Physics Model Paper 2 2025

Time Allowed: 1 Hour 45 minutes
Total Marks: 65

You must bring a soft pencil (preferably type B or HB), a clean eraser, and a dark blue or black pen.

Before attempting the paper, write your name, candidate number, centre name, and centre number clearly in the designated spaces.

Instructions for Candidates

- **Section A** contains multiple choice questions. You are required to attempt all questions by selecting the most appropriate option and marking it on the separate MCQ answer sheet using a soft pencil.
- **Section B** comprises both theoretical questions and practical questions. All questions in this section are compulsory. Answers must be written in the space provided on the question paper using a dark blue or black pen.You may use an HB pencil for any diagrams or graphs.
- You may use a scientific calculator.
- You should show all your working and use appropriate units.
- Do not use an erasable pen or correction fluid.
- Avoid writing over any barcodes printed on the paper.


Information for Candidates

- This paper consists of a total of **65 marks**.
- **Section A** includes **30 multiple choice questions**, each carrying **1 mark**. There is no negative marking for incorrect answers.
- **Section B** carries a total of **35 marks**, divided as follows:
  Theoretical Questions: 25 marks
  Practical Questions: 10 marks
- The number of marks for each question or part question is shown in brackets [ ].
- A formula sheet will be provided with this paper.

Please read all questions carefully and follow the instructions exactly to ensure your responses are properly evaluated.

Section A: Multiple Choice Questions (30 questions)

1. A transmitter emits a pulse of electromagnetic waves towards a reflector. The pulse is reflected and returns to the transmitter.

   A detector is located at the transmitter. The emitted pulse and the reflected pulse are displayed on a cathode-ray oscilloscope (CRO) as shown.

   1 cm

   1 cm
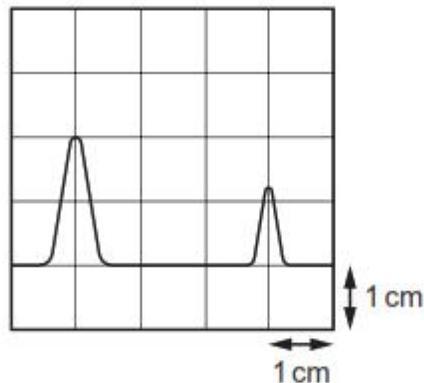
   The pulse takes 6.3 μs to travel from the transmitter to the reflector.

   What is the time-base setting of the CRO?

   A 2.1 μs cm^{-1} **B** 3.2 μs cm^{-1} **C** 4.2 μs cm^{-1} **D** 6.3 μs cm^{-1}

2. A cylinder contains a volume of 0.012 m^3 of gas at a pressure of 1.0 × 10^5 Pa.

   400 J of work is done **on** this gas, with its pressure remaining constant throughout.

   What is the final volume of the gas?

   A 0.0040 m^3 **B** 0.0080 m^3 **C** 0.016 m^3 **D** 0.020 m^3

3. A sledge of mass 50 kg sits on a snowy surface. It is pulled horizontally for 10 m against a frictional force of 200 N, then it is pulled horizontally across ice for 10 m. There is no friction between the ice and the sledge. It is lifted up vertically by 1 m and finally carried back at a constant speed to where it started.

   During which stage of its journey is most work done on the sledge?

   A being carried back 20 m at constant speed

   B being lifted up 1 m

   C being pulled 10 m across ice

   D being pulled 10 m across snow

4   An object is moved in a vertical plane from X to Y, and then from Y to Z, as shown in the diagram.

The distances between various points are indicated on the diagram.

Lines XY and VZ are vertical.

The object weighs 20 N.

How much gravitational potential energy does the object gain by moving from X to Z?

A   60 J   B   120 J   C   140 J   D   260 J

5   A car travels at a constant speed of 25 ms⁻¹ up a slope. The wheels driven by the engine exert a forward force of 3000 N. The total force due to air resistance and friction is 2100 N. The weight of the car has a component down the slope of 900 N.

What is the rate at which thermal energy is dissipated?

A   zero   B   2.3 × 10⁴ W   C   5.3 × 10⁴ W   D   7.5 × 10⁴ W

6   A wave of frequency 15 Hz travels at 24 ms⁻¹ through a medium.

What is the phase difference between two points 2.0 m apart?

A   There is no phase difference.

