1 A student wanted to determine the density of a small piece of rock.

(a) Describe how the student could measure the volume of the piece of rock.

(4)

(b) The volume of the piece of rock was 18.0 cm^3.

The student measured the mass of the piece of rock as 48.6 g.

Calculate the density of the rock in g/cm^3.

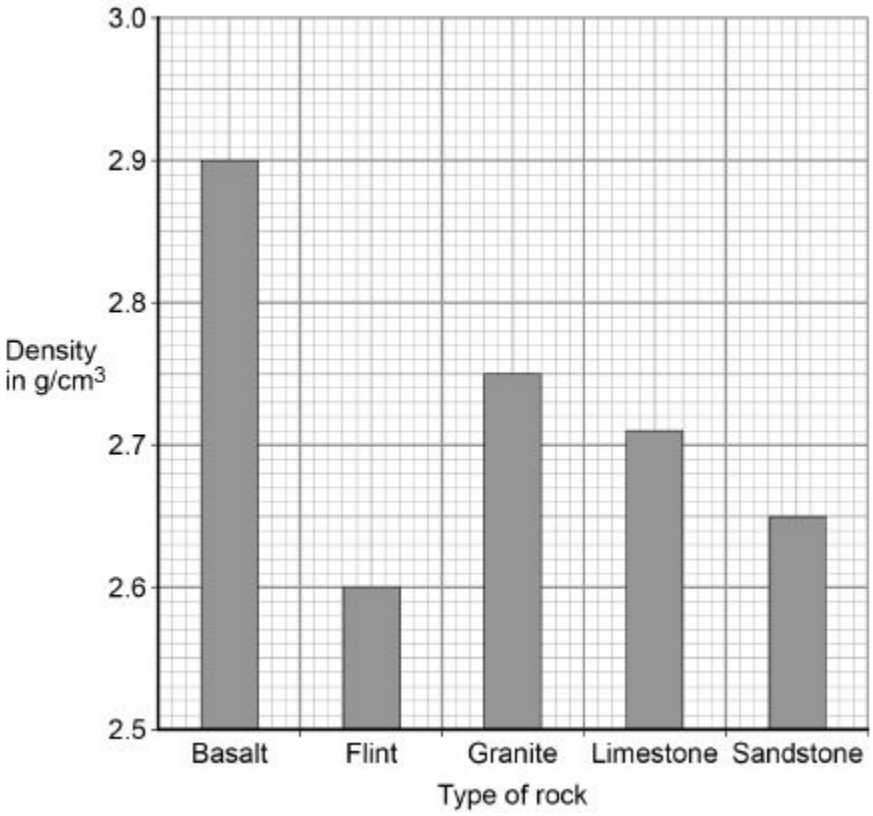
Use the equation:

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Density = _____ g/cm^3

(2)

The graph below shows the densities of different types of rock.



(c) What is the most likely type of rock that the student had?

Tick **one** box.

Basalt ☐

Flint ☐

Granite ☐

Limestone ☐

Sandstone ☐

(1)

(d) Give **one** source of error that may have occurred when the student measured the volume of the rock.

_____

_____

(1)

(e) How would the error you described in part **(d)** affect the measured volume of the rock?

_____

_____

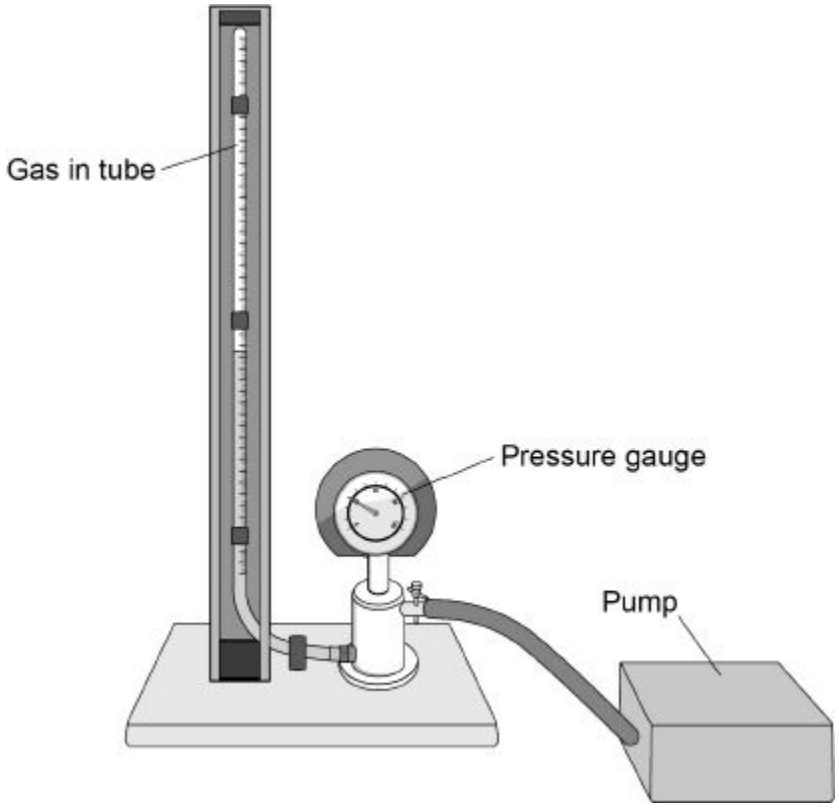
(1)

