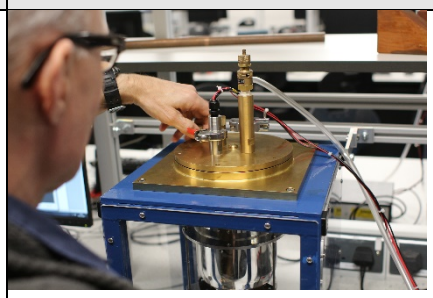
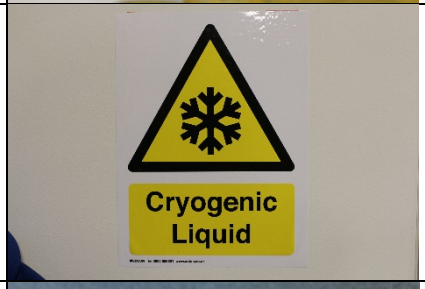
EXAMPLE STORYBOARD

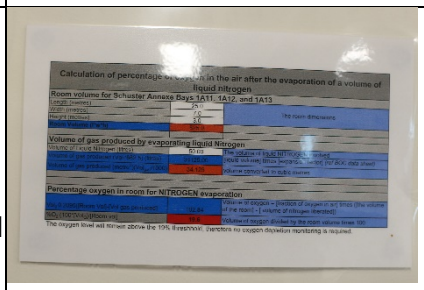
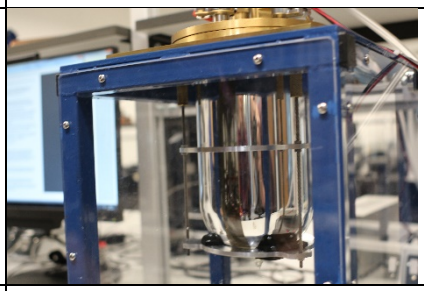
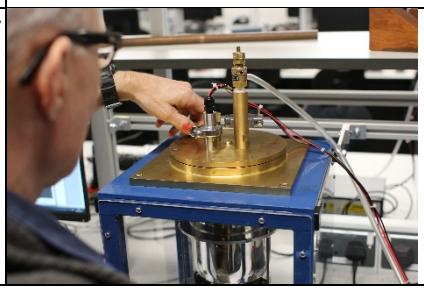
Project Name	The Latent Heat Experiment
Department	

Primary Contact:

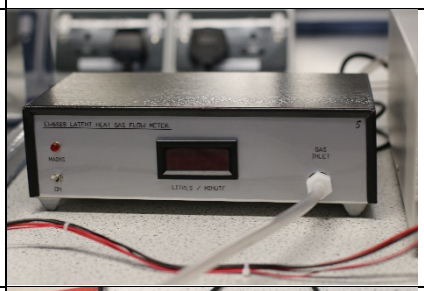
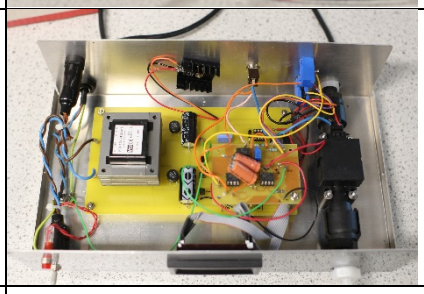
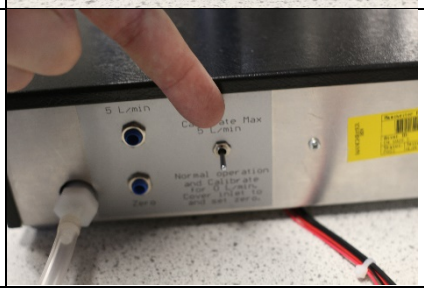
Name	
Email	

