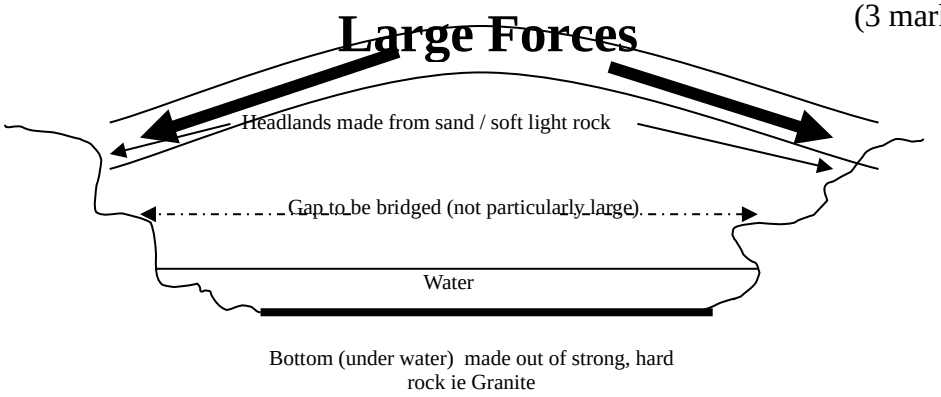
4. What is the advantage of using reinforced concrete instead of using pure concrete for the span of a beam bridge? Use diagrams to assist your explanation.

(4 marks)

a. Diagram
b. Concrete is week under tension
c. Concrete is good under compression
d. Combine steel and concrete and you get a cheep composite material that is good under tension and compression

5. In the following situation which type of bridge would you **not** use? Why? Draw the bridge on the diagram to assist your explanation

(3 marks)



- *Don't use an arch*
- *The gap is small*
- *The headlands are not strong enough to support the forces*

6. In the diagram shown in question 5 what would be the <u>simplest</u> way of spanning the gap with a bridge? Explain why with reference to the surfaces on which the bridge will be built.

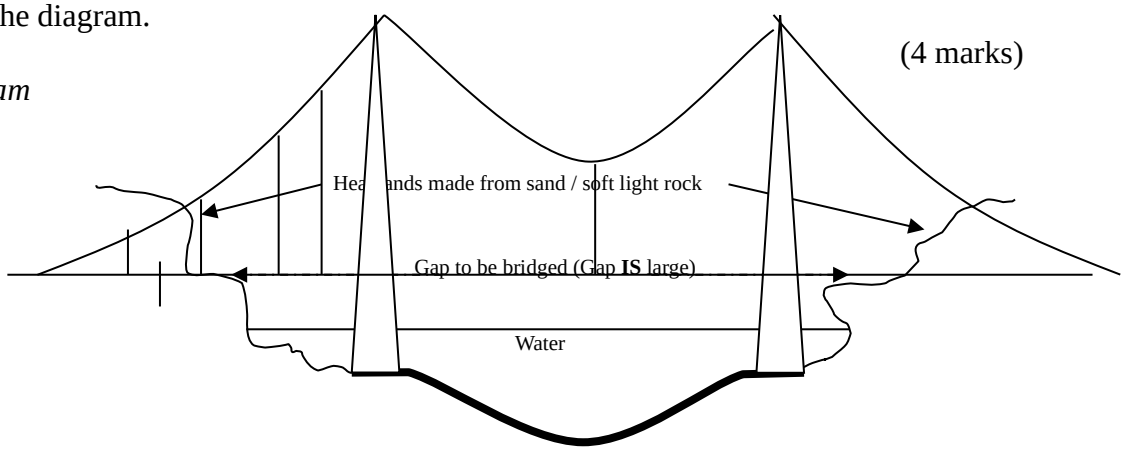
(3 marks)

- *Do use a beam and post - simplest*
- *The bottom of the river is not deep*
- *The bottom of the river is made form hard stone*

7. If the gap to be bridged is very large and the river is very deep **in the middle**, what type of bridge would you use and why? Explain why with reference to the surfaces on which the bridge will be built. Draw an example of the bridge on the diagram.

(4 marks)

Diagram



- Use a suspension
- Capable of spanning ling distances
- River too deep to support multiple piers (towers) (posts)
- Bottom of the river can support towers near edges

8. Why does the roadway of a bridge need to take into account wind? How have past and present engineers taken wind into account in their design of roadways?