The graph shows the non-linear force–extension curve for a wire made from a new composite material.

7

What is the best estimate of the work done in stretching the wire to point P?

A   0.09 J   B   0.10 J   C   0.11 J   D   0.20 J

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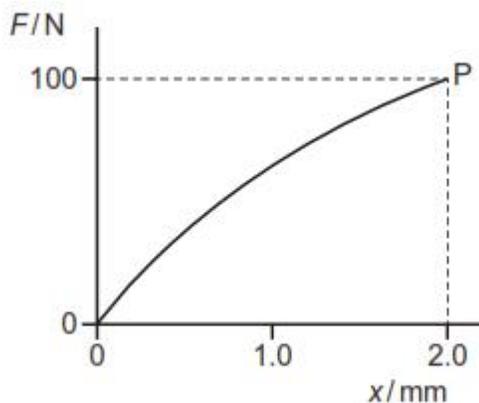
What is the rate at which thermal energy is dissipated?

A   zero   B $2.3 \times 10^4\,\text{W}$ C $5.3 \times 10^4\,\text{W}$ D $7.5 \times 10^4\,\text{W}$

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8 Which row describes a longitudinal wave and a medium through which it can travel?

	direction of oscillation of the medium compared with the direction of propagation of wave energy	medium
A	parallel	air
B	parallel	vacuum
C	perpendicular	air
D	perpendicular	vacuum

9 A sound wave is displayed on the screen of a cathode-ray oscilloscope, as shown.
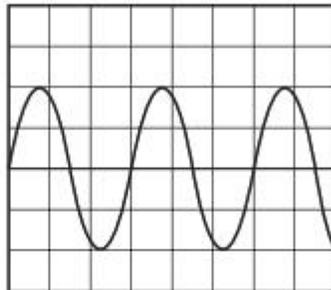
A musical instrument is made using a long tube with a mouthpiece at one end. The other end is open and flared, as shown.

A musician maintains stationary sound waves with a node at the mouthpiece and an antinode at the other end. The lowest frequency of sound that the instrument can produce is 92 Hz.

Which different frequencies of sound can be produced by the instrument?

A   92 Hz, 138 Hz, 184 Hz, 230 Hz

B   92 Hz, 184 Hz, 276 Hz, 368 Hz

C   92 Hz, 276 Hz, 460 Hz, 644 Hz

D   92 Hz, 276 Hz, 828 Hz, 1288 Hz

10

11 A water wave passes through a gap between two barriers. The wavefronts spread out as shown.
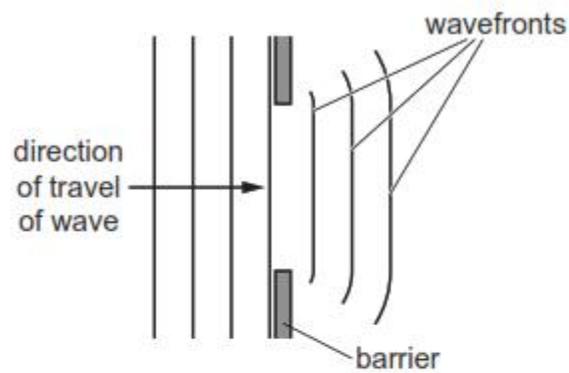
A gas is contained in a cylinder by a movable piston.

12
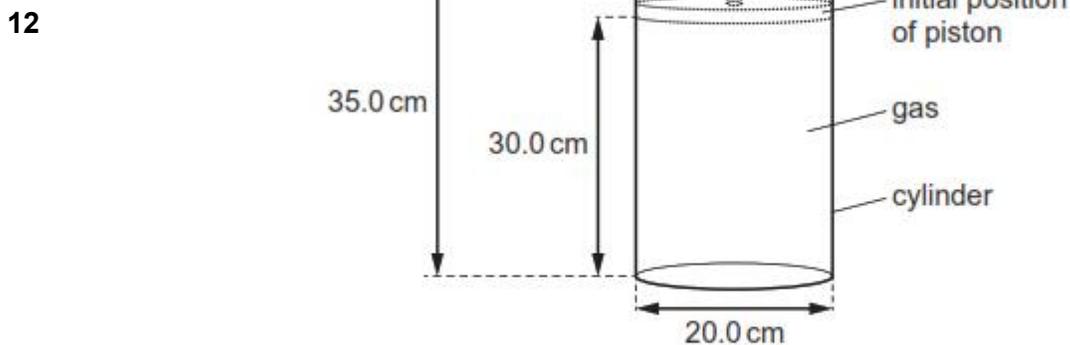
The cylinder has a circular cross-section of diameter 20.0 cm.

