APPLIED SCIENCE

USING MATHS IN FORENSIC SCIENCE

SUMMER PROJECTS
YEAR 11 STUDENTS

WHAT HAPPENS TO A BODY AFTER DEATH?

HEART OF
WORCESTERSHIRE
COLLEGE

KICK START YOUR STUDY AT HOW COLLEGE WITH ONE OF OUR CURRICULUM BRIDGING PROJECTS

Background

In applied science and forensics numeracy skills are essential to analyse data and form valid conclusions. In this task you will be investigating what happens to the body after death to determine the time of death from a range of evidence including Identification of insects at various stages of their life cycle, such as eggs, larva, and adults, and body temperature. You will develop and demonstrate numeracy skills that require calculation from cooling rates and creating line graphs and extract data from graphs.

What you should hand-in: You will need to read over the information and complete the tasks in The L3 Forensics Maths Booklet- What happens to a body after death

Resources: The L3 Forensics Maths Booklet- What happens to a body after death

Objective:

Understand what happens to a body after death.

Outcomes:

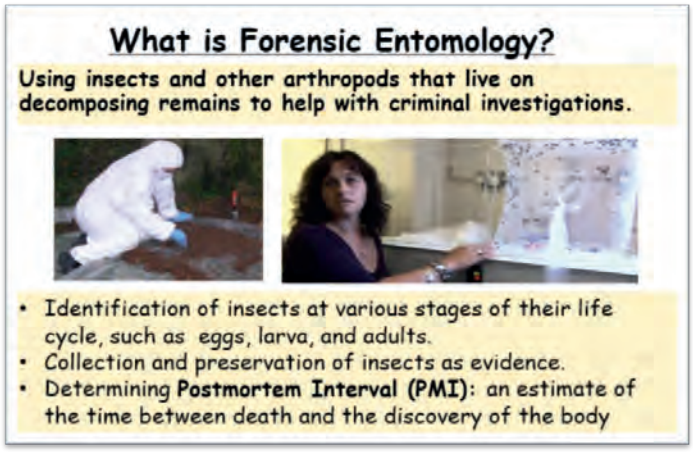
MUST:
State what happens to a body after death (Pass).

SHOULD:
Explain what happens to a body after death (Merit).

COULD:
Estimate time of death using data (distinction).

What happens to a body after death

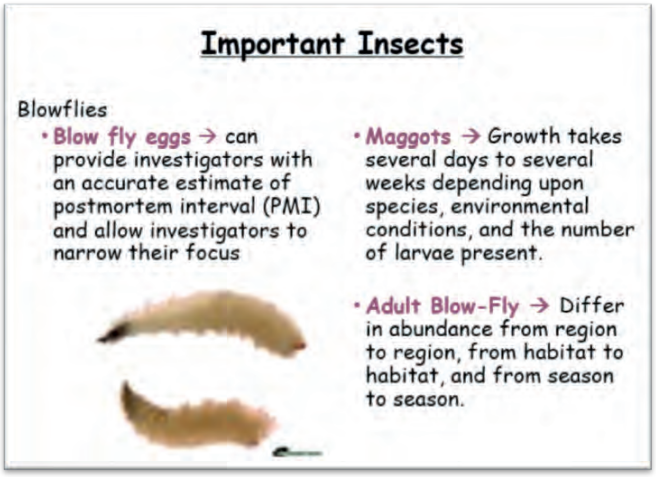
- Body breaks down (body decays)
- Insects are attracted to the body and live on the body (forensics entomology)
- The body stiffens- Rigor Mortis
- Heart stops pumping blood around the body and then Livor Mortis takes place
- The body's temperature drops- Algor Mortis
- Digestion stops (can analyse stomach and intestinal contents)

