Spooky Scene - Big Fog Effects

This is the one you have to do - it creates a wow factor that students from 6 to 18 will love! Ideal for an assembly.

**Things You Need**

- Polycarbonate Scoop (provided with chilly science pack, or ceramic coffee mug with handle is ideal)
- 10 Litre Plastic Container (with science pack or similar large container)
- Mop and bucket
- Supply of hot water (the temperature of a cup of tea 80°C)

**Time**

5-10 minutes per demonstration

**Safety:** as with all experiments the supervisor will prepare appropriate safety procedures according to School guidelines. In this experiment it is important to ensure that no students put their hands into the bucket. The demonstration will produce CO₂ gas which in large concentrations is an asphyxiant. Good ventilation is a must, so windows and doors should be left open. A calculation on the safe release of CO₂ is provided in the discussion.

**Instructions**

We suggest that you use the demonstrations suggested in the Small Fog Effect section as a useful warm-up. There is plenty of dry ice in the box for practice purposes.

To make a BIG fog effect that will get people talking place a towel on a table top or elevated platform and use the 10 litre plastic container supplied with the Science Pack.

Place 500 grams of dry ice in the bucket, this is approximately two scoop-fulls from the polycarbonate scoop supplied in the Science Kit.

(HINT: bulk density of dry ice pellets is about 1, a small ½ pint ceramic coffee mug with handle makes an ideal dry ice scoop and holds about 250g).

Add 2 litres of boiled water from the kettle that has rested for 3 minutes; if you do not let the water cool down the fog generated will ‘lift off’ like a cloud. This is a BIG effect, and the temptation is to stop pouring! The fog effect will spread over 5 – 10 metres and placing it on an elevated surface hopefully everyone will be able to see the fog flow downwards on to the floor.
Class Discussion

Is this safe?

We know that the fog contains CO₂ gas and tiny water droplets - could this be dangerous? CO₂ gas is heavier than air and therefore displaces air at low levels. In a low level space without ventilation there would be a risk of suffocating (asphyxia) due to depleted oxygen. (please see the fire extinguisher experiment). In a classroom with plenty of ventilation and a small amount of CO₂ gas as specified in this activity this is not a problem. At theatres and venues which use dry ice for fog effects calculations are performed to confirm that the ice can be used safely. In certain situations CO₂ monitors are installed to warn people if the level becomes dangerously high.

You might want to ask older students to estimate the safety of using dry ice with this hazard in mind. Safe working limits are set for all kinds of chemicals provided by the Health and Safety Executive. Useful safety information for all chemicals can be found in their Material Safety Data Sheets. The data of interest is the exposure limits for CO₂ gas:

- long term exposure limit = 9,150 mg/m³ (8 hours)
- short term exposure limit = 27,400 mg/m³ (15 minutes)

Assume with reasonable ventilation that your classroom/laboratory has 10 air changes per hour, this is usual for a correctly ventilated work space. The concentration in the room should always be a small fraction of the short-term exposure limit.

1. Estimate classroom size: Vm³
2. The dry ice will sublime over a period of 5 minutes (ask students to check this timing as it will vary with water temperature).
3. Calculate concentration: \[\text{concentration} = \frac{\text{dry ice used in mg}}{(\text{volume of room m³}) \times (\text{air changes per hour})} \]

For a classroom of 70m³ subliming 1kg of dry ice with 10 air changes the concentration is: 1,428mg/m³.

What does this mean?

If the CO₂ gas is immediately well mixed with the rest of the air in the classroom then it can be argued that the average concentration over 15 minutes is 1,428/3 = 476mg/m³. As the CO₂ gas takes time to mix with the air in the classroom the average figure will be between 476 and 1,428 for a 15-minute time period and as can be seen this is a small fraction of the safe exposure limit over this period of
27,400mg/m³. However take care: if the sublimation occurs within a small container and there is little mixing, because a lid is added for example, then the local concentration will be much higher. Also the concentration near the floor will be higher than near the ceiling.

How much CO₂ is being produced by people breathing in the room?

On average each of us breathes 1kg of CO₂ per day, so an assembly with 50 people for one hour will produce 2kg of CO₂ - more than the weight of dry ice used in the demonstration.