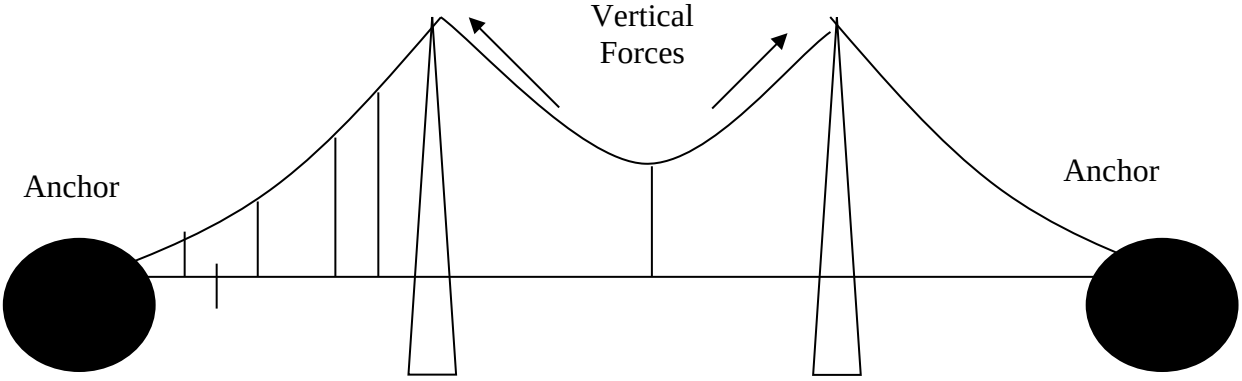
(3 marks)

- *Wind loads can topple a bridge*
- *Old truss was hollow to let the breeze blow through*
- *New road is aerodynamic to move the wind around*

9. Why must a suspension bridge contain two towers and what else must be present at either end of the bridge? Use a diagram to assist your explanation.

(4 marks)

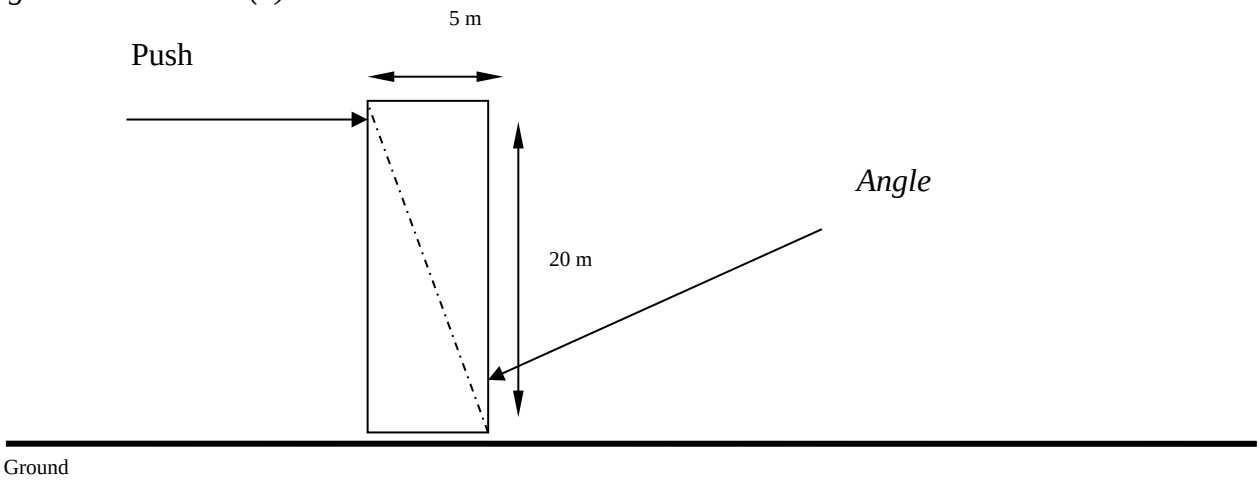
- *tension in top wire is not sufficient to support road at long distances if there is insufficient vertical component provided by wire hence two towers.*
- *Firm anchors to stop the towers toppling*



10. The following diagram is a pillar (post) that is going to be used in a beam bridge. At what angle (as formed between the base of the post and the ground) will the post topple (toppling angle) when the post is pushed sideways? Assume that the whole post is above ground level and that none of the post is buried.

(3 marks)

Diagram *(1)*



Tan (angle) = top / base *(1)*

Angle = arc tan (5/20)

Angle = 14.0^0 *(1)*

END OF EXAM