A-Level Physics

Thermal Physics (Multiple Choice)

Question Paper

Time available: 25 minutes
Marks available: 20 marks

1. An ideal gas, initially at $300\ \text{K}$, is compressed to half its original volume. It is then cooled at constant volume until the pressure is restored to its initial value.

What is the final temperature of the gas?

A $150\ \text{K}$ ⬭

B $200\ \text{K}$ ⬭

C $300\ \text{K}$ ⬭

D $600\ \text{K}$ ⬭

(Total 1 mark)

2. A fixed volume of an ideal gas is heated.

Which row gives quantities that double when the kelvin temperature of the gas doubles?

A	rms speed of the molecules	pressure of the gas	⬭
B	density of the gas	rms speed of the molecules	⬭
C	internal energy of the gas	density of the gas	⬭
D	pressure of the gas	internal energy of the gas	⬭

(Total 1 mark)

3. A solar panel transfers energy at a rate of 1.2 kW to liquid passing through it. The liquid has a specific heat capacity of 4.0 kJ kg^{-1} K^{-1}.

When the liquid flows through the solar panel, its temperature increases by 3.0 K.

The flow rate of the liquid is

A 0.10 kg s^{-1}. ⬭

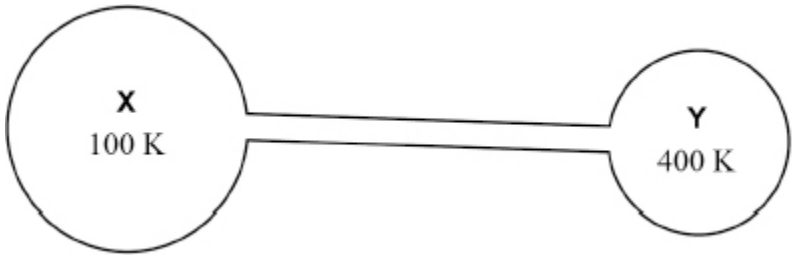
B 1.1 kg s^{-1}. ⬭

C 10 kg s^{-1}. ⬭

D 100 kg s^{-1}. ⬭

(Total 1 mark)

4. The diagram shows two flasks **X** and **Y** connected by a thin tube of negligible volume.



The flasks contain an ideal gas.

The volume of **X** is twice the volume of **Y**. When **X** is at a temperature of 100 K and **Y** is at a temperature of 400 K there is no net transfer of particles between the flasks.

X contains gas of mass *m*.

What is the mass of gas in **Y**?

A $\frac{m}{8}$ ⬭

B $\frac{m}{2}$ ⬭

C $2m$ ⬭

D $8m$ ⬭

(Total 1 mark)

5. A sample **P** of an ideal gas contains 1 mol at an absolute temperature *T*.

A second sample **Q** of an ideal gas contains $\frac{2}{3}$ mol at an absolute temperature $2T$.

The total molecular kinetic energy of **P** is E.

What is the total molecular kinetic energy of **Q**?

A $\frac{2}{3}E$ ⬭

B $\frac{3}{4}E$ ⬭

C $\frac{4}{3}E$ ⬭

D $\frac{3}{2}E$ ⬭

(Total 1 mark)

6. A transparent illuminated box contains small smoke particles and air.
The smoke particles are observed to move randomly when viewed through a microscope.

What is the cause of this observation of Brownian motion?

A Smoke particles gaining kinetic energy by the absorption of light. ⬭

B Collisions between smoke particles and air molecules. ⬭

C Smoke particles moving in convection currents caused by the air being heated by the light. ⬭

D The smoke particles moving randomly due to their temperature. ⬭

(Total 1 mark)

7. A continuous stream of water falls through a vertical distance of 100 m.
Assume no thermal energy is transferred to the surroundings.
The specific heat capacity of water is 4200 J kg^{-1} K^{-1}.

What is the temperature difference of the water between the top and bottom of the waterfall?

A 0.023 K ⬭

B 0.23 K ⬭

C 2.3 K ⬭

D 4.3 K ⬭

(Total 1 mark)

8. A student measures the power of a microwave oven. He places 200 g of water at 23 °C into the microwave and heats it on full power for 1 minute. When he removes it, the temperature of the water is 79 °C.

The specific heat capacity of water is 4200 J kg^{-1} K^{-1}.

What is the average rate at which thermal energy is gained by the water?

A 780 W ⬭

B 840 W ⬭

C 1.1 kW ⬭

D 4.6 kW ⬭

(Total 1 mark)

9. An ice cube of mass 0.010 kg at a temperature of 0 °C is dropped into a cup containing 0.10 kg of water at a temperature of 15 °C.

