

YuMi Deadly Maths

Year 9 Teacher Resource:
MG – Total body surface area
(surface area of prisms)

Prepared by the YuMi Deadly Centre
Faculty of Education, QUT





ACKNOWLEDGEMENT

We acknowledge the traditional owners and custodians of the lands in which the mathematics ideas for this resource were developed, refined and presented in professional development sessions.

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Year 9 Measurement and Geometry

Total body surface area (surface area of prisms)

Learning goal	Students will determine the surface area of the human body by approximating the body to a collection of right prisms.
Content description	Measurement and Geometry – Using units of measurement <ul style="list-style-type: none">Calculate the surface area and volume of cylinders and solve related problems (ACMMG217)Solve problems involving the surface area and volume of right prisms (ACMMG218)
Big idea	Measurement – surface area of a three-dimensional shape; approximation
Resources	Sheets of paper (newspaper)

Reality

Local knowledge and Prior experience *Has anyone been involved in a fire or had relatives or friends involved in a fire? House fires? Bush fires? (Be cautious with this reality if you are aware of students' possibly traumatic involvement in fire-related incidents.)*

Discuss the meaning of the term **third-degree burns**. We often think of it as the worst kind of burn, but what does it actually mean?

The severity of a burn is related to:

- the depth of the burn into the layers of the skin; and
- the percentage of the body surface area that is burnt.

See **Appendix A** for details on this.

Discuss how to stay safe in a bush fire and how to stay safe in a house fire. For details and web links see **Appendix B**.

Abstraction

Body/Hand

What is the total surface area of the body (TBSA)?

If appropriate ask students to estimate the surface area of their body. *Is it 1 metre squared? 2 metres squared?* Hold up a piece of newspaper that is 1 metre square in area.

Students work in small groups to approximately determine the area of the body.

- Groups brainstorm ways to do this.
- Be open to inventive ways to carry this out, however in Year 9 maths we are using this activity as a lesson in surface area. Students will have studied the volume of cylinders and other prisms, so you can direct student thinking to this approach if they need prompting.
- One approach is to approximate each section of the body as a prism, find the dimensions of each prism and then calculate the surface area of each prism.
- Discuss the strengths and limitations of this model. Strengths: we are taking values off a real body and just need to decide if our value will be an overestimation or an underestimation. Limitations: the body parts are not prisms.
- Choose one member of the group to be “the body”. The other students form cylinders or prisms by wrapping a paper around each section of the person’s body. They measure and record the body part, shape name and dimensions for each shape. Prompt students to use an organised method for collecting data. For example, they can use a table like the one below:

Body Part	Shape	Dimensions	Surface Area	% of Total Body Surface Area
Torso: shoulders to top of legs	rectangular prism	W = L = H =		
Head	Cylinder (or sphere)			

Mathematics

Language/symbols area, surface area, centimetres, metres, millimetres, length, width, height, depth, cylinder, rectangular prism, prism

Practice Calculate Total Body Surface Area (TBSA)

- Use the data collected in the table to calculate the surface area of each body element and the total body surface area. Choose appropriate formulas and take care with units. Decide whether to measure in cm or metres.
- Compare different groups' data by collating either on a whiteboard or in a spreadsheet. Discuss reasons for the variation.
- Research the value on the internet. Calculate a class average TBSA from the groups' data and compare this to the researched value. Take care with any conversion between square cm and square metres, because the internet value may be in square metres. *Is our value an over-estimation or under-estimation? Is this what we anticipated?*
- Calculate each body section as a percentage of the TBSA and compare this to the values on the **Lund and Browder chart** (Appendix A).
- Calculate the area of the palm of each person's hand and see how close it is to 1% of the class's average TBSA.

Connections Connect to number, geometry, shape, units (length and area, cm, cm², metres, m²), unit conversion.

Reflection

Validation Students compare their values to other groups and to a researched value.

What other objects have a surface area close to ours?

Extension Find the surface area of a child, a student in primary school.

Investigate the body surface area calculator: http://stats.areppim.com/calc/calc_bsa.php

Teacher's notes

- Suggestions in Local Knowledge are only a guide. It is very important that examples in Reality are taken from the local environment that have significance to the local culture and come from the students' experience of their local environment.
- Students need to be taught the skill of visualising: closing their eyes and seeing pictures in their minds, making mental images; e.g. show a picture of an object, students look at it, remove the picture, students then close their eyes and see the picture in their mind; then make a mental picture of a different object.
- Useful websites for Aboriginal and Torres Strait Islander perspectives and resources: www.rrr.edu.au; <https://www.qcaa.qld.edu.au/3035.html>
- Explicit teaching that aligns with students' understanding is part of every section of the RAMR cycle and has particular emphasis in the Mathematics section. The RAMR cycle is not always linear but may necessitate revisiting the previous stage/s at any given point.
- Reflection on the concept may happen at any stage of the RAMR cycle to reinforce the concept being taught. Validation, Application, and the last two parts of Extension should not be undertaken until students have mastered the mathematical concept as students need the foundation in order to be able to validate, apply, generalise and change parameters.