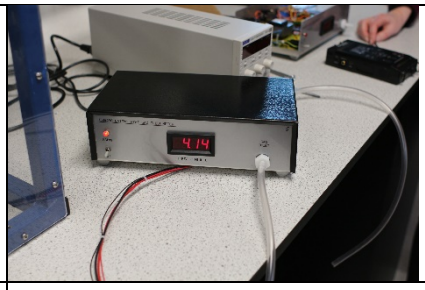
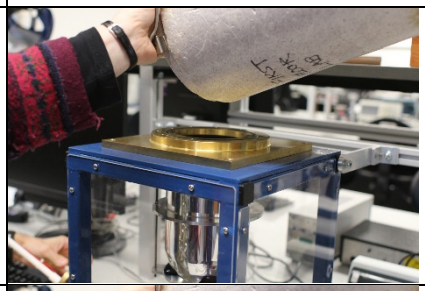
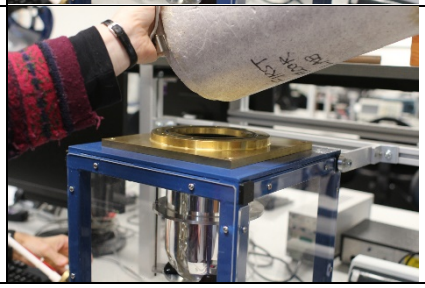
	Script		Notes
1.	This experiment is to determine the latent heat of liquid nitrogen by measuring the rate at which the liquid nitrogen is boiled off.		Use a warm object dropped in rather than the heating element to create boiling conditions.
2.	Since you'll be handling liquid nitrogen you'll need to be aware of its		Shot of the pour,
3.	properties and characteristics in order to be able to handle it safely.		Close up of pour

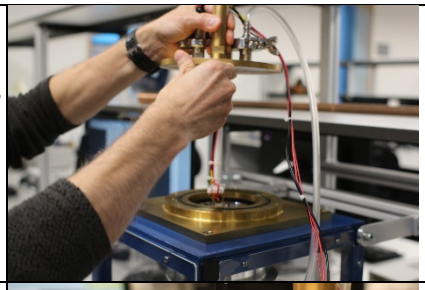
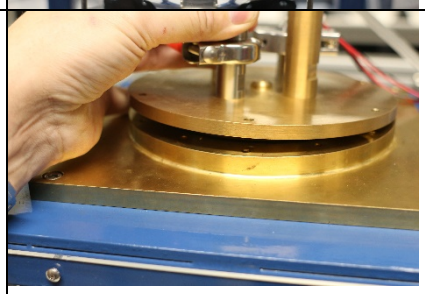
4.	Although the quantities of LN used in this experiment are small, the health and safety procedures are important and use of PPE is mandatory.		Wide shot of pour
5.	You will apply these handling procedures whenever you work with LN, regardless of quantity.		Shot of putting PPE in front of camera.
6.	There are four risks to be aware of when handling LN for this experiment. These are detailed in the risk assessment for this experiment.		Add shot of risk assessment document.
7.	Firstly, direct sustained contact with LN will produce cold burns. As quantity and exposure time increases the cold burns increase in severity.		
8.	Avoid wearing clothes than can trap and hold the LN – such as loose weave garments, open pockets or open shoes – anywhere where the LN might collect near to your skin.		Manikin foot, crocs
9.	Secondly, any material in contact with LN (particularly metals which have high thermal conductivity) will cool rapidly and can also cause cold burns.	Tracking macro shot of the lid and probe with frost on.	
10.	In this experiment the brass top of the Dewar and the aluminium heating element pose a cold burn risk.	Tracking shot of dewar lid	
11.	Thirdly, if the LN storage	Shot of air turning green?	