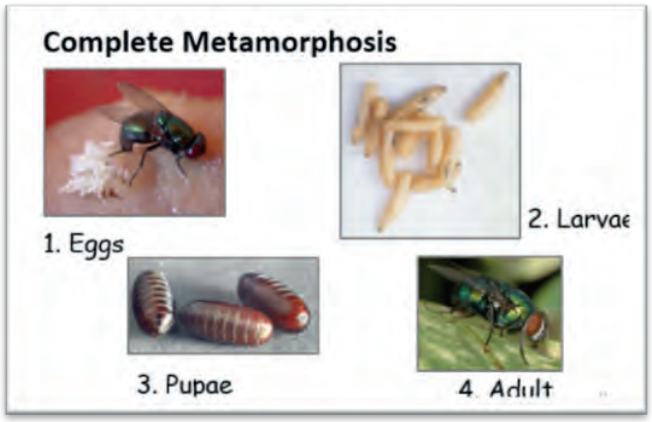


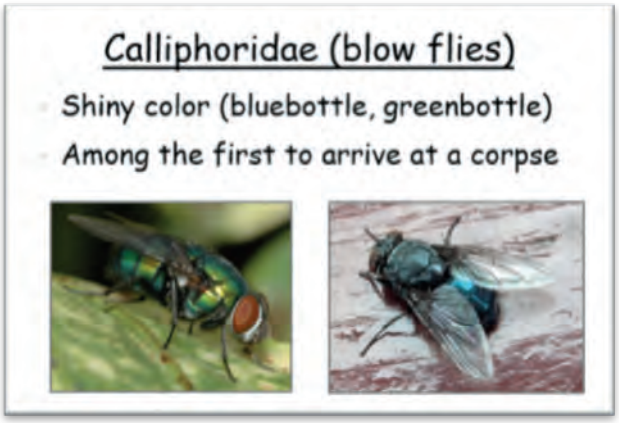
Want a career in Forensic Entomology?

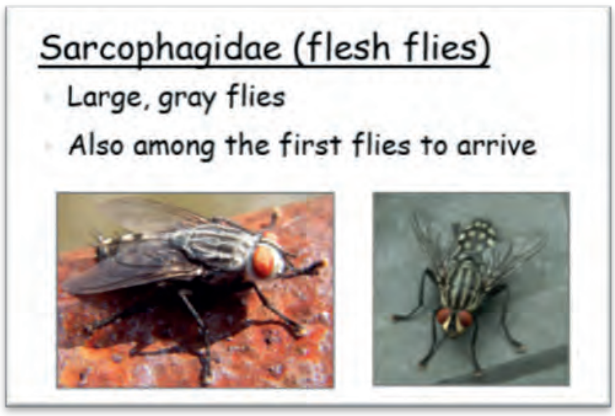
www.inputyouth.co.uk/jobguides/job-entomologist.html

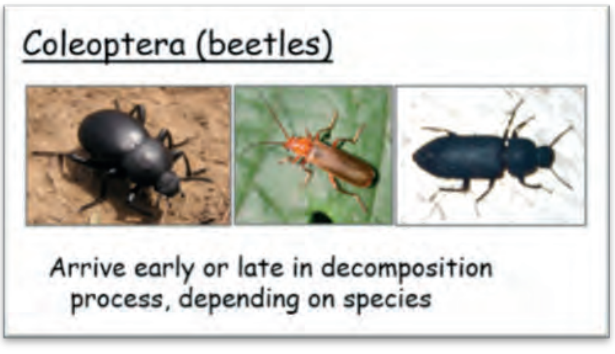
- Insects are a class of Arthropods that have three segments to their body, one pair of antennae, three pairs of legs, compound eyes and breathe air via small holes or spiracles along the side of their body.
- Most arthropods are insects BUT there are also bugs that are NOT insects such as spiders (Arachnida), woodlice (Crustacea) and millipedes & centipedes (Diplopoda & Chilopoda - sometimes collectively known as Myriapoda).











