Physics

Question	Maximum Mark	Mark Awarded
#1	6	
#2	10	
#3	11	
#4	15	
#5	10	
#6	15	
#7	12	
#8	20	
Total	99	

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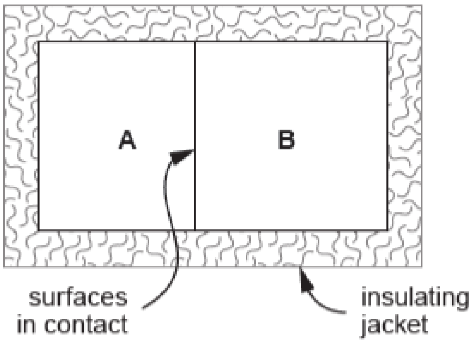
#1

Two copper blocks, **A** and **B**, are placed in contact and the assembly is covered by a thermally insulating jacket. **Initially A is at a higher temperature than B.**



Describe what happens over a period of time, in terms of heat, internal energy, temperature **and** the motion of copper atoms. [6 QER]

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Question taken from Eduqas examination paper 842101, November 2020

#2

7. (a) State what is meant by the *heat*, Q, entering a system. [2]

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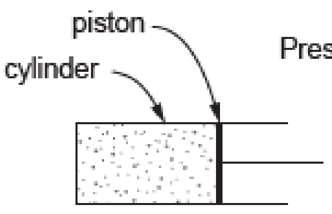
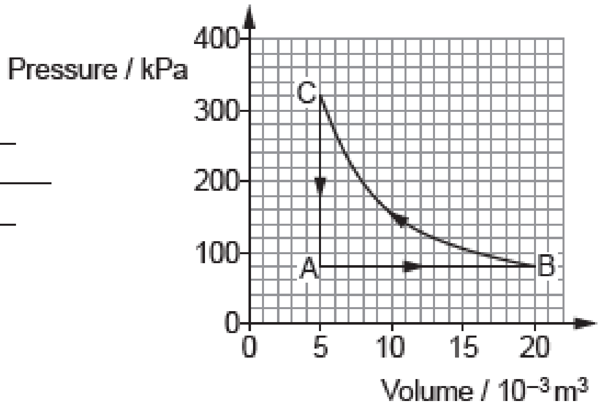
(b) A gas (assumed ideal) is contained in a cylinder with a moveable, leak-proof piston. The gas is taken through the cycle ABC shown on the graph. The stage BC takes place at constant temperature.





(i) Calculate the work done by the gas in the stage AB. [2]

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(ii) For each of the stages AB, BC and CA separately, and for the cycle as a whole, use the first law of thermodynamics to explain whether heat flows into the system or out of the system. Calculations are not required. [6 QER]

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Question taken from Eduqas examination paper 842101, June 2019

#3

(a) Calculate the critical density of the universe giving appropriate units. [2]

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(b) An astronomer makes the following statement:

Assuming that the rate of expansion of the universe is constant, two objects a distance R apart in space will increase their separation by nearly 15% over a 2 billion year period.
[1 billion = 1×10^9 years]
Justify this statement. [3]

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(c) A star in a distant galaxy shows a bright hydrogen emission line at 475 nm. The equivalent emission line on Earth has a wavelength of 410 nm.

(i) Calculate the radial velocity of the star. [2]

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(ii) Calculate the distance of the star from the Earth. [2]

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(iii) The temperature of the photosphere of the star is 7 100 K. Calculate the mean kinetic energy of particles in the photosphere. Give your answer in eV. [2]

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Question taken from Eduqas examination paper 842102, November 2020

#4

6. *(a)* Vadim uses a ruler to measure the sides of a copper block. He records the measurements as:

length = 50 ± 1 mm, breadth = 42 ± 1 mm, height = 36 ± 1 mm.

Using an electronic balance he measures the mass of the block as 670.85 ± 0.01 g.

Use Vadim's data to answer the following.

(i) Determine a value for the density of copper in kg m^{-3} and the **absolute** uncertainty in this value. [4]

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(ii) Determine the number of atoms per m^3 of copper. The uncertainty is **not** required. The atomic mass of copper is 63.5 u. [2]

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(b) (i) I. Calculate the number of molecules per m^3 for a gas (assumed to be ideal) at a temperature of 15 °C and a pressure of 101 kPa. [3]

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II. When asked why there are far fewer gas molecules per m^3 than atoms per m^3 in the copper block, a student replies, "Each molecule of the gas takes up much more space." Discuss whether or not he is right. [2]

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(ii) I. Two gases have molecular masses $m_{(1)}$ and $m_{(2)}$. Show clearly that when the gases are at the same temperature, the ratio of the rms speeds of their molecules is: [2]

$$\frac{c_{\mathrm{rms}(1)}}{c_{\mathrm{rms}(2)}} = \sqrt{\frac{m_{(2)}}{m_{(1)}}}$$