Appendices

Appendix A: Categories of burns

Burns are classified by a number of factors, predominantly:

- the depth of the burn into the skin – called the degree of the burn; and
- the percentage of total body surface area (TBSA) affected by a partial or full burn.

The degree of the burn relates to how far through the layers of the skin the damage has gone. The layers of the skin are called *epidermis* (above the dermis) and *dermis*. Below the dermis are the underlying fat and muscle (subcutaneous layer or *hypodermis*). See Table 1 and Figure 1.

Seventy percent of burns involve less than 10% of the TBSA. There are a number of methods to determine the TBSA. One is the Lund and Browder chart (see Figure 2). It gives an approximate figure for the percentage surface area for each area of the adult body. For infants, the percentages differ because the size of an infant's head is larger relative to the rest of their body. In the Lund and Browder chart in Figure 2, the size of a person's handprint is generally considered to be 1% of TBSA.

In the American Burn Association severity classification (see Table 2), the severity of the burn is related to both of these factors, as well as the part of the body that is burnt and the cause of the burn.

Table 1: Description of the degree of burns (Downloaded from: <https://en.wikipedia.org/wiki/Burn>)

Type ^[1]	Layers involved	Prognosis
Superficial (1st-degree)	Epidermis ^[7]	Heals well. ^[1] Repeated sunburns increase the risk of skin cancer later in life. ^[19]
Superficial partial thickness (2nd-degree)	Extends into superficial (papillary) dermis ^[1]	Local infection (cellulitis) but no scarring typically ^[13]
Deep partial thickness (2nd-degree)	Extends into deep (reticular) dermis ^[1]	Scarring, contractures (may require excision and skin grafting) ^[13]
Full thickness (3rd-degree)	Extends through entire dermis ^[1]	Scarring, contractures, amputation (early excision recommended) ^[13]
4th-degree	Extends through entire skin, and into underlying fat, muscle and bone ^[1]	Amputation, significant functional impairment, and, in some cases, death. ^[1]

Table 2: American Burn Association severity classification (Downloaded from: <https://en.wikipedia.org/wiki/Burn>)

Minor	Moderate	Major
Adult <10% TBSA	Adult 10–20% TBSA	Adult >20% TBSA
Young or old <5% TBSA	Young or old 5–10% TBSA	Young or old >10% TBSA
<2% full thickness burn	2–5% full thickness burn	>5% full thickness burn
	High voltage injury	High voltage burn
	Possible inhalation injury	Known inhalation injury
	Circumferential burn	Significant burn to face, joints, hands or feet
	Other health problems	Associated injuries

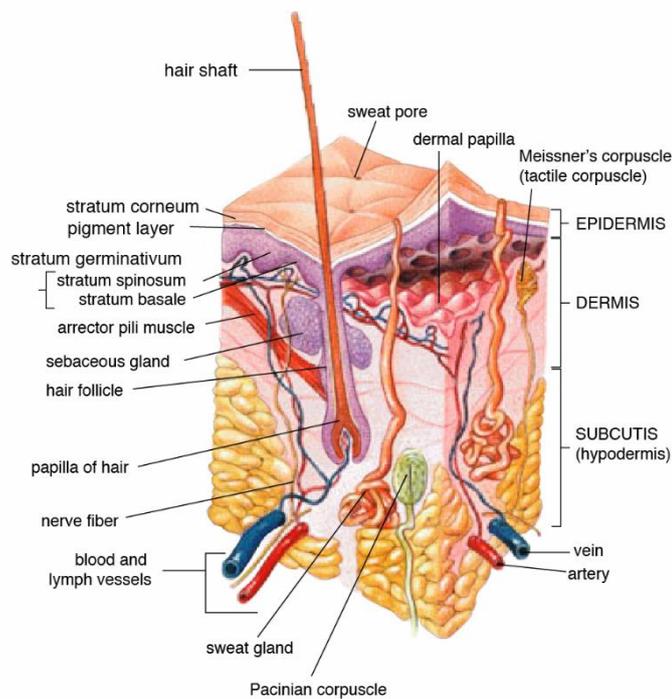
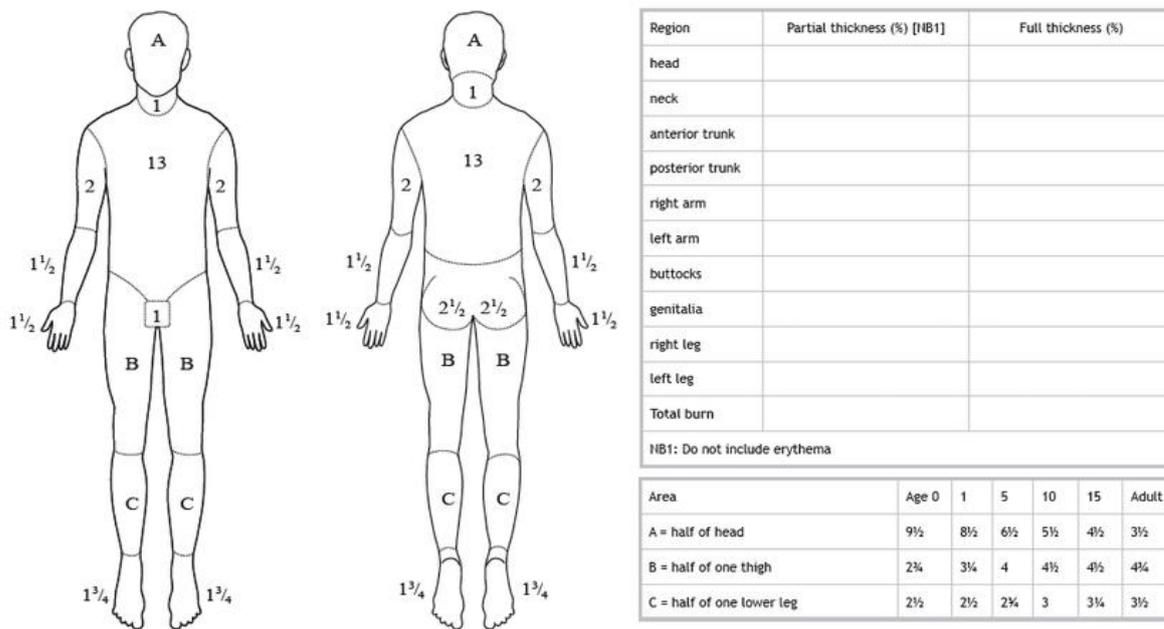