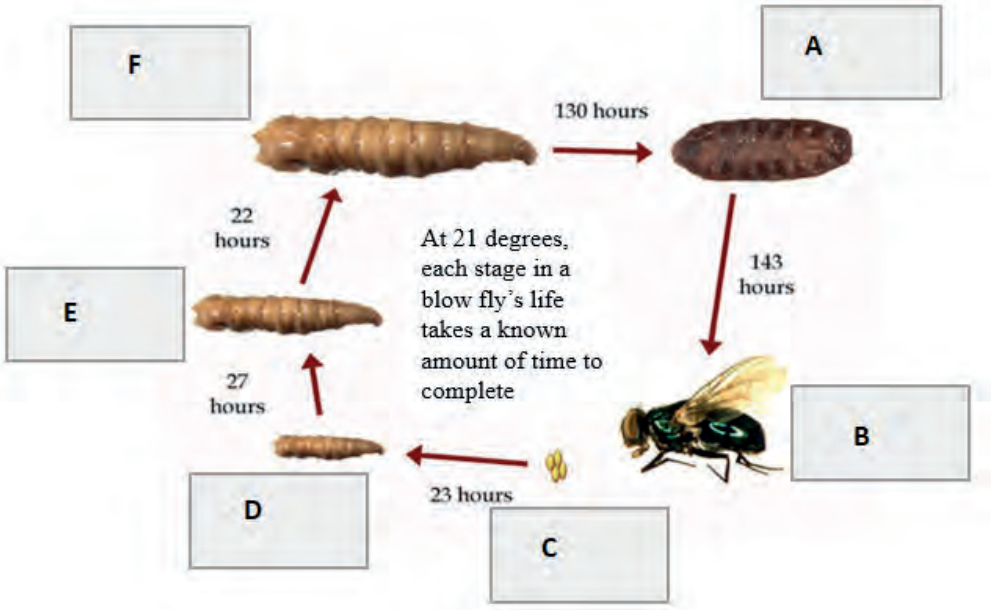
Since eggs are rarely deposited on a corpse before death...

The age of immature insect specimens is the absolute minimum amount of time a person has been dead.

For example, a three-day-old maggot on a corpse would indicate the body has been dead for at least three days.

Section 1: Evidence from entomology

1. Name the stages in the blowfly life cycle by completing the labels below:



Example of Forensic entomology being used

- Shafilea Ahmed was a 17 year old British Pakistani girl from Warrington. She disappeared on 11th September 2003. She had been absent from school for a week so the school informed the police.
- Prior to her disappearance, Shafilea had visited Pakistan and turned down an arranged marriage proposal. To avoid the arranged marriage, Shafilea tried to kill herself by drinking a bottle bleach. This incidence left her throat badly scarred but she lived.
- Her parents claimed that she had run away with a boyfriend shortly after the arranged marriage fell through. Her body was found on February 2004. Entomologist Amoret Whitaker found insects on Shafilea's body which proved that the girl had died as soon as she had disappeared, disproving her parent's suggestion that she had run off.
- Shafilea's younger sister confessed to police that their parents had murdered Shafilea after she would not accept the arranged marriage and they felt her refusal would bring shame to the family

Five stages of body decay

1. Initial Decay

- Days after death: 0-3 days
- Insects: blowflies

External appearance shows only small changes

2. Putrefaction

- Days after death: 4-7 days
- Insects: Fly larvae and beetles which feed on them

Bacteria cause the skin to gain a greenish tint which spreads outwards from the abdomen; veins near the surface become more visible; gases produced by microorganisms cause the body to swell and smell

3. Black Putrefaction

- Days after death: 8-18 days
- Insects: Ants, cockroaches and beetles

Flesh discolours and may be blue, green, purple, brown or black. Swelling collapses and gases escape. Tissues become fluid, smell increases, intestines decay first followed by liver, lungs, brain and the kidneys; stomach decay may be delayed if it is full of acid

4. Butyric Putrefaction

- Days after death: 19-30 days
- Insects: A mixture of species attracted to the different wet and dry parts- Mainly beetles

Fluids escape and the body dries out; usually covered by mould. Odour changes and becomes less vile

5. Dry decay

- Days after death: 31+ days
- Insects: Beetles and Clothes moth larvae (feed on hair)

Tissues dry out and rot away until only bones, teeth and hair remain

2. Complete the table below on how a dead body decays over time.

Days after death	Stage	Description of dead body	Insects found on corpse
0-3			
4-7			
8-18			
19-30			
31+			

3. Read through the case study below and then answer the questions

Case study

Alton Coleman was a brutal criminal who went on a savage crime spree in 1984. When captured, he was wanted for eight murders, seven rapes and fourteen armed robberies.