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II. Calculate the percentage difference in the rms speeds of nitrogen and oxygen molecules in the same sample of air. Take the percentage difference to be defined as:

$$\frac{\text{rms speed for nitrogen} - \text{rms speed for oxygen}}{\text{rms speed for oxygen}} \times 100\%$$

[Molecular mass for nitrogen = 28.0 u. Molecular mass for oxygen = 32.0 u.]
[2]

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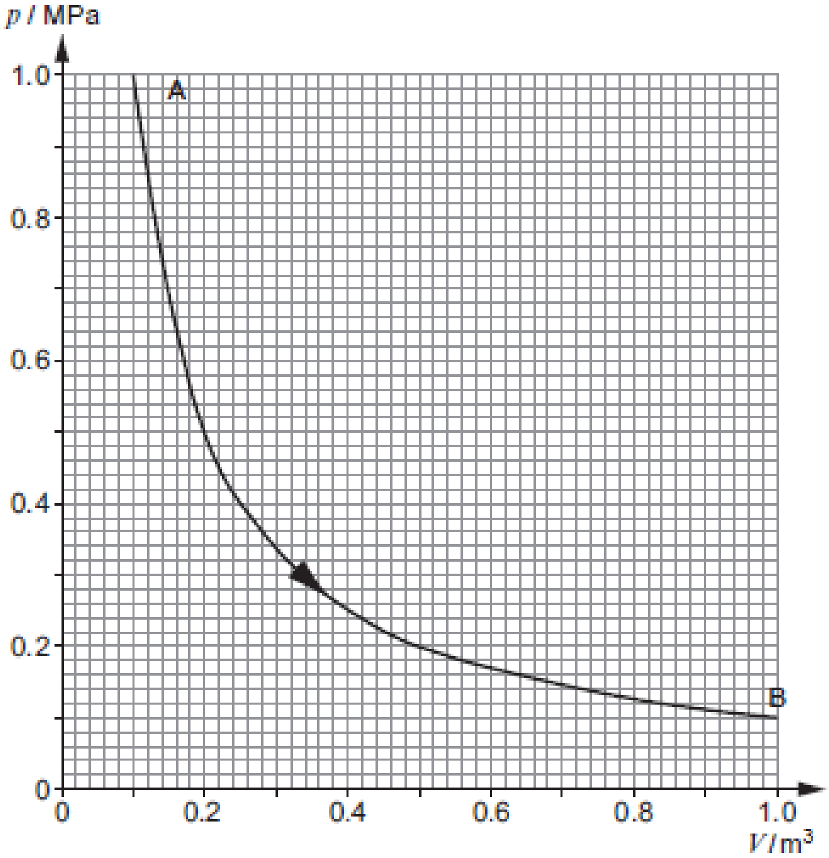
Question taken from Eduqas examination paper 842101, June 2019

#5

8. *(a)* 33.2 mol of nitrogen gas is contained in a cylinder fitted with a piston. The gas is allowed to expand from A to B, doing work against the piston. A p–V graph for the expansion is given below.



(i) Show that the expansion occurs at a constant temperature of approximately 360 K. [3]

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(ii) Determine the approximate amount of work done by the gas during the expansion. [2]

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(iii) Rini claims that the work done by the gas results in an equal amount of internal energy being lost by the gas. Give the *correct* application of the first law of thermodynamics to this isothermal expansion. [2]

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(b) An estimated 600 MJ of work can be produced by an ordinary car engine burning 0.10 m^3 (100 litre) of petrol. An estimated 15 MJ of work can be produced by the expansion of the same volume of air compressed to the highest safe (initial) pressure.

Discuss the advantages and disadvantages of powering cars by compressed air rather than petrol. Calculations are not required. [3]

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Question taken from Eduqas examination paper 842101, June 2018

#6

3. (a) Two parallel plate capacitors, X and Y, have equal plate areas. The capacitance of X is greater than the capacitance of Y. Suggest two possible reasons for the difference. [2]

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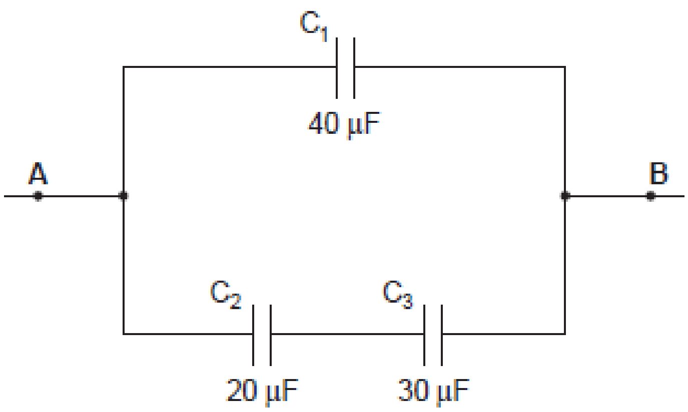
(b) The diagram shows an arrangement of 3 capacitors.



