**4.7 Higher order questions**

We have been building up a bank of higher order questions over the years and have a collection of them here. The aim is to incorporate them into the students’ notes at both Leaving Cert and Junior Cert level.

See juniorscience.ie:

<http://juniorscience.ie/jsss/Files/3B1_assess_heat.doc>

**Heat**

1. Why are there lines of tar in footpaths and concrete walls?
2. How are metal rings put so tightly around barrels and wooden wheels?
3. Why are there gaps in railway tracks?
4. Why are telephone wires loosely strung on the poles?
5. How does an automatic fire sprinkler system work?
6. Why does a thick glass tumbler crack if boiling water is added to it, whereas one made of thin glass does not?
7. Why are bottles of lemonade, etc. not filled completely to the top?
8. Why are we told not to throw aerosol cans into the fire?
9. Why is it dangerous to open the radiator cap in a car while the engine is still hot?
10. Why do water pipes sometimes burst in cold weather?
11. Large aeroplanes are up to 20cm. longer when they are flying. Why?
12. Why is one side of aluminium foil dull and the other side bright and shiny? Does it matter which side is on the outside of a potato if we want to bake it?
13. Would putting an overcoat on a snowman melt him or make him last longer.
14. Why, in terms of heat, is it an advantage that our body is 70% water?
15. If a washer is heated, will the hole in the centre of it get bigger, smaller or stay the same size?
16. Why do floorboards in your house creak at night after the heating goes off?
17. If black is the best absorber of heat, why do Bedouins wear black robes in the hot desert?
18. Why does ice cool down a drink much more effectively than water at 00 C?
19. Why does water vapour at 1000 C cause more harm to skin than water at 1000 C?
20. Do you think that “radiator” is a suitable name for the heaters in a central heating system?
21. On a cold morning the frame of a bicycle feels very cold whereas the plastic on the handlebars feels much less cold. Why is this?
22. If you left a pot of cold water and an identical pot of same volume of hot water outside if freezing weather, the hot water freezes first. Why do you think this happens?
23. Why does your hand sometimes stick to the metal ice tray in the freezer?
24. Why do you feel cold when you first step out of a warm shower?
25. “Fire walkers” who can run on hot coals usually wet their feet first. Can you explain why they do this?
26. Would you cool down the kitchen on a hot day by leaving the door of the fridge open?

**Puzzle Books – all available in the Physics Library in A7**

* *Flying Circus of Physics* by Jearl Walker (WiLey)
* *Mad About Physics* by CP Jargozki & F.Potter (Wiley)
* *Thinking Physics* by LC Epstein (Insight Press)
* *Thinking Like a Physicist* N. Thompson (Adam Hilger)
* *Physical Paradoxes & Sophisms* V.N.Lange (MIR: Moscow) Probably no longer in print, but worth tracking down.
* *200 Puzzling Physics Problem* by P Gnadig, G Honyek & K Riley (CUP)
* *Last Word 1 & 2 from new Scientist Column* (Oxford)
* *Turning The World Inside Out* by R Ehrlich (Princeton)
* *Why Toast Lands Jelly Side Down* by Robert Ehrlich (lots of good demonstrations) and
* *How To Dunk A Doughnut* by Len Fisher (includes chapters on the physics of sex and another on beer). Peter Coghill
* *Can reindeer fly? The science of Christmas* by Roger Highfield
* *Do your ears pop in space? and 500 other surprising questions about space travel* by R Mike Mullane

There are lots of useful Web sites. Try New Scientist Last Word and

Physics in the open air: <http://home.hetnet.nl/~smvanroode/nvhvv/index2.html>

**Puzzlers and Nuggets**

What would happen if:

gravity doubled?

density of air doubled?

evolution stopped?

If you leave the fridge door open, will the room get hotter or colder?

You have a bar magnet and a similarly shaped, un-magnetised piece of iron. Without using any material how can you tell which one is the magnet?

A carton of ice-cream is wrapped in a scarf. Will this make the ice-cream melt more quickly or less quickly?

Why don’t rain drops fall down and kill us?

Why do people in African countries sometimes wear dark clothes if dark materials are better absorbers than bright materials?

"Why walking into a door at my house on the moon hurts just as much as doing it on Earth."

 "Why diet? Visit the moon and lose weight!"

Why does a compass point north?

You have a bar-magnet and a similarly shaped unmagnetised piece of iron. They both appear to be identical. Without using any other items, how can you tell which one is the magnet?

If you leave the fridge door open, will this make the kitchen get warmer or cooler?

Why do solids expand when heated (Junior Cert and Leaving Cert)?

You could also ask them how they would measure the height of a house using a barometer...