A nine year old female called Vernita had been reported missing for a month when her body was found in a derelict building. The flesh of the body was a purple colour, the body tissues had started to become fluid and the smell from the rotting corpse was very strong. The insects found on the body were ants, cockroaches and beetles as well as blue bottle eggs.

Alton Coleman had witnesses who saw him talking to Vernita on the afternoon she disappeared, hence he was suspected of murdering her. The FBI sent the insects and eggs found with the corpse to forensic entomologist Bernard Greenberg. They wanted him to deduce how long Vernita had been dead for.

Greenberg carefully incubated the pupae he had been sent. 16 days later the eggs hatched into maggots. Greenberg knew that at a constant 15˚C, the eggs can take 33 days to hatch once they've been laid on a dead body.

Use the information above to decide how many days Vernita had been dead for when her body was found in the derelict building.

Number of days that Vernita had been dead for: _____

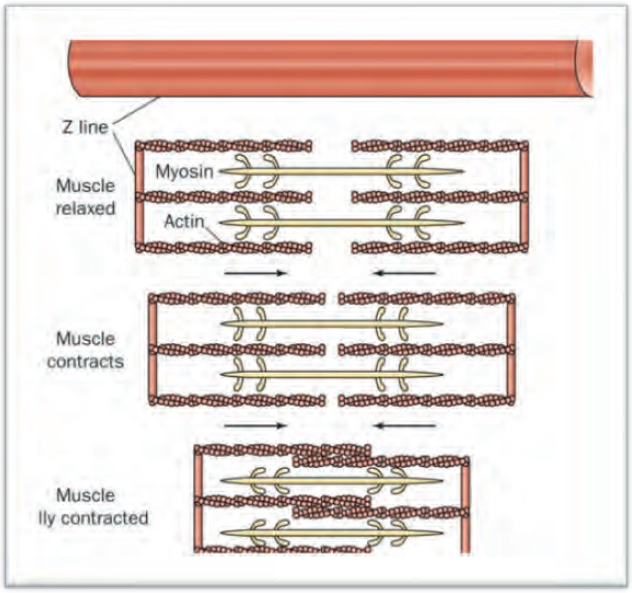
State two pieces of information that support your answer above:

Information 1:

Information 2:

Rigor Mortis

Muscle Fibres and Contraction



- Rigor Mortis is the stiffening of the body after death because of a loss of Adenosine Triphosphate (ATP) from the body's muscles.
- ATP is the substance that allows energy to flow to the muscles and help them work and without this the muscles become stiff and inflexible.
- Rigor Mortis begins throughout the body at the same time but the body's smaller muscles - such as those in the face, neck, arms and shoulders - are affected first and then the subsequent muscles throughout the rest of the body; those which are larger in size, are affected later.
- Rigor normally appears within the body around two hours after the deceased has passed away
- Once the contracting of all the body's muscles has taken place this state of Rigor - technically referred to as the Rigid Stage - normally lasts anything from eight to twelve hours after which time the body is completely stiff.
- Rigor Mortis actually does reverse and the body returns to a flaccid state- the muscles losing their tightness