(i) Calculate the total capacitance of this combination of capacitors. [3]

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(ii) Explain why:

pd across C_2 = 1.5 × pd across C_3. [2]

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(iii) Hence, calculate the pd across C_3 given that 100 V is applied between A and B. [1]

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(iv) Explain which of the three capacitors stores the greatest charge, and calculate the size of this charge. [2]

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(c) A 1.6 mF capacitor is charged from a 300 V d.c supply. Engineers wish to use the energy stored in this capacitor to heat a small coil embedded in a thermally insulated block of aluminium of mass 0.10 kg. It is required that the heating process be at least 80% efficient. Experiments show that when the capacitor is discharged through the coil, the temperature of the block increases by 0.60 K.

Determine whether this method of heating meets the efficiency specified.
[Specific heat capacity of aluminium, c = 910 J kg^{-1} K^{-1}]. [5]

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Question taken from Eduqas examination paper 842102, June 2019

#7

(a) (i) A cylinder of gas fitted with a pressure gauge is surrounded by melting ice. The gas pressure stabilises at 96 kPa. The cylinder is then surrounded instead by boiling water. The pressure stabilises at 131 kPa. Show that this is consistent with a value of −273 °C for the absolute zero of temperature. [3]

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(ii) State the significance, in terms of molecules, of the absolute zero of temperature. [1]

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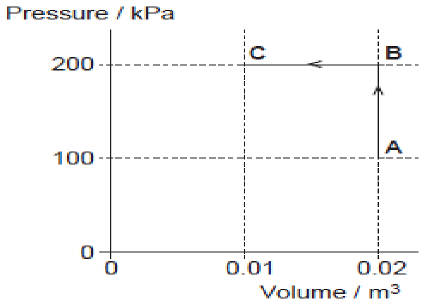
(b) A cylinder with a moveable, leak-proof piston contains 0.850 mole of an ideal gas. The gas is taken along the path **ABC** shown on the $p-V$ grid.



(i) Show clearly that the gas is at the same temperature at **A** and **C**, and determine this temperature. [3]

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(ii) Calculate the work done on the gas over **ABC**. [2]

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(iii) Determine the net heat flow over **ABC**, stating whether it is in or out of the system, **and** justifying your answer clearly in terms of the *1st law of thermodynamics*. [3]

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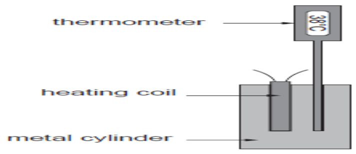
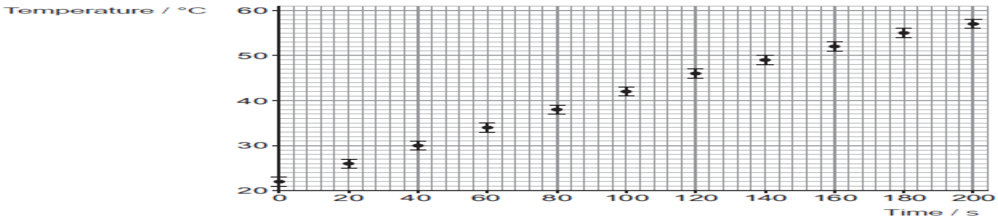
Question taken from Eduqas examination paper 842101, November 2020

#8

(a) Alice performs an experiment to determine the specific heat capacity, c, of a metal in the form of a cylinder with holes drilled in it for a heating coil and a thermometer. She determines the mass, m, of the cylinder using a digital balance. Alice sets up a circuit to provide constant power to the heating coil and to enable the pd, V, across it and current, I, through it to be measured. The graph of temperature against time for the cylinder, as well as her other measurements, are given below.

$m = 0.570\,\text{kg}$, $V = 12.20\,\text{V}$, $I = 3.81\,\text{A}$





(i) Draw a circuit diagram of the circuit required. [Show the heating coil as a resistor.] [2]

(ii) Suggest why the points for the highest temperatures show significant deviations from the trend of the points at lower temperatures, and what could have been done to reduce the deviation. [2]

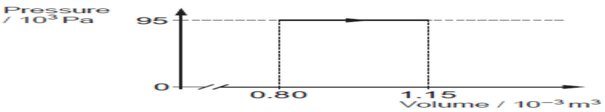
(iii) **Using an appropriate portion of the graph**, determine the maximum gradient and the minimum gradient. [4]

(iv) Show clearly that the graph gradient should be: [2]

$$\text{gradient} = \frac{VI}{mc}$$

(v) Hence determine a value for the specific heat capacity of the metal of the cylinder, together with its **absolute uncertainty**. Assume that the percentage uncertainties in m, V and I are negligible. [5]

(b) In another experiment, 0.031 mol of helium (a monatomic gas) is heated so that it expands at constant pressure (see diagram). Its temperature rises from 295 K to 424 K.



(i) Calculate the heat flow into the gas during this change. [3]

(ii) Discuss whether or not this amount of heat would be needed in all circumstances to raise the temperature of 0.031 mol of helium from 295 K to 424 K. [2]

Question taken from Eduqas examination paper 842101, June 2017