(Total 9 marks)

2 A student investigated how the pressure exerted by a gas varied with the volume of the gas.

Figure 1 shows the equipment the student used.

Figure 1



A pump was used to compress the gas in a tube. As the volume of the gas decreases, the pressure of the gas increases.

(a) The student only recorded one set of results.

Give **two** reasons why taking repeat readings could provide more accurate data.

1. _____

_____

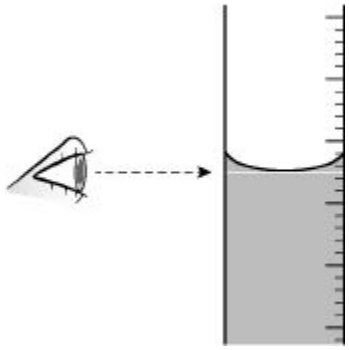
2. _____

_____

(2)

(b) **Figure 2** shows the position of the student's eye when taking volume measurements.

Figure 2



Explain what type of error would be caused if the student's eye was **not** in line with the level of the liquid in the tube.

_____

_____

_____

_____

(2)

(c) If the gas is compressed too quickly the temperature of the gas increases.

Explain how the temperature increase would affect the pressure exerted by the gas.

_____

_____

_____

_____

(2)

(d) One of the student's results is given below.

pressure = 1.6×10^5 Pa
volume = 9.0 cm^3

Calculate the volume of the gas when the pressure was 1.8×10^5 Pa.

The temperature of the gas was constant.

Volume = _____ cm^3

(3)

(e) **Figure 3** shows a person using a bicycle pump to inflate a tyre.

Figure 3

The internal energy of the air increases as the tyre is inflated.

Explain why.

_____

_____

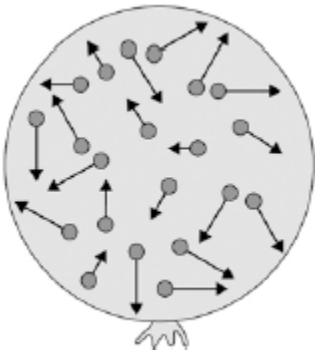
_____

_____

(2)

(Total 11 marks)

3 The figure below shows a balloon filled with helium gas.



(a) Describe the movement of the particles of helium gas inside the balloon.

_____

_____

_____

_____

(2)

(b) What name is given to the total kinetic energy and potential energy of all the particles of helium gas in the balloon?

Tick **one** box.

External energy ☐

Internal energy ☐

Movement energy ☐

(1)

(c) Write down the equation which links density, mass and volume.

_____

(1)

(d) The helium in the balloon has a mass of 0.00254 kg.

The balloon has a volume of 0.0141 m^3.

Calculate the density of helium. Choose the correct unit from the box.

m^3 / kg	**kg / m^3**	**kg m^3**

_____

_____

_____

_____

Density = _____ Unit _____

(3)

(Total 7 marks)

4 The diagram below shows a wind turbine.

(a) At a particular wind speed, a volume of 2.3×10^4 m^3 of air passes the blades each second.

The density of air is 1.2 kg/m^3.

Calculate the mass of air passing the blades per second.

Mass of air per second = _____ kg

(3)

(b) The power output of the turbine is directly proportional to the kinetic energy of the air passing the blades each second.

Describe the effect on the power output when the wind speed is halved.

(3)

(c) At a different wind speed, the wind turbine has a power output of 388 kW.

The mass of air passing the wind turbine each second is 13 800 kg.

Calculate the speed of the air passing the blades each second.

Assume that the process is 100% efficient.

