Oxford Resources for IB

Physics – 2023 Edition

Answers

Theme B – The particulate nature of matter

B.1 – Thermal energy transfers

Practice questions – Page 202

1 **a.** Resistivity of a metal

b. Measure your property from (a) at 0 °C in ice-water mixture, measure the property at 100 °C in boiling water. Plot both data points on graph of property versus temperature. Draw a straight line between them. Measure property at intermediate unknown temperature and read off temperature from graph.

Practice questions – Page 204

2 A

3 B

Practice questions – Page 209

4 **a.** The molecules of each liquid initially have a different average kinetic energy. During intermolecular collisions, energy is transferred from fast moving molecules of one liquid to slow moving molecules of the other liquid. As a result, the molecular energy is averaged, and the mixture approaches an equilibrium temperature.

b. B

5 D

6 460 $J\,kg^{-1}\,K^{-1}$

7 380 $J\,kg^{-1}\,K^{-1}$

8 **a.** 85.0 °C

b. $\frac{1}{66} \approx 0.015$

9 **a.** 130 s

b. 310 W

10 1200 W

Practice questions – Page 213

11 The specific heat capacity of water is large. So, in winter, the rate of cooling of the water is slow, as larger amounts of energy must be transferred from the water compared to the land. The specific heat capacity of the air (which largely carries the energy away) is constant so the lakes cool slower.

12 **a.** 17 kJ

b. 200 g

c. A mixture of water and ice at 0 °C

13 **a.** 0.13 kg

b. 0.11 kg

14 9.7 s

15 **a.** 76 g

b. 66 kJ kg^{-1}

c. Increases at a lower rate than for $t < 10$ s

Practice questions – Page 219

16 **a.** 3.1 kW m^{-2}

b. 58 W m^{-2}

17 **a.** 38 W

b. 6.8 g

Practice questions – Page 220–221

18 **a.** 130 W

b. 382 W m^{-1} K^{-1}

19 **a.** around 0.044−0.045 K s^{-1}

b. 9.2−9.4 W

c. 0.11 W m^{-1} K^{-1}

Practice questions – Page 229

20 T_{min} = 4100 K, T_{max} = 7300 K

21 **a.** 2000 K

b. 1400 nm

22 **a.** 180 °C

b. 11 W

Practice questions – Page 231

23 8.6×10^{-8} W m^{-2}

24 5.5×10^{17} m

25 **a.** $4P$

b. $\sqrt[4]{0.25} \times T \simeq 0.71T$

B.2 – Greenhouse effect

Practice questions – Page 235

1 350 K

2 0.84

3 **a.** 31 W, absorbed by the cube

b. $2.9 \times 10^{-3}\,\text{K s}^{-1}$

c. There are additional ways of transferring energy between the cube and the environment e.g. thermal conduction.

Practice questions – Page 236

4 $\left(\frac{1.0167}{0.9833}\right)^2 = 1.069$

The intensity received in January is greater by 6.9% than in July.

5 2.2 kW

Practice questions – Page 240

6 $300\,\text{W m}^{-2}$

7 0.25

8 24

Practice questions – Page 243

9 The radiation emitted from the Earth's surface is mostly in the infrared range, and hence can be absorbed by the molecules of greenhouse gases in the atmosphere. The gases re-emit this radiation in all directions, partly back towards the surface.

10 The symmetric mode does not cause the positive and negative charges to be displaced relative to each other within a molecule. Hence, the molecule oscillating in this mode is unlikely to interact with the electric field of the wave. The opposite is true for the anti-symmetric mode.

Practice questions – Page 251

11 **a.** Increase by 1.2 K

b. Water has a lower albedo and absorbs more energy than sea ice, leading to a further increase in the temperature. This is known as positive feedback loop. Clouds have a greater albedo than the surface and so reduce the average intensity reaching the surface, countering the effect of warming. This is an example of negative feedback.

12 **a.** $390\,\text{W m}^{-2}$

b. E.g. evaporation of surface water, thermal conduction to the air above the surface.

c. $104\,\text{W m}^{-2}$

B.3 – Gas laws

Practice questions – Page 254

1 1.7 MPa

2 **a.** 50 kPa

b. 0.10 mm

Practice questions – Page 256

3 Gold: 3.67×10^{22}

Copper: 3.79×10^{22}

About 3% more of copper atoms than gold.

4 1.6×10^{15} molecules

5 0.02 µg

Practice questions – Page 261

6 C

7 D

8 **a.** 1.2×10^{5} Pa

b. 0.17 g

9 **a.** 8.2×10^{-2} mol

b. 9.4×10^{4} Pa

c. 49 N

10 **a.** 3×10^{-7} mol

b. 25 million particles

Practice questions – Page 267

11 These estimates assume a room of dimensions 4.5 m × 3 m × 3 m.

a. 40 m^3

b. 10^{27}

c. 0.1 m^3

12 **a.** 1.5×10^{-21} J

b. 20%

13 In an inelastic collision, energy is removed from the moving particles and transferred away to the environment. The effective temperature of the particles would decrease as they lose kinetic energy and slow down. The assumption of elasticity is very good.