The pressure of the gas is 102 Pa and the piston is initially 30.0 cm from the base of the cylinder.

The gas is heated causing the piston to move up so that it is 35.0 cm from the base. The pressure of the gas remains constant.

13 How much work does the gas do in moving the piston?

A 0.160 J   B 0.641 J   C 1.12 J   D 4.49 J

14   An egg of mass 25 g falls vertically downwards from the surface of a table which is 900 mm above the ground. Air resistance is negligible.

What is the kinetic energy of the egg when it hits the ground?

A   0.023 J   **B**   0.22 J   **C**   23 J   **D**   220 J

15   A progressive radio wave in a vacuum has a frequency of 75 MHz.

What is the phase difference between two points on the wave that are 50 cm apart from each other?

A   23°   **B**   45°   **C**   90°   **D**   180°

16   Which of the following is not a fundamental assumption of the kinetic theory of an ideal gas?

A.   Gas molecules occupy negligible volume
B.   Intermolecular forces are negligible
C.   Collisions between molecules are inelastic
D.   Molecules move randomly in straight lines

17 A gas exerts a pressure of 2 × 10⁵ Pa on a surface area of 0.5 m². What is the force exerted by the gas?

A. 1 × 10⁵ N   **B.** 2 × 10⁵ N   **C.** 1 × 10⁶ N   **D.** 4 × 10⁵ N

18 If the velocities of gas molecules are 300 m/s, 400 m/s, and 500 m/s, what is the root-mean-square speed?

A. 400 m/s   **B.** 433 m/s   **C.** 300 m/s   **D.** 600 m/s

19 A sample of gas occupies 0.025 m³ at 300 K and 1.2 × 10⁵ Pa. How many moles are present?
(R = 8.314 J/mol·K)

A. 1.2 mol   **B.** 0.5 mol   **C.** 1.0 mol   **D.** 0.3 mol

20 Which of the following graphs best represents an isothermal process for an ideal gas?

  A. Pressure vs. Volume – Hyperbolic curve
  B. Pressure vs. Temperature – Straight line
  C. Volume vs. Temperature – Straight line
  D. Pressure vs. Volume – Straight line through origin

21   Which of the following best defines **internal energy** of a gas?

  A. Energy due to pressure and volume
  B. Total kinetic energy of the molecules
  C. Energy stored in chemical bonds
  D. Heat transferred during expansion

22 The first law of thermodynamics is expressed as:

  A. $Q = mc\triangle T$
  B. $W = p\triangle V$
  C. $\triangle U = Q - W$
  D. $PV = nRT$

23 The area under a pressure–volume graph represents:

  A. Internal energy
  B. Heat absorbed
  C. Work done
  D. Temperature change

24 In a temperature vs. heat graph, a flat region indicates:

  A. Specific heat capacity is zero
  B. Temperature is increasing rapidly
  C. Phase change is occurring
  D. Heat is lost to surroundings

25 A 0.5 kg pan at 25°C is mixed with 1 kg of water at 80°C. Assuming no heat loss, what principle helps calculate the final temperature?

    A.   Zeroth law of thermodynamics
    B.   First law of thermodynamics
    C.   Boyle's law
    D.   Charles's law

26 A 2 kg object is lifted to a height of 5 m. What is its gravitational potential energy? (g = 9.8 m/s²)

    A. 10J   **B.** 49J   **C.** 98J   **D.** 100J

27 Which of the following statements is true about **inelastic collisions**?

    A. Total kinetic energy is conserved
    B. Momentum is not conserved
    C. Kinetic energy is partially lost
    D. Objects bounce off with equal speed

28 Which formula correctly defines power in physics?

    A. P=F x d
    B. P=W / t
    C. P=mgh
    D. P= V / I

29 A spring is compressed by 0.2 m with a spring constant of 100 N/m. What is the energy stored?

    A. 2J   **B.** 4J   **C.** 10J   **D.** 20J

30 In a pendulum swing, which energy transformation occurs at the lowest point?

    A. Gravitational → Elastic
    B. Kinetic → Potential
    C. Potential → Kinetic
    D. Elastic → Gravitational

Section B (35 marks)
Theoretical Questions (25 marks)
1 (a) For a progressive wave, state what is meant by wavelength.