Speed of air = _____ m/s

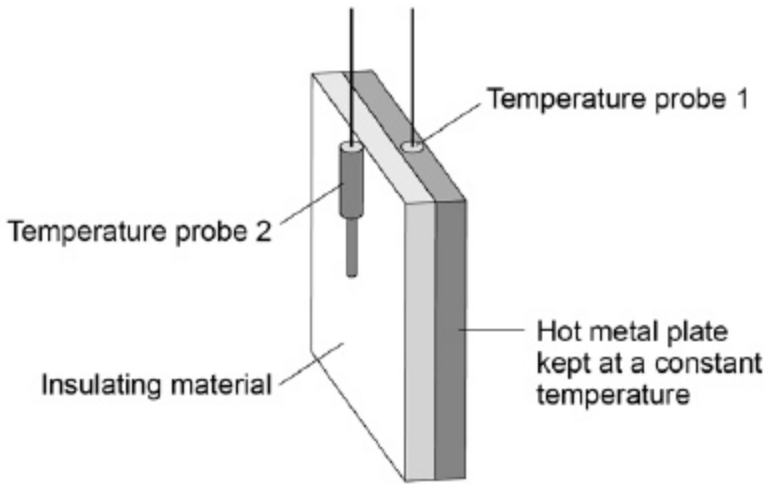
(3)

(Total 9 marks)

5 A student investigated the properties of three types of insulation.

Figure 1 shows the apparatus the student used.

Figure 1



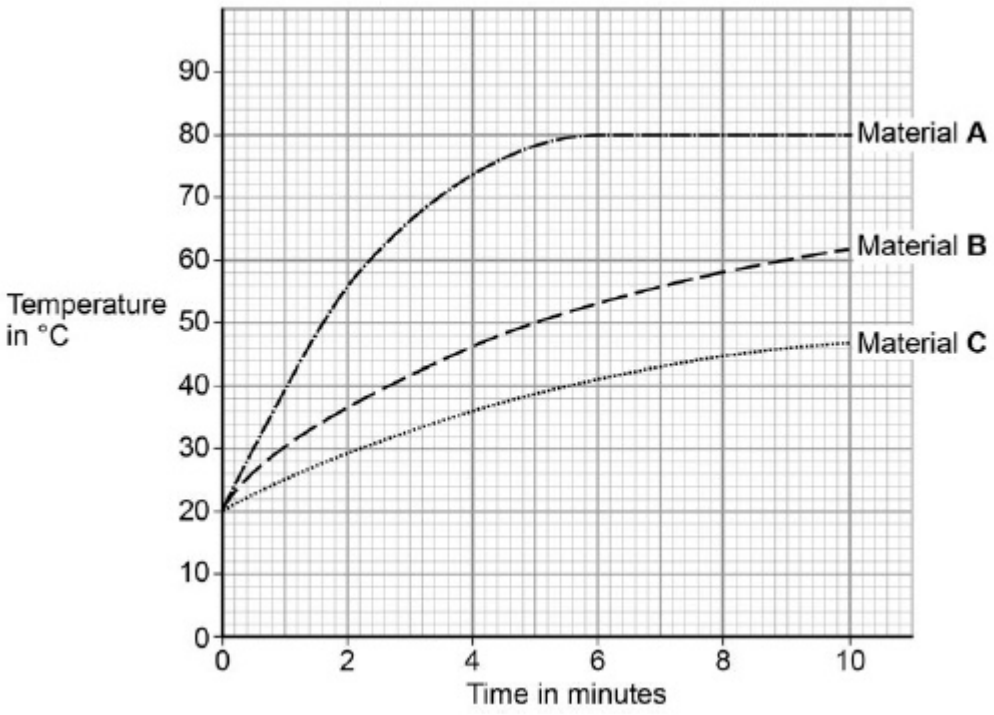
In the investigation different insulating materials were placed in contact with the hot metal plate.

Temperature probes measured the temperature on each side of the material.

The temperature probes were connected to a data logger.

Figure 2 shows how the temperature measured by temperature probe 2 changed over 10 minutes for each of the materials.

Figure 2



(a) What was the temperature of the hot metal plate?

_____ °C

(1)

(b) Which material is the best insulator?

Tick **one** box.

A ☐ **B** ☐ **C** ☐

Give the reason for your answer.

_____

_____

(2)

(c) Another student repeated the investigation but doubled the thickness for all three insulating materials.

Suggest how using thicker insulation would affect the results of the second student's investigation compared with the first student's results.