Section 2: Rigor Mortis

Rigor Mortis Reference Table

Time after death	Event	Appearance	Circumstances
2- 6 hours	Rigor begins	Body becomes stiff and stiffness moves down body	Stiffness begins with the eyelids and jaw muscles after about three hours, then center of body stiffens, then arms and legs
12 hours	Rigor complete	Peak rigor is exhibited	Entire body is rigid
15-36 hours	Slow loss of rigor	Loss of rigor in small muscle first followed by larger muscles.	Rigor lost first in head and neck and lastly in bigger leg muscles
36-48 hours	Rigor totally disappears	Muscle become flaccid	Many variables may extend some extend of rigor beyond the normal 36 hours
Factors Affecting Rigor	**Event**	**Effect**	**Circumstances**
Temperature	Cold temperature	Inhibits rigor	Slower onset and slower progression of rigor
	Warm temperature	Accelerates rigor	Faster onset and faster progression of rigor
Activity before death	Aerobic exercise	Accelerates rigor	Lack of oxygen to muscle accelerates rigor
	Sleep	Slows rigor	Muscles fully oxygenated will exhibit rigor more slowly
Body weight	Obesity	Slows rigor	Fat stores oxygen
	Thin	Accelerates rigor	Body loses oxygen quickly

Factors affecting rate of rigor mortis

Clothing or Lack of Clothing

- Clothes- accelerates rigor
- No Clothes- slows rigor

Sun Exposure

- Accelerates rigor

During death

- If person was struggling/being attacked- accelerates rigor
- If person died in their sleep- slows rigor

Use the Rigor Mortis reference table above to estimate how long ago death happened for the following situations:

1. A body found with rigor exhibited throughout the whole body

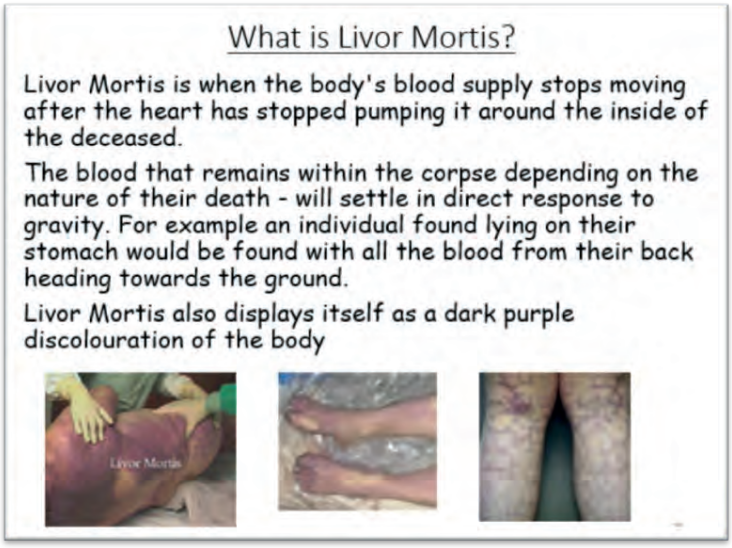
2. A body found with rigor present in the legs but not the upper torso.

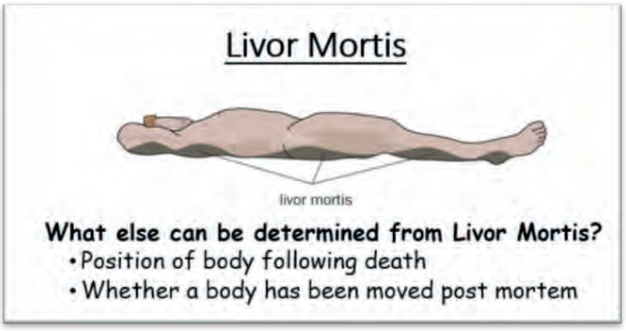
3. A frail, elderly woman's body was found in her apartment on a hot summer's evening. Her body exhibited advanced rigor in all places except her face and neck