What is the maximum estimated change in temperature of the contents of the cup?

specific heat capacity of water = 4200 J kg^{-1} K^{-1}
specific latent heat of fusion of ice = 3.4×10^5 J kg^{-1}

A 1.5 K ⬭

B 8.7 K ⬭

C 13.5 K ⬭

D 15.0 K ⬭

(Total 1 mark)

10. Specimens **P** and **Q** of the same gas exert the same pressure. **P** is at a temperature of 280 K and contains 10^{20} molecules per unit volume. The temperature of **Q** is 350 K.

What is the number of molecules per unit volume in **Q**?

A 0.09×10^{20} ⬭

B 0.75×10^{20} ⬭

C 0.80×10^{20} ⬭

D 1.25×10^{20} ⬭

(Total 1 mark)

11. A fixed mass of an ideal gas initially has a volume V and an absolute temperature T. Its initial pressure could be doubled by changing its volume and temperature to

A $V/2$ and $4T$

B $V/4$ and $T/2$

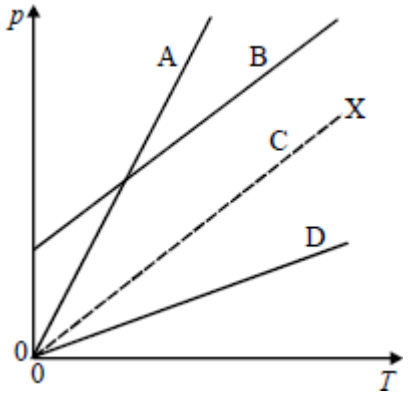
C $2V$ and $T/4$

D $4V$ and $2T$

(Total 1 mark)

12. In the diagram the dashed line **X** shows the variation of pressure, p, with absolute temperature, T, for 1 mol of an ideal gas in a container of fixed volume.

Which line, **A**, **B**, **C** or **D** shows the variation for 2 mol of the gas in the same container?



(Total 1 mark)

13. A 1.0 kΩ resistor is thermally insulated and a potential difference of 6.0 V is applied to it for 2.0 minutes. The thermal capacity of the resistor is 9.0 J K^{-1}. The rise in temperature, in K, is

A 1.3×10^{-3}

B 8.0×10^{-3}

C 0.48

D 0.80

(Total 1 mark)

14. An ideal gas is contained in a cubical box of side length a. The gas has N molecules each of mass m.

What is the pressure exerted by the gas on the walls of the box?

A $\frac{mNa^3}{2} \times c_{rms}^2$ ⬭

B $\frac{mNa^2}{2} \times c_{rms}^2$ ⬭

C $\frac{mN}{3a^2} \times c_{rms}^2$ ⬭

D $\frac{mN}{3a^3} \times c_{rms}^2$ ⬭

(Total 1 mark)

15. Which statement is true about an experiment where Brownian motion is demonstrated using smoke particles in air?

A The experiment makes it possible to see the motion of air molecules. ⬭

B The motion is caused by the collisions of smoke particles with each other. ⬭

C The motion is caused by collisions between air molecules and smoke particles. ⬭

D The motion occurs because air is a mixture of gases and the molecules have different masses. ⬭

(Total 1 mark)

16. When an ideal gas at a temperature of 27 °C is suddenly compressed to one quarter of its volume, the pressure increases by a factor of 7

What is the new temperature of the gas?

A 15 °C ⬭

B 47 °C ⬭

C 171 °C ⬭

D 252 °C ⬭

(Total 1 mark)

17. Which is **not** an assumption about gas particles in the kinetic theory model for a gas?

A They collide elastically with the container walls. ⬭

B They have negligible size compared to the distance between the container walls. ⬭

C They travel between the container walls in negligibly short times. ⬭

D They collide with the container walls in negligibly short times. ⬭

(Total 1 mark)

18. The average mass of an air molecule is 4.8×10^{-26} kg

What is the mean square speed of an air molecule at 750 K?

A 3.3×10^5 m^2 s^{-2} ⬭

B 4.3×10^5 m^2 s^{-2} ⬭

C 6.5×10^5 m^2 s^{-2} ⬭

D 8.7×10^5 m^2 s^{-2} ⬭

(Total 1 mark)

19. Two flasks **X** and **Y** are filled with an ideal gas and are connected by a tube of negligible volume compared to that of the flasks. The volume of **X** is twice the volume of **Y**.
X is held at a temperature of 150 K and **Y** is held at a temperature of 300 K

What is the ratio $\frac{\text{mass of gas in } \mathbf{X}}{\text{mass of gas in } \mathbf{Y}}$?

A 0.125 ⬭

B 0.25 ⬭

C 4 ⬭

D 8 ⬭

(Total 1 mark)

20. What is the total internal energy of 2.4 mol of an ideal gas which has a temperature of 15 °C?

A 6.0×10^{-21} J ⬭

B 1.4×10^{-20} J ⬭

C 4.5×10^{2} J ⬭

D 8.6×10^{3} J ⬭

(Total 1 mark)