<http://www.snopes.com/college/exam/barometer.asp>

Alby

Put a dry piece of ice in a microwave – it doesn’t melt

Feynman: we know more about what goes on in the sun than we do about what happens inside our own planet.

Paper aeroplane competition - best in a sports hall.

One of the hardest we have set is to make a timer for a fixed time e.g. 30s, using available goodies.

It has to do something definite after the fixed time interval which signals the end.

This could consist of a circuit which gets completed by water falling, or sand from a funnel falling onto a lever, or burning string.

Can you 'weigh' a person using only a bag of sugar and a plank?

Find the mass of a retort stand with a 1kg mass and another retort stand and a bit of string - always made a good lesson.

Slow marble race - an equipment tray, a measured amount of blutack or plasticine, a marble, which group can make it travel most slowly from top left to bottom right?

Law of Lever to find missing mass

Use mass volume graph to calculate density (from slope of graph), and use this to calculate mass of new object

See physics education October 2005

Scope activity with mirrors

You have 9 objects, one of which is slightly (imperceptibly to the touch) lighter than the remaining 8.

You have a balance (2 arms with pans on each side) but no 'known' masses.

How can you identify the 'culprit' in only 2 'weighings'?

**Answer**:

Divide the 9 objects into 3 groups, A, B and C.

Compare A and B using balance.

This will narrow the culprit down to one of 3 (Group C if 'balance' occurs between A and B or the group that moves upwards otherwise).

Label the remaining 3 objects X, Y and Z.

Compare X and Y using balance.

In a similar vein:

If you have a true balance (2 arms with pans on each) and masses of units 1, 3, 9 and 27 you can measure all the integer masses from 1 to 40 units.

Think about it.

Why does a compass point North South?

Why do Catherine Wheels speed up as they burn?”

If I put my fan on, does it heat up or cool down the room?

Which fall faster – big or small raindrops?

Why does the shower curtain always attract to your body when you are having a hot shower?

Why does cold glass crack when you pour hot water on it?

Why do biros have holes in them?

“If I put a thick coat on a snowman, will it melt quicker or last longer?”

Do astronauts take medicines with them on space missions?

I’ve just made a cup of coffee and the doorbell rings.

I want the drink to be as hot as possible when I get back, should I put the milk in before or after I answer the door?

Would straws work in outer space?

How long is a day?

Would straws work in outer space?" any thoughts?

Answer: in zero gravitational field they are unlikely to break the camel's

back

Blowing Hot and Cold

Open your mouth wide and breath onto the palm of your hand. Notice how the air seems warm. Now purse your lips and blow again – this time the air is quite cool. Why the difference?

Imagine that you are travelling in a car. You have a glass bottle in your hand which you want to get rid of, but you want to minimise the danger of it breaking on hitting the ground. Should you

Throw it forward,

Allow it to drop from your hand, or

Throw it back?

If the sun disappeared right now, how long would it take before it affected the gravit of our planet?

Questions for students

See Wolpert’s book

**HEAT**

Why is putting on your clothes more comfortable than sitting in a bath if both are at room temperature?

Why does touching a cold metal chair seem more painful than touching a cold wooden chair, though both are at the same temperature?

ISTA Question – Shouldn’t a fan heat up the air instead of cooling it?

How does firewalking work?

Why is water a good fire-extinguisher?

Calculate the chance of getting a hole-in-one on a green, given the size of the green, and assuming all tee-shots will actually reach the green.

Explain all assumptions.

How many piano tuners are there in Dublin?

Check this out with Music academy and Yellow Pages.

How many people do you need to have in a room in order for there to be a greater than 50:50 chance that any two people will have the same birthday.

**Misc**

Cresent shape of the moon – can you determine position of the sun from the shape of the moon?

Why do clouds stay in the sky? See McWilliams p.96

The following questions have been taken from *Mad About Physics* by CP Jargozki & F.Potter (Wiley)

**Springing into Action**

A spring balance is hung from the ceiling by a long rope. A second rope is attached to the spring balance, pulled tight so the balance reads 100 pounds, and then anchored to the floor. If a 60-pound weight is now hung on the hook of the balance, what do you predict the balance will read?

**The Monkeys and the Bananas**

This problem is an old one and is said to have been invented by Charles Dodgson (also known as Lewis Carroll): A long rope passes over a pulley. A bunch of bananas is tied to one end of the rope, and a monkey of the same mass holds the other end. What will happen to the bananas if the monkey starts climbing the rope?

Assume the ideal rope and pulley: Neither has weight, the rope is extensionless, and there is no friction opposing the turning of the pulley.

**Hourglass and a Balance**

An hourglass timer is being weighed on a sensitive balance, first when all the sand is in the lower chamber, and then after the timer is turned over and the sand is falling. Will the balance show the same weight in both cases?