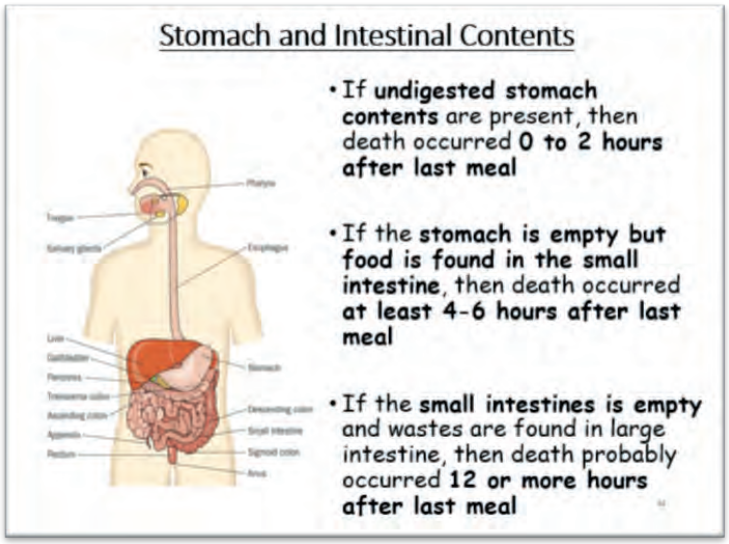
Explain these observations:

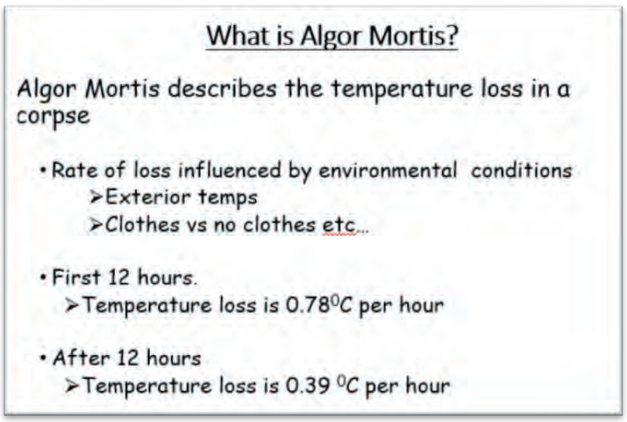
4. A body was discovered in the woods. The man had been missing for two days. The average temperature was 10 degrees Celsius. When the body was discovered, it was discovered at peak rigor. Explain why the body was at peak rigor.

5. A group of people witnessed a person that was jogging have a heart attack in a park on a hot summer's day. This person died straight away. Six hours later the body was examined by a coroner and they observed that the body was at peak rigor. Explain why the body was at peak rigor.









CALCULATING TIME OF DEATH USING ALGOR MORTIS

- For the first 12 hours, the body loses 0.78oC per hour.
- After the first 12 hours, the body loses 0.39oC per hour.
- Normal body temperature is 37oC.

6. What is the temperature loss for someone who has been dead for 12 hours?

7. Calculate the time of death if a person has been dead for less than 12 hours and the temperature of the body was determined to be 32.2oC

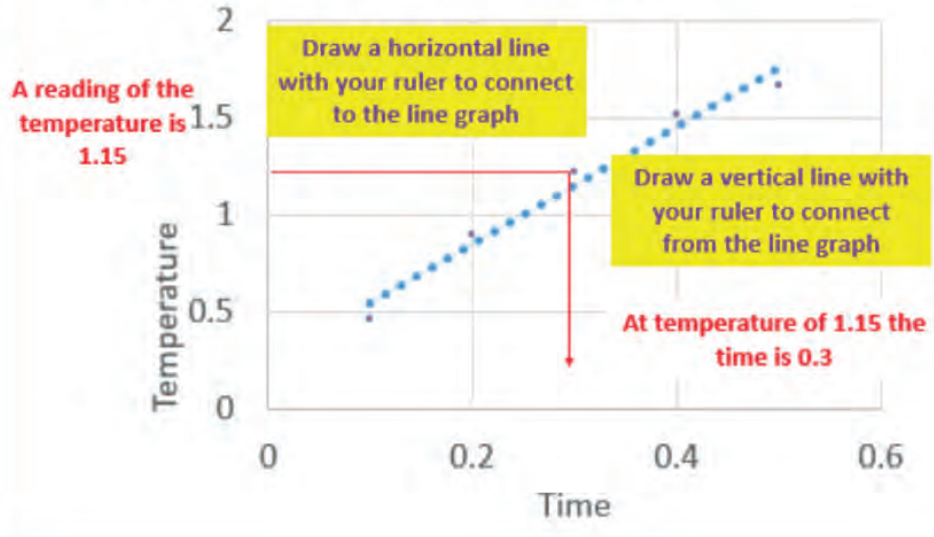
8. Calculate the time of death if a person has been dead for more than 12 hours and the body temperature was determined to be 22.2oC.