....

....[1]

(b) A light wave from a laser has a wavelength of 460nm in a vacuum.

Calculate the period of the wave.

period = ... s [4]

(c) The light from the laser is incident normally on a diffraction grating.

Describe the diffraction of the light waves at the grating.

....

....

....[2]

(d) A diffraction grating is used with different wavelengths of visible light. The angle θ of the fourth-order maximum from the zero-order (central) maximum is measured for each wavelength. The variation with wavelength λ of sin θ is shown in Fig. 1.1.
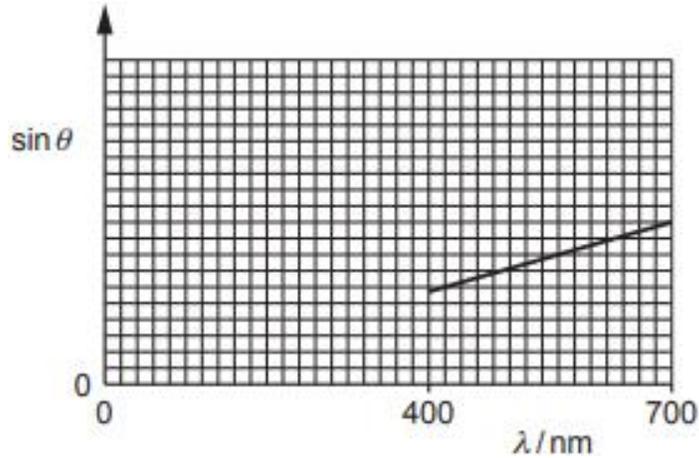
Fig. 1.1

(i) The gradient of the graph is G. Determine an expression, in terms of G, for the distance d between the centres of two adjacent slits in the diffraction grating.

d = ... [2]

(ii) On Fig. 1.1, sketch a graph to show the results that would be obtained for the **second**-order maxima. [2]

2 A fixed mass of an ideal gas is at a temperature of 21°C. The pressure of the gas is 2.3 × 10⁵ Pa and its volume is 3.5 × 10⁻³m³. (a) (i) Calculate the number N of molecules in the gas.

N = ... [2]

(ii) The mass of one molecule of the gas is 40u. Determine the root-mean-square (r.m.s.) speed of the gas molecules.

r.m.s. speed = ... ms⁻¹ [2]

(b) The temperature of the gas is increased by 84°C.

Calculate the value of the ratio

$$\frac{\text{new r.m.s. speed of molecules}}{\text{original r.m.s. speed of molecules}} .$$

ratio = ... [2]

3 (a) Using a simple kinetic model of matter, describe the structure of a solid.

....

....

.... [2]

(b) The specific latent heat of vaporisation is much greater than the specific latent heat of fusion for the same substance.

Explain this, in terms of the spacing of molecules.

....

....

.... [1]