**How Much Do I Weigh, Anyway?**

Even if you stand very still on an accurate scale, the reading keeps oscillating around your average weight. Why? As you begin to step off the scale, what do you predict for the immediate value of the scale reading?

**The Wobbly Horse**

There is an old toy horse that has straight legs that swing forward and backward only at the connections to the sides of the horse’s body. When pulled forward on a tabletop by a string, the horse wobbles forward. Imagine that the toy horse is arranged as shown in the diagram. The horse begins about a foot from the edge of the table and is pulled forward by the constant applied force along the thread that passes over the edge of the table to support the hanging object (here consisting of several paper clips). What do you predict for the behaviour of the horse after it begins to move forward?

**Two Cannons**

What will happen if two identical cannons are aimed at each other and the shells fired simultaneously and at the same speeds? One cannon is higher than the other, but the two are perfectly aligned.

**217. Balancing a Broom**

A metre stick will balance on your finger if you support it at its center of gravity—the midpoint. The two halves have equal weights. A broom will also balance on your finger if you support it at its center of gravity. Suppose you cut the broom into two part on a scale. Would their weights be equal?

**220. Tightrope Walker**

Walkers along high wires carry a heavy horizontal bar. You would think that this extra weight makes each step harder to achieve than with a lighter bar. What’s going on here? And how would a physicist distribute the bar’s weight?

**283. Newton’s Paradox**

Is it true that when a horse pulls forward on a wagon, the wagon pulls backward to the same extent on the horse? In this tug-of-war it would seem, at least from the point of view of the connecting rope that it was being pulled by equal forces from each end. In fact, one can show that the forces at the two ends of the rope are always equal and opposite. So, as far as the rope is concerned, the opposing forces always add up to zero. Therefore, when starting from rest there can be no ensuing motion. So how does the clever horse succeed in pulling the wagon forward from rest?

Begin with two well known formulas for uniformly accelerated motion: *v = at* and

*S = ½ at^2.* Solving for acceleration a, and setting the two expression equal to each other, produces *v/t=2s/T^2.* Simplifying and using *v = S/t yields v = 2V or 1 = 2.*

**299. Hanging in the Air!**

Great jumpers on the basketball court sometimes seem to hang in the air with exceptional body control before taking a remarkable shot. But this effect seems even more amazing on the ballet stage, where one witness’s remarkable, seemingly effortless jumping ability combined with exceptional body control and grace. Ballet dancers appear to be able to wilfully suspend their bodies in flight for several seconds. can an athlete really hang in air?

**307. Doing the Impossible!**

Determine whether you can do this stunt. Face the edge of an open door with your nose and stomach touching the edge and your feet extending forward slightly beyond it. Now try to rise on tiptoes. Why is this feat impossible?

**139. Conch Shell**

Put a conch shell up to your ear and you can hear a marvellous symphony of sounds. Why are these sounds in the conch shell?

**140. Hearing Oneself**

Most of us will swear upon hearing our own recorded voce that this recorded voice sounds different from the voice we know. Are we victims of an illusion, or is the difference real?

**141. A Rumble in the Ears**

In a quiet room, put both thumbs in your ears and listen carefully to the low rumbling sound at about 25 hertz or slightly lower in frequency. What is producing this sound?

**142. Sound in a Tube**

How does a sound wave travelling down a tube get reflected from its open end, from nothing?

**156. Singing in the Shower**

In the shower, even a bad singer’s voice can occasionally sound beautiful. Any thoughts about this transformation?

**157. Scratcing Wood**

Take a long piece of wood and put your ear to one end. Stretch out your arm and scratch the most distant place on the wood that you can reach. Your scratching will sound quite loud, yet if you take your ear away and go on scratching as before, there is hardly a sound to hear. Why?

**168. Where Does the Energy Go?**

When two sound waves meet in a region and are cancelled by destructive interference, where does the energy go?

**169. A Bell Ringing in a Bell Jar**

In a well-known demonstration, an electric bell is hung inside a bell jar. When the air is being pumped out, the bell sounds become less audible until at a pressure of about 1,000 N/m2 the bell is completely inaudible. Why is this demonstration spurious?

**171. Driving Tent Stakes into the Ground**

A steel tent stake can be driven into hard ground easily and will fit snugly, while an identically shaped wooden stake is hard to drive in and will end up fitting loosely. Why such a dramatic difference?

Q: What do you do when your resistors get too hot?

A: Open the switch and coulomb off.

 -Anonymous

**189. Which is the Magnet?**

The only difference between two steel bars is that one is a permanent magnet and the other is unmagnetized. Without using any equipment, how can you tell which is which?

**190. Why the Keeper?**

Some permanent magnets have a bar called a “keeper” connecting their poles. Why is the keeper important?

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Ans: 23

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