Practice questions – Page 268

14 1300 m s^{-1}

15 483 m s^{-1}

16 2300 m s^{-1}

17 **a.** 0.44 kg m^{-3}

b. 410 m s^{-1}

c. 44 g mol^{-1}

Practice questions – Page 269

18 **a.** 0.047 mol

b. **i.** 1.9×10^{-3} kg

ii. 310 J kg^{-1} K^{-1}

19 **a.** 3.76×10^{23}

b. 10.3 K

B.4 – Thermodynamics

Practice questions – Page 276

1 D

2 **a.** 0

b. 53 K

3 26 J

4 **a.** **i.** 5.0 J

ii. −2.0 J, energy removed from the gas

b. 5.0 J

Practice questions – Page 279

5 **a.** 7.2×10^{-3} mol

b. **i.** 2.0×10^{-4} m^3

ii. 400 K

iii. 15 J

6 **a.** −40 J

b. 330 K

c. −60 J

Practice questions – Page 282–283

7 **a.**

	***Q* / J**	**Δ*U* / J**	***W* / J**
AB	**0**	**970**	−970
BC	**−1570**	−1570	**0**
CA	1000	**600**	**400**

b. 570 J

8 **a.** 4.55×10^5 Pa

b. 200 K

9 **a.** 3.10×10^{-4} m^3

b. The change in temperature is proportional to the change in the internal energy. The internal energy increases because the work is done on the gas and no energy is transferred.

c. 174 J (work done by the gas)

d. 75 J

e. 435 J

Practice questions – Page 285

10 **a.** 8.2 kJ

b. 0.71

c. 1000 °C (1270 K)

11 **a.** **i.** AB

ii. CD

b. **i.** 2.40 kJ

ii. 1.44 kJ

12 By reducing T_c to about 30 °C

Practice questions – Page 289–290

13 **a.** **i.** 2.7×10^5 Pa

ii. 832 K

iii. 175 J

b. **i.** 56.0 J

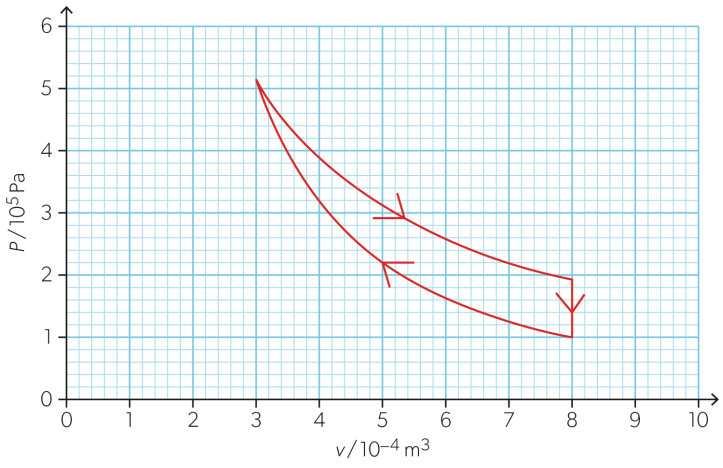
ii. 0.320

14 **a.** **i.** 5.1×10^5 Pa

ii. 615 K

b. 1.9×10^5 Pa

c.



d. 0.27

B.5 – Current and circuits

Practice questions – Page 301

1 **a.** 16 C

b. 1.0×10^{20}

2 75 minutes

Practice questions – Page 304

3 5.1×10^{8} J

4 **a.** 1.1×10^{4} C

b. 2.0 hours

Practice questions – Page 306

5 C

6 **a.** 2.1 kW

b. 9.1 A

7 **a.** 36 A

b. 500 km

c. 5.75 kW

d. 18 hours

Practice questions – Page 309

8 **a.** 6.6 A

b. 1.5 kW

9 **a.** 0.67 A

b. 6.8 Ω

c. 13 C

Practice questions – Page 314

10 D

11 **a.** 880 Ω

b. **i.** 0.26 A

ii. 60 W

12 **a.** 0.17 Ω

b. 2.6×10^{-8} Ω m

13 1.6 mm

14 1.8×10^{-6} Ω m

Practice questions – Page 319

15 **a.** 220 Ω

b. 150 Ω

16 **a.** current = 30 mA, p.d. = 3.0 V

b. current = 22 mA, p.d. = 2.2 V

17 **a.** **i.** 0.40 A

ii. 3.0 Ω

iii. 4.0 A

b. The current in each of the nine remaining lamps is unchanged, the current in the ammeter is the sum of the individual currents in all lamps so it decreases by 10%.