_____

_____

_____

_____

_____

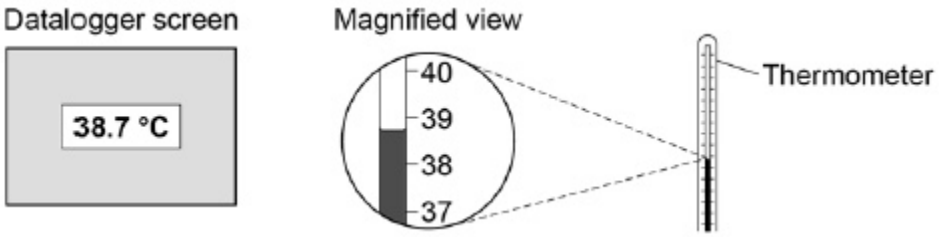
_____

(2)

(d) The students could have used a thermometer instead of temperature probes and a datalogger.

Figure 3 shows the datalogger screen and a thermometer.

Figure 3



Give two advantages of using the datalogger and temperature probes compared to a thermometer.

1. _____

_____

2. _____

_____

(2)

(e) The table gives information about four types of insulation that could be used for insulating the cavity walls of houses.

Type of insulation	**Thermal conductivity in W/m °C**
Felt wool	0.070
Mineral wool	0.040
Polyurethane foam	0.030
Rock wool	0.045

Explain which one of the types of insulation in the table would be the best to use for cavity wall insulation.

_____

_____

_____

_____

_____

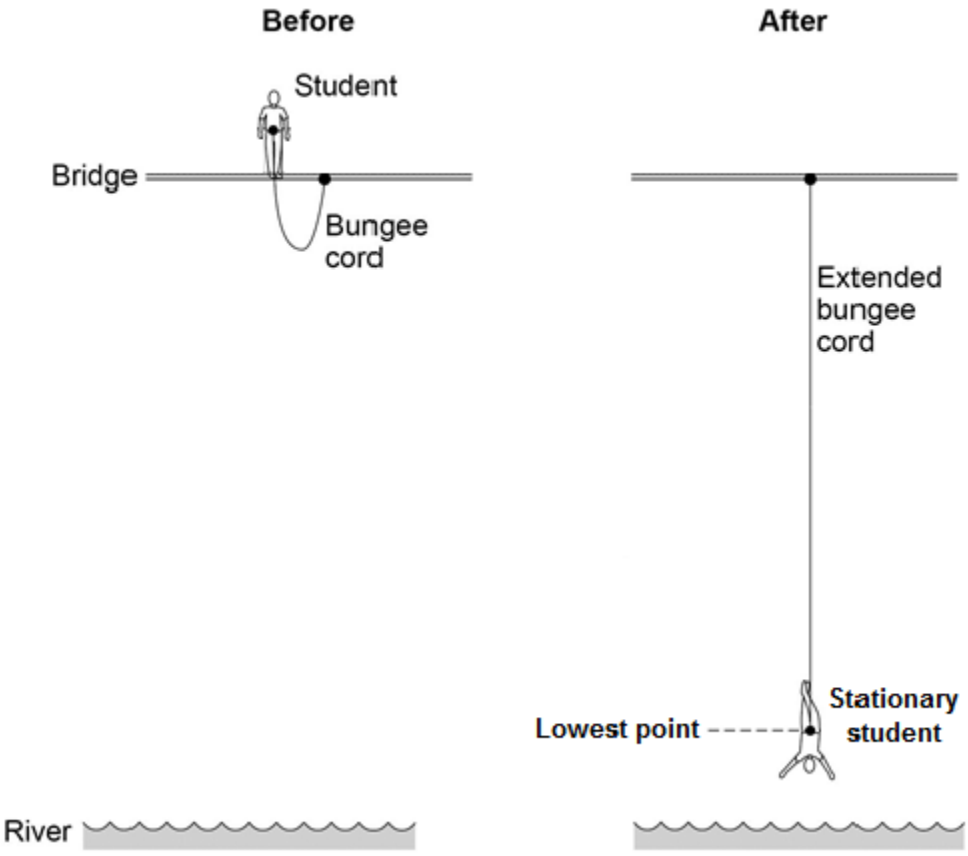
_____

(2)

(Total 9 marks)

6 The image below shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20 m.



(a) For safety reasons, it is important that the bungee cord used is appropriate for the student's weight.

Give **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(b) The student jumps off the bridge.

Complete the sentences to describe the energy transfers.

Use answers from the box.

elastic potential	**gravitational potential**	**kinetic**	**sound**	**thermal**

Before the student jumps from the bridge he has a store of

_____ energy.

When he is falling, the student's store of _____

energy increases.

When the bungee cord is stretched, the cord stores energy as

_____ energy.

(3)

(c) At the lowest point in the jump when the student is stationary, the extension of the bungee cord is 35 metres.

The bungee cord behaves like a spring with a spring constant of 40 N / m.

Calculate the energy stored in the stretched bungee cord.