(c) A heater supplies energy at a constant rate to 0.045 kg of a substance. The variation with time of the temperature of the substance is shown in Fig. 3.1. The substance is perfectly insulated from its surroundings.
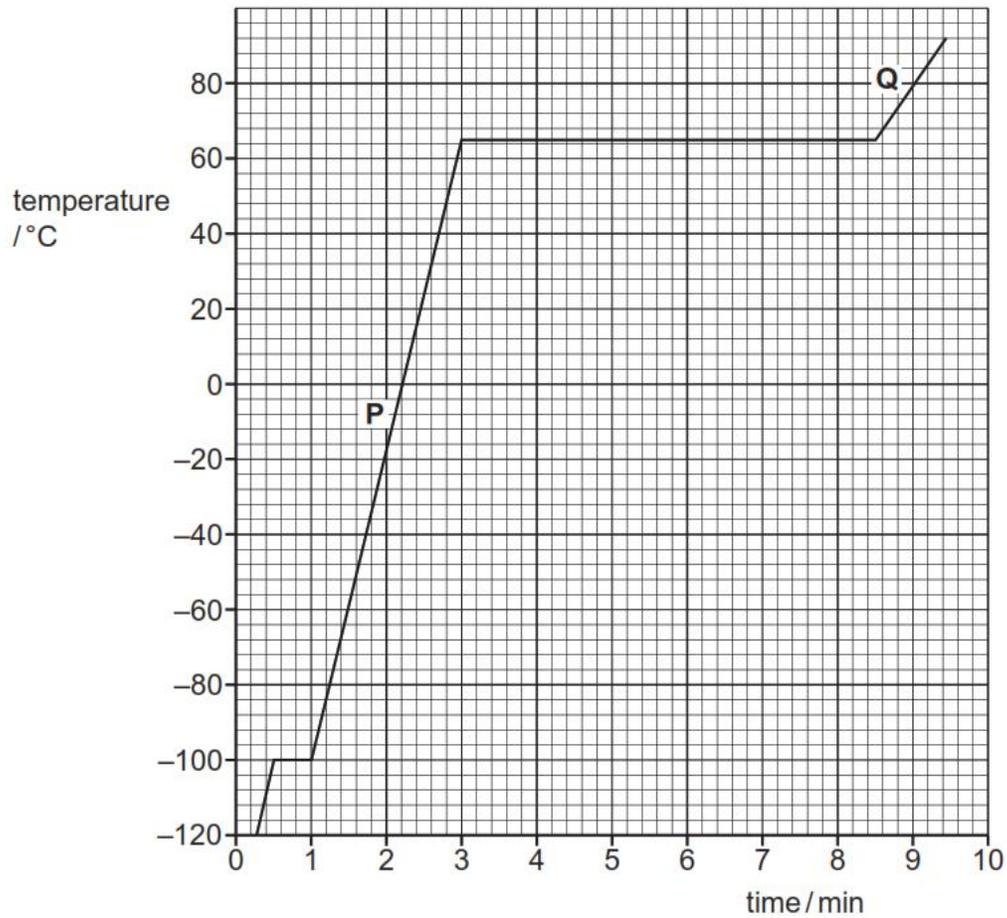
Fig. 3.1

(i) Determine the temperature at which the substance melts.

temperature = ... °C [1]

(ii) The power of the heater is 150 W.

Use data from Fig. 3.1 to calculate, in kJ kg⁻¹, the specific latent heat of vaporisation L of the substance.

L = ... kJ kg⁻¹ [3]

(iii) Suggest what can be deduced from the fact that section **Q** on the graph is less steep than section **P**.

....

.... [1]

Practical Component (10 marks)

1 A student investigates how the temperature of the surroundings affects the rate of cooling of water.

(a) (i) The student:
- pours 100 cm³ of hot water into a 250 cm³ beaker
- uses a thermometer to take the temperature of the water at time t = 0 s.

The thermometer reading at time t = 0 s is shown in Fig. 1.1.

Fig. 1.1

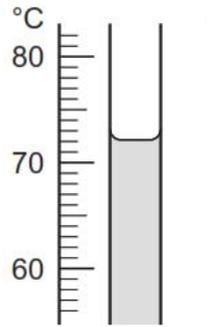Record the temperature of the water at time t = 0s in Table 1.1. [1]

Table 1.1

t/s	$\theta/°C$
0	....
30	69
60	67
90	66
120	65
150	64
180	63
210	62
240	61

(ii) The student then records the temperature θ of the water every 30 s for 240 s.

The results are recorded in Table 1.1.

Before taking each temperature reading, the student carefully stirs the water in the beaker. Explain why.

....

....

.... [1]

(iii) Calculate the average cooling rate C_1 of the water for the first 90 s of the experiment.

Use the readings in Table 1.1 and the equation:

$$C_1 = \frac{\theta_0 - \theta_{90}}{t}$$

where θ_0 is the temperature of the water at 0 s, $\theta_{90,}$ is the temperature at 90 s and t is the time of 90 s.

Give the unit for C_1.

$C_1 =$ .... unit .... [2]

(iv) Calculate the average cooling rate C_2 of the water for the final 90 s of the experiment.

Use the equation:

$$C_2 = \frac{\theta_{150} - \theta_{240}}{t}$$

where θ_{150} is the temperature of the water at 150 s, θ_{240} is the temperature of the water at 240 s and t is the time of 90 s.

$C_2 =$ .... unit .... [1]

(v) Compare your values of C_1 and C_2. Explain any difference in these values.