Figure 1: The layers of the skin

Downloaded from: <https://upload.wikimedia.org/wikipedia/commons/2/27/Skin.png>



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Figure 2: The Lund and Browder chart

Downloaded from:

https://www.researchgate.net/figure/306034027_fig2_Figure-2-The-Lund-and-Browder-Chart-for-calculation-of-TBSA-Permission-to-reproduce

Appendix B: How to keep safe during a fire

How to keep safe in a bushfire in a car

<http://www.cfa.vic.gov.au/plan-prepare/staying-safe-in-the-car/>

Staying safe in the car. Driving during a bushfire is extremely dangerous and can result in serious injury or death; always plan to leave early to avoid this situation.

How to protect yourself:

Take the following actions if you encounter smoke or flames and are not able to turn around and drive to safety.

- Position the car to minimise exposure to radiant heat.
- Park away from dense bush – try to find a clearing.
- If possible, park behind a barrier such as a wall or rocky outcrop.
- The car should ideally face towards the oncoming fire front.
- Park off the roadway and turn hazard lights on. Car crashes are common in bushfires due to poor visibility
- To increase your chances of survival:
 - Stay in the car, and tightly close windows and doors.
 - Cover up with woollen blankets and get down below window level – this is your highest priority.
 - Drink water to prevent dehydration.
- As soon as you become aware that the fire front is close by:
 - Shut all vents and turn the air conditioning off.
 - Turn the engine off.

Be prepared: if you drive in bushfire-prone areas, keep woollen blankets in your car. This is an essential precaution during the warmer months.

How to keep safe during a house fire

<https://www.wikihow.com/Keep-Safe-During-a-House-Fire>

1. React as soon as you hear your smoke alarm go off. If you hear your smoke detector or alarm going off and see fire, try to exit your home as safely as possible. Do *not* try to grab your phone, valuables, or your other important possessions. Your only concern is to get out of there as fast as possible. Nothing else is as important as this. You should be getting yourself and your family members out safely. If it's night time, yell loudly to get everyone up.
2. Safely exit through doors. If you see smoke under a door, then you cannot go out that door, because smoke is toxic and fire is sure to follow. If you don't see smoke, put *the back of your hand* up to the door to make sure it doesn't feel hot. If the door feels cool, then open it slowly and pass through it. If your door is open and there is a fire preventing you from exiting the room, close the door to protect yourself from the fire.
3. Protect yourself from smoke inhalation. Get low to the floor and crouch or crawl on your hands and knees to evade the smoke. Though you may think that running is faster, encourage your family members to crouch or crawl, too. Smoke inhalation causes people to become disoriented and can even render a person unconscious. Knowing this, you should cover your nose and mouth if you have to walk by or through a heavily smoke-filled room.
4. Stop, drop, and roll if your clothes catch fire. If your clothes catch fire, immediately stop what you're doing, drop flat to the ground, and roll around until you put the fire out. Rolling around will smother the fire quickly. Cover your face with your hands as you're rolling to protect yourself.
5. Ward off the smoke if you can't get out. If you can't escape your home and are waiting for help, don't panic. You may not be able to get out, but you can still take some measures to ward off the smoke and stay safe. Close your door and cover all vents and cracks around it with cloth or tape to keep the smoke out for as long as you can. Whatever you do, don't panic.