How to create a graph with excel

1. **Enter your data.** A line graph requires two axes in order to function. Enter your data into two columns. For ease of use, set your X-axis data (time) in the left column and your recorded observations in the right column.
2. **Select your data.** Click and drag your mouse from the top-left cell in the data group to the bottom-right cell in the data group. This will highlight all of your data. Make sure you include column headers if you have them.
3. **Click the Insert tab.** It's on the left side of the green ribbon that's at the top of the Excel window. This will open the **Insert** toolbar below the green ribbon.
4. **Click the "Line Graph" icon.** It's the box with several lines drawn on it in the **Charts** group of options. A drop-down menu will appear.
5. **Select a graph style.** Hover your mouse cursor over a line graph template in the drop-down menu to see what it will look like with your data.
6. Change the graph title by clicking on the title of the graph. You can also add in axes titles

https://www.wikihow.com/Make-a-Line-Graph-in-Microsoft-Excel

How to extract data from a graph



Section 3: Using graphs to estimate the time of death

1. Using excel, plot the following body temperature measurements taken at 30 minute intervals on a murder victim. Using your graph, estimate the time of death (normal body temperature 37 oC). Assume a fairly even rate of temperature drop.

Time	Temperature (°C)
7.00 am	32.5
7.30 am	31.8
8.00 am	31.2
8.30 am	30.5
9.00 am	29.9
9.30 am	29.3

Estimated time of death:_____

2. A forensic biologist takes temperature measurements on a body every 30 minutes to help determine the time of death. Using the data in the table below, estimate the time of death.

Time	Temperature (°C)
1.00 pm	29.7
1.30 pm	29.2
2.00 pm	28.6
2.30 pm	28.1
3.00 pm	27.7

Estimated time of death:_____

3. What adjustments to the estimated time of death would need to be made under the following circumstances? In each case explain your answer.

a) The body is found unclothed in autumn by the river.

b) The body is found lightly clothed next to an electric heater which is still operating

4. (a) If a person died at 2.00am and his body temperature dropped by 0.78 degrees per hour, what would the body temperature be by 9.30am.

(b) Is it likely that the rate of heat loss would get faster or slower as time goes by? Explain your answer.

5. Why is it so important to get an accurate estimate of the time of death when someone has died under suspicious circumstances?

6. Soon after death, blowfly eggs can be found in the moist parts of a corpse.

Time after death (hours	**Number of blowfly eggs**
0	0
1	5
2	15
3	40
4	110
5	300
6	800

a) Display the data above by plotting a graph.

b) Describe the trend in the graph you have plotted.

c) Estimate the rate of eggs being laid by taking tangents at three different points on the curve.

Copy and paste graphs here:

Plenary

Objective: Understand what happens to a body after death

Outcomes	I'm confident	I'm nearly there	I'm not sure
MUST: State what happens to a body after death (Pass)			
SHOULD: Explain what happens to a body after death (Merit)			
COULD: Estimate time of death using data (Distinction)			

Indicative time for this project:

Up to 3 hours.

Instructions on how to submit this:

Please submit all work to:

Neil Tabram
Curriculum, Resource & Quality (CRQ) Leader – Hospitality and Applied Science

e. science@howcollege.ac.uk
t. 01905 743515

How will I benefit from this project:

The project will help you understand what to expect when you come to College and also give you a head start in working on topics and content that will be relevant when you begin your journey with us.

What can I expect to get back after I submit my project work:

The receipt of your work will be acknowledged and a member of the team will give you some feedback.

Key information you should include:

Your name

Your email address

A contact telephone number