....

....

.... [1]

(b) The student repeats the procedure described in **(a)(i)** but this time he places the 250 cm³ beaker inside a larger beaker containing iced water. The arrangement is shown in Fig. 1.2.
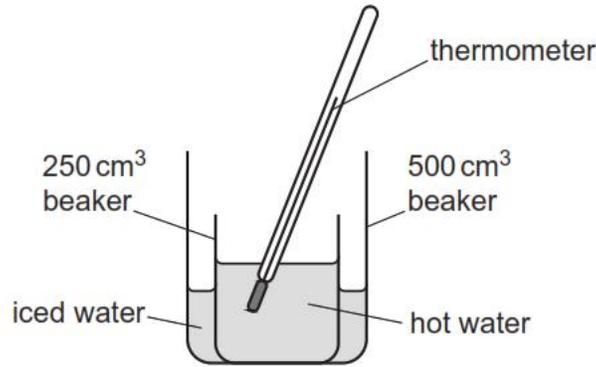

Fig. 1.2

The student reads the temperature θ of the hot water, records the reading and immediately starts the stop-watch. Table 1.2. shows the temperature θ at times $t = 0$ s, 30 s, 60 s, and 90 s.

Table 1.2

$t/$s	$\theta/°C$
0	75
30	68
60	62
90	57

(i) Calculate the average cooling rate of the hot water for the 90s. Use the readings in Table 1.2 and the equation:

$$C_3 = \frac{\theta_0 - \theta_{90}}{t}$$

$C_3 =$ .... unit .... [1]

(ii) Describe how C_3 differs from C_1. Explain your answer.

....

....

.... [1]

(iii) The recorded readings show that this experiment is **not** a valid comparison of C_1 and C_3.

By referring to the results recorded in Table 1.1 and Table 1.2, explain why this is not a valid comparison.

....

.... [1]

(iv) State **one** other variable that should be kept constant to make a valid comparison.

....

.... [1]

Marking Scheme

INFORMATION:

- This paper has a total of 65 marks.
- In objective section there are 30 questions, each carries one mark. There is no negative marking for incorrect responses.
- In subjective section, 25 marks are for extended theory and 10 marks for practical component.

A: **(30**

Question Number	Answer Key
1	C
2	B
3	D
4	A
5	C
6	B
7	C
8	A
9	B
10	C
11	B
12	C
13	A
14	B
15	B

Question Number	Answer Key
16	C
17	A
18	B
19	B
20	A
21	B
22	C
23	C
24	C
25	B
26	C
27	C
28	B
29	A
30	C

1 (a)	distance moved by wavefront/energy during one cycle/oscillation/period (of source) **or** minimum distance between two wavefronts **or** distance between two adjacent wavefronts	1
1 (b)	$v = \lambda / T$ **or** $v = f\lambda$ **and** $f = 1 / T$	1
	$f = 1 / T$	1
	$T = 460 \times 10^{-9} / 3.00 \times 10^{8}$	1
	$= 1.5 \times 10^{-15}$ s	1
1 (c)	waves pass through/enter the slit(s)	1
	waves spread (into geometric shadow)	1
1 (d) (i)	$n\lambda = d \sin \theta$	1
	$G = \sin \theta / \lambda$ $d = 4 / G$	1
1 (d) (ii)	straight line from 400 nm to 700 nm that is always below printed line	1
	straight line has smaller gradient than printed line and is 5 small squares high at wavelength of 700 nm	1
2 (a) (i)	$pV = NkT$ or $pV = nRT$ <u>and</u> $N = nN_A$ $N = \dfrac{2.3 \times 10^5 \times 3.5 \times 10^{-3}}{1.38 \times 10^{-23} \times 294}$	1
	$= 2.0 \times 10^{23}$	1
2 (a) (ii)	$pV = \dfrac{1}{3}Nmc^2$ $c^2 = \dfrac{3 \times 2.3 \times 10^5 \times 3.5 \times 10^{-3}}{2.0 \times 10^{23} \times 40 \times 1.66 \times 10^{-27}}$ $= 182\,000$ r.m.s. speed $= 430$ m s^{-1} or	1
	$\frac{1}{2}mc^2 = \frac{3}{2}kT$	1
	$c^2 = \dfrac{3 \times 1.38 \times 10^{-23} \times 294}{40 \times 1.66 \times 10^{-27}}$ $= 183\,000$ r.m.s.speed $= 430$ m s^{-1}	(1) (1)
2 (b)	$c^2 = \dfrac{3 \times 2.0 \times 10^{23} \times 1.38 \times 10^{-23} \times (294 + 84)}{2.0 \times 10^{23} \times 40 \times 1.66 \times 10^{-27}}$ $c^2 = 236\,000$ $c = 485$	1
	$ratio \left(= \dfrac{485}{430} \right) = 1.1$	1