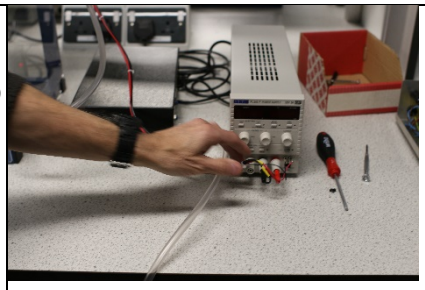
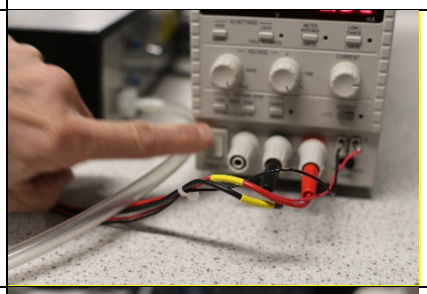
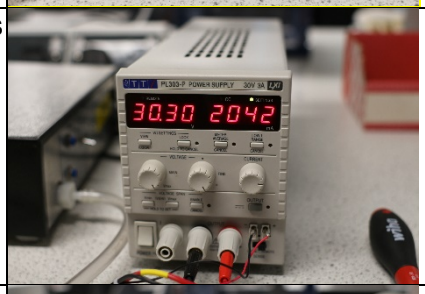
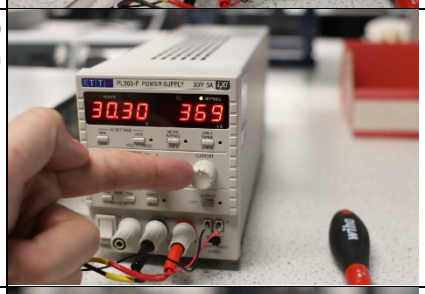
	vessels were to fail catastrophically, the LN would liquid boil off rapidly. This would reduce the oxygen level in the atmosphere which may lead to asphyxiation.		
12.	There is a standard formula to calculate the potential drop in O2 levels – the calculation and results are displayed on a data sheet on the wall in any area where LN is stored.		Slider shot, Show formula.
13.	If the calculation shows that there is a risk to health, additional measures such as air monitoring systems or personal monitors should be in place. For this experiment no monitoring equipment is required.	Shot of O2 alarm, shot of personal monitor.	
14.	Fourthly, there is the possibility of gas expansion causing explosions of the dewars used in this experiment.		
15.	The dewars are glass vacuum vessels. If the inner face of the dewar is damaged, the vacuum will be lost. LN can the seep into the interspace and will expand rapidly as it warms (1 litre of LN at -180 degrees C = 682 litres of nitrogen gas at 20 degrees C).	Animated line diagram – front then cross section, Gas fills the interspace and expands.	
16.	The rapid expansion of nitrogen gas in the interspace can cause the glass dewar to explode.	Animation of explode – animated 2d cross section line diagram.	Animated diagram
17.	When lowering the heater assembly into the dewar be careful not to bang the sides of the dewar.		

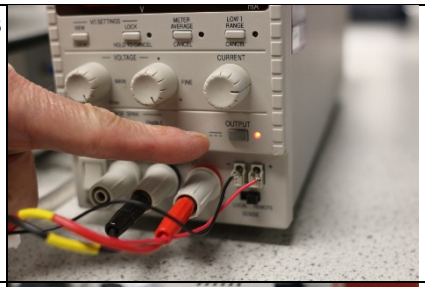
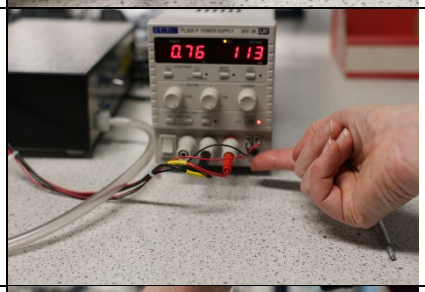
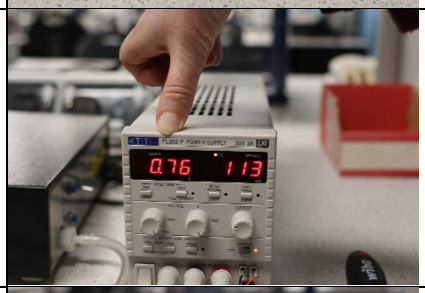
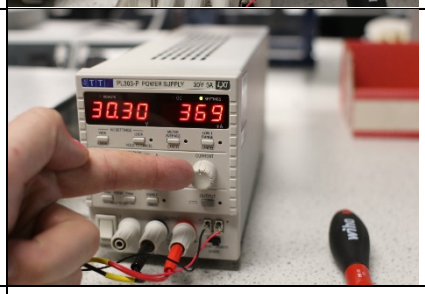
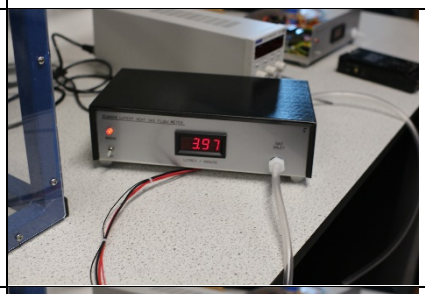
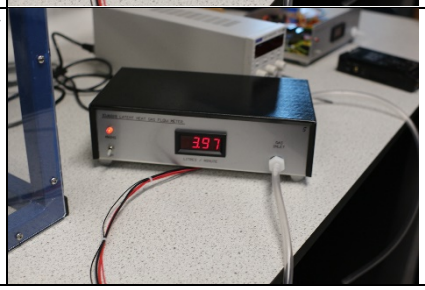
18.	The dewar is held in a protective cage to reduce the risk of external damage and to contain glass fragments should an explosion occur.		
19.	During the experiment you will handle liquid nitrogen, so the correct Personal Protective Equipment (PPE) must be worn.		Shot of a person walking to the lab coats – putting one on.
20.	This includes a visor to protect the face and eyes from LN splashes.		
21.	Gloves or mitts to project your hands from contact with cold surfaces.		
22.	A lab coat to protect against splashes. The lab coat is pocketless to prevent any spills being held in pockets.		Shot of putting on lab coat
23.	And closed shoes - preferably with a sewn in tongue.		Shot of tying laces