18 **a.** **i.** 2.0 V

ii. 1.0 V

b. 50 Ω

Practice questions – Page 323

19 **a.** 4.13 μA

b. 41.3 mV

c. **i.** 80.6 Ω **ii.** 0.496 mA

20 A

21 From 0.30 A to zero

Practice questions – Page 324

22 8.9 V

23 **a.** 65 Ω

b. 230 V

c. 1.2 mm

24 270 W

25 C

26 D

Practice questions – Page 327

27 **a.** 2.0 Ω

b. 4.5 V

28 B

29 **a.** 9.0 V

b. 1.2 Ω

c. 17 Ω

End-of-theme questions – Pages 330–331

1 **a.** $I = \frac{\sigma A T^4}{4\pi d^2} = \frac{5.67 \times 10^{-8} \times \left(7.0 \times 10^8\right)^2 \times 5800^4}{\left(1.5 \times 10^{11}\right)^2} = 1397 \text{ W m}^{-2}$

b. Transmitted intensity = 0.7 × 1400 = 980 W m^{-2}. The exposed surface is ¼ of the total surface so the average intensity is

$$\frac{980}{4} = 245 \text{ W m}^{-2}$$

c. 256 K

2 **a.** Intensity = 5.67 × 10^{-8} × 289^4 = 396 W m^{-2}

b. The oceans emit short-wave infrared radiation that is absorbed by greenhouse gases in the atmosphere and re-emitted in all directions, partly back towards oceans.

c. **i.** 104 W m^{-2}

ii. E.g. evaporation, thermal conduction to the air above the ocean.

3 **a.** **i.** 2.3 × 10^6 J kg^{-1}

ii. All of the added energy is used to increase the intermolecular potential energy of the molecules; the temperature is related to the average kinetic energy so remains constant.

b. 86 °C

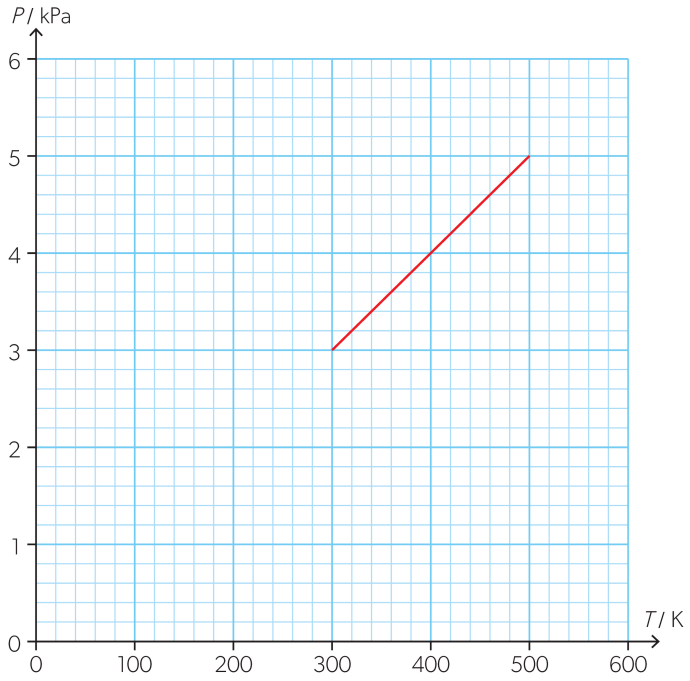
c. **i.** $R = \frac{V^2}{P} = \frac{220^2}{1600} = 30.25\ \Omega$

ii. 3200 W

4 **a.** The total random kinetic energy of the particles of the gas.

b. **i.** 3.0 × 10^3 Pa

ii.



c. The average kinetic energy depends on the temperature only and must be the same for both gases since their temperature is the same.

5 **a.** **i.** $\frac{250 \times 10^3}{1.5^{\frac{5}{3}}} = 127$ kPa

ii. 1.31

b. **i.** 940 J

ii. Thermal energy is removed from the gas hence *S* decreases.

iii. The total entropy of the system and the surroundings is the same or increased, and the 2nd law is not violated.

6 **a.** When there is a current in the cell, the potential drops across the internal resistance.

b. 7.2 Ω

c. 0.12

7 **a.** 5.4×10^{-3} m

b. 38 lamps

c. E.g. the brightness of each lamp stays the same when adding more lamps in parallel; the p.d. across each lamp is the operating value in the parallel arrangement but not in series.

8 **a.** Current is not directly proportional to the potential difference, so the resistance of X is not constant.

b. 85 Ω

c. 0.080 W