	OR $v \propto \sqrt{T}$ or $v^2 \propto T$	(1)
	$ratio = \sqrt{\dfrac{273+21+84}{273+21}}$ or $\sqrt{\dfrac{378}{294}}$ ratio = **1.1**	(1)

3 (a)	Any 2 from:
	
	   particles / atoms / molecules / ions (very) close together / touching
	   regular, repeating pattern
	   vibrate about a fixed point
		2

3 (b)	(much) greater increase in spacing of molecules (for vaporisation compared with fusion)	1
3 (c) (i)	−100 °C	1
3 (c) (ii)	time = 8.5 – 3.0 = 5.5 min	1
	$Pt = mL$ energy = power × time = $150 \times 5.5 \times 60$ = 49 500 J $L = \dfrac{E}{m}$ $= \dfrac{49500}{0.045}$	1
	$= 1100\,kJ\,kg^{-1}$	1
3 (c) (iii)	gas has a higher specific heat capacity (than liquid)	1

Practical Component (10 marks)

1 (a) (i)	θ = 72(°C) in the table ;	1
1 (a)(ii)	to ensure an even temperature throughout the water owtte / heat is evenly spread / make sure temp is the same through the water/beaker/ water has equal temperature ;	1
1 (a)(iii)	correct calculation from candidate readings (0.067) ;	1
	C/s ;	1
1 (a) (iv)	0.03(333)	1
1 (a) (v)	C_1 greater than C_2 because less drop in temperature as the temperature approaches room temperature owtte	1
1 (b) (i)	0.20 (C/s) ;	1
1 (b) (ii)	C_3 greater than C_1 stated because more energy is lost to the colder surroundings/ iced water provides increased cooling effect/ lower temp of surroundings / heat transferred to iced water ;	1
1 (b) (iii)	different initial temperatures ;	1

1 (b) (iv)	Any one from:
	   volume of (hot) water
	   position of thermometer in the water
	   room temperature
		1

Question-wise Breakdown

Section	Question	Related Chapter	AO
MCQS	1	10	3
	2	7	3
	3	12	2
	4	12	3
	5	12	3
	6	10	1
	7	12	1
	8	10	1
	9	10	1
	10	10	2
	11	10	1
	12	10	2
	13	7	2
	14	12	2
	15	12	3
	16	7	1
	17	7	2
	18	7	2
	19	7	2
	20	7	3
	21	13	1
	22	13	1
	23	13	2
	24	13	3
	25	13	3
	26	12	2
	27	12	2
	28	12	1
	29	12	2
	30	12	3
Theory	1	10	1,2,3
	2	7	1,2,3
	3	13	1,2,3
ATP	1	13	1,2,3

Chapter-wise Breakdown

No.	Chapter Title	MCQs (1 mark)	AO	Theory	AO	ATP	AO
7	Kinetic Theory of Gases and the Ideal Gas Equation	7	AO1 (1) AO2(4) AO3 (2)	6	AO1 (2) AO2(2) AO3 (2)		
10	Waves, polarisation and Doppler effect	8	AO1 (4) AO2(2) AO3 (2)	11	AO1 (3) AO2(4) AO3 (4)		-
12	Energy and work	9	AO1 (2) AO2(5) AO3 (2)	0			
13	Thermodynamics and specific heat capacity/latent heat	6	AO1 (2) AO2(2) AO3 (2)	8	AO1 (5) AO2(0) AO3 (3)	10	AO1 (2) AO2(4) AO3 (4)
							-

Marks for AO1		Percentage
MCQ	9	
Theory	8	30%
TOTAL	17	

Marks for AO2		Percentage
MCQ	13	
Theory	10	40%
TOTAL	23	

Marks for AO3		Percentage
MCQ	8	
Theory	7	30%
TOTAL	15	