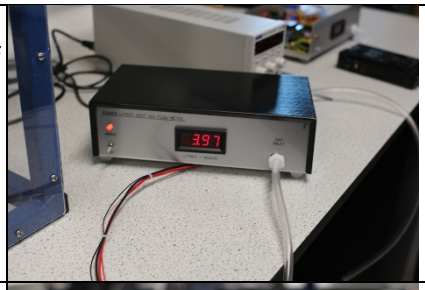
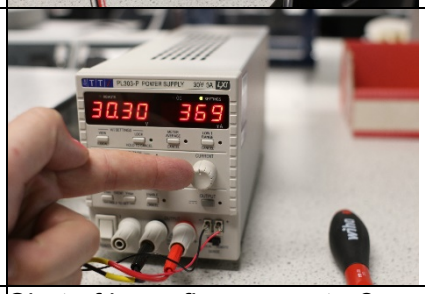
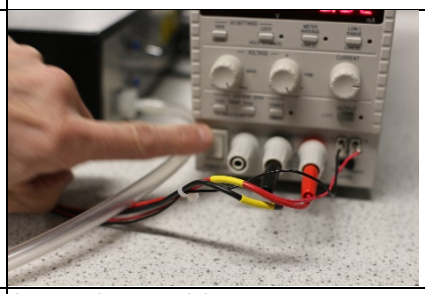
24.	If boots are worn, trousers should be worn over the outside of the boots to prevent spills from running inside.		Boots
25.	Section transition		'Experimental procedure'
26.	Before filling the dewar, the gas flow meter needs to be calibrated.		This is the start of a new section of the report, so needs a pause or a shot of some wording to this effect, e.g. Calibrating the Gas Flow Meter
27.	The gas flow meter uses a transducer to measure the flow rate of boiled off nitrogen coming out of the dewar.		
28.	First prevent any flow of air by blocking the sensor off using your thumb or something to seal the tube such as blue tack.		Macro Shot of thumb over hose.
29.	Switch the flow meter to the bottom position (zero) and adjust the bottom potentiometer		
30.	using a small screw driver until the reading is 0.00.		
31.	Move the switch to the top position (which switches in a 5 volt reference chip inside the meter).		

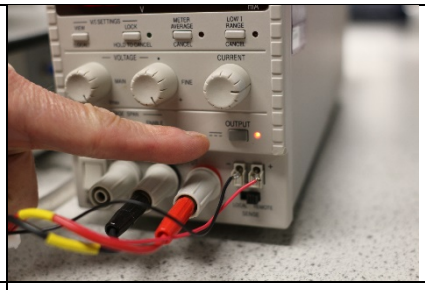
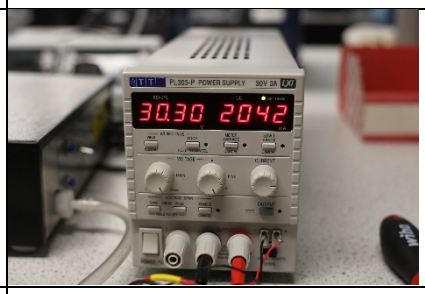
32.	Adjust the top potentiometer until it reads 5.00.		
33.	Once calibrated double check that the output pipe isn't blocked. The flow meter is now calibrated and can be used to make measurements.		Inside of hose end.
34.	After calibration put on the PPE.		Again, a new section so maybe a pause or slide with wording 'Filling the Dewar with Liquid Nitrogen' or some such.
35.	Take the bucket to LN dewar trolley and pour LN into the bucket until it's full.		
36.	Since the bucket is at room temperature there will be some boil off so expect some splashing		Shot of LN in the bucket boiling
37.	Pour the LN into the bench mounted dewar. Again, the dewar will be at room temperature so expect some splashing.		
38.	Wait for any LN boil off to take place.		

39.	Slowly lower the brass lid containing the heating element into the LN. This will cause more boil off, resulting in splashes and possible overflow.		
40.	Expect the brass lid to move around due to the pressure of the nitrogen gas as it boils off.		
41.	Once the temperature has stabilised check the level of the LN through		
42.	the sighting glass and if necessary top up the LN.		
43.	When the boiling off has subsided the lid of the dewar is screwed down with brass screws. Make sure the screw holes are aligned. Connect the flow pipe to the top of the lid.		Shot of screwing up
44.	After the lid has been screwed on, the PPE can be removed. Be careful of touching the equipment with your bare skin since the equipment may get very cold.		Shot of taking off PPE

45.	Now set up the Power Supply Unit (PSU). The PSU will provide power to the resistor submerged in the LN. This transfers heat energy into the LN causing it to boil off in a controlled way.		
46.	Switch the PSU on. (You may see a LAN Err message which will disappear after a few seconds.		
47.	Adjust both voltage knobs to their maximum.		Macro of dial to max
48.	Then adjust the current to your first value – say 100 mA		Show current knob being turned
49.	The constant current LED is illuminated and the display shows the current to be output.		
50.	The PSU is also used to monitor the voltage across the heating element via the remote sensor. The switch should be set to REMOTE		

51.	When the output button is switched on, the output light will be illuminated, to indicate that the PSU is now supplying power to the output load.		
52.	The heating element will heat up and LN will start to boil off.		
53.	With remote sensing switched ON, the voltage display will show the voltage being measured across the resistor.		Show readings stabilising
54.	Each time the current is adjusted the amount of heat coming off the resistor will change, and so the rate at which LN is boiled off will also change.		
55.	Section change		Taking your measurements
56.	The flow meter is heavily damped, to smooth out fluctuations in the gas flow readings, and doesn't respond quickly to changes in the gas flow.		
57.	It takes a few seconds for the reading to stabilise as the system reaches equilibrium.		

58.	When the reading has stabilised, make a note of it, and also the current and voltage readings on the PSU.		
59.	Increase the current in steps up to say 1600 mA, taking readings as you go. Think about how many readings you will need in total.		
60.	If LN is boiled off too quickly, you'll need to refill the dewer – the PPE must be put back on if you do this.	Shot of large flow on meter? Time lapse of Sighting glass running down?/14	
61.	When you have finished taking readings, you should have all the data you need to complete the experiment data analysis.	Graph of data	Graph of data
62.	Before leaving the experiment make sure you leave the equipment in a safe condition.	Wide shot returning to kit after taking off PPE	
63.	Switch off the power supply.		
64.	If there's any LN left in the dewer leave it to boil off through the flow meter	Shot of end of flow tube.	Shot of end of flow tube.
65.	Section change		Pause and text slide 'Some issues to be aware of'
66.	Although the PSU is very straight forward to use, there's a couple of things to bear in mind.	Shot of mode switching	

67.	There is no output to the resistor until this output button is switched to on and the light is illuminated.		
68.	The PSU normally delivers currents between 1 and 3000 mA. However, it also has a Low Current Range mode, which should be OFF for this experiment.		Image/video of this setting being changed
69.	This light indicates that the Low Current Range mode is selected.	Shot of light	
70.	To change the setting you must first turn off the OUTPUT.	Shot of switching output to off	
71.	Deselect the Low Current Range mode and then	Shot of delesecting current range	
72.	switch the OUTPUT back on.	Output to on	
73.	Finally, the PSU retains its settings after being shut down, so switching it off and on again won't reset it to the default.		
74.	For more information about the PSU, see the Quickstart guide and Manufacturer's Manual available on the Blackboard experiment page.		Show the blackboard page with links to manuals etc.
75.	END		