Use the correct equation from the Physics Equations Sheet.

_____

_____

_____

Energy = _____ J

(2)

(Total 7 marks)

1 (a) **Level 2:** The method would lead to the production of a valid outcome. Key steps are identified and logically sequenced.

3–4

Level 1: The method would not necessarily lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- part fill a measuring cylinder with water
- measure initial volume
- place object in water
- measure final volume
- volume of object = final volume − initial volume

- fill a displacement / eureka can with water
- water level with spout
- place object in water
- collect displaced water
- measuring cylinder used to determine volume of displaced water

(b) $\text{density} = \frac{48.6}{18.0}$

1

density = 2.70 (g/cm^3)

1

*an answer of 2.70 (g/cm^3) scores **2** marks*

(c) limestone

1

(d) eye position when using measuring cylinder
or
water level in can (at start) not at level of spout
or
not all water displaced by stone is collected in container

1

(e) volume would be lower / higher

1

[9]

2

(a) any **two** from:

- calculate a mean
- reduces the effect of random errors

  reduces human error is insufficient
- identify / remove anomalies

  allow to assess the repeatability of the data

2

(b) random error

allow a parallax error
human error is insufficient

1

(because) eye position would not be the same each time (relative to the liquid)

allow systematic error only if it is clear that the student always viewed liquid level from above meniscus (or below)

1

(c) (a temperature increase would) increase the pressure in the tube
(even if the volume was constant)

1

(because a higher temperature would mean) higher (average) kinetic energy of molecules / particles

allow higher (average) speed for higher (average) kinetic energy

1

(d) $1.6 \times 10^5 \times 9.0 \; (= 1.44 \times 10^6)$

1

$1.44 \times 10^6 = 1.8 \times 10^5 \times V$

*allow for **2** marks*

$$V = \frac{1.6 \times 10^5 \times 9.0}{1.8 \times 10^5}$$

1

or

$$V = \frac{1.44 \times 10^6}{1.8 \times 10^5}$$

$V = 8.0 \; (cm^3)$

1

*an answer of 8.0 (cm^3) scores **3** marks*

(e) work is done on the air (in the tyre)

1

so the temperature (of the air) increases

allow the (average) kinetic energy of the particles increases

1

[11]

3 (a) range of speeds

1

moving in different directions

accept random motion

1

(b) internal energy

1

(c) density = mass / volume

1

(d) 0.00254 / 0.0141

1

0.18

1

*accept 0.18 with no working shown for the **2** calculation marks*

kg / m^3

1

[7]

4 (a) $1.2 = \frac{m}{2.3 \times 10^4}$

1

$m = 1.2 \times 2.3 \times 10^4$

1

m = 27 600 (kg)

allow an answer of 28 000 (kg) or 2.8 × 10^4 (kg)

or

m = 2.76 × 10^4 (kg)

1

*an answer of 27 600 (kg) scores **3** marks*

(b) mass of air passing the turbine blades is halved which decreases kinetic energy by a factor of two

1

(wind speed is halved) decreasing kinetic energy by a factor of four

1

so kinetic energy decreases by a factor of eight

1

allow power output for kinetic energy throughout

(c) $388\,000 = 0.5 \times 13\,800 \times v^2$

this mark may be awarded if P is incorrectly / not converted

1

$$v^2 = \frac{(2 \times 388\,000)}{13\,800}$$

this mark may be awarded if P is incorrectly / not converted

or

$$v^2 = \frac{388\,000}{(0.5 \times 13\,800)}$$

or

$v^2 = 56.2$

1

v = 7.50 (m/s)

an answer that rounds to 7.50 (m/s) only

1

[9]

5 (a) 80 (°C)

1

(b) **C**

1

temperature after 10 minutes was lowest
or
final temperature was lowest

*reason only scores if material **C** is chosen*

allow temperature after 10 minutes was lower

1

(c) lower total temperature rise (for all materials)

allow lower final temperature (for all materials)

1

(because) the rate of temperature increase would be lower

allow lower gradient lines

1

(d) higher resolution

1

reduced risk of misreading instrument

1

(e) polyurethane foam

no marks if polyurethane foam not chosen

1

(because it has the) lowest rate of energy transfer

1

[9]

6 (a) any **two** from:

- bungee rope may snap
- rope may extend too much
- student may land in the river

2

(b) gravitational potential

correct order only

1

kinetic

1

elastic potential

1

(c) $\frac{1}{2} \times 40 \times 35^2$

1

24 500 (J)

accept 25 000 (J) (2 significant figures)

1

*allow 24 500 (J) with no working shown for **